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LINUX

INTRODUCTION

AUGUST 2025

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Linux History

↘ Linux is an open source computer operating system, initially developed on and for Intel x86-based personal computers. It has been subsequently ported to an astoundingly long list of other hardware platforms, from tiny embedded appliances to the world's largest supercomputers.

↘ In this section, we follow the surprising history of how Linux evolved from a project of one Finnish college student, into a massive effort with an enormous impact on today's world.

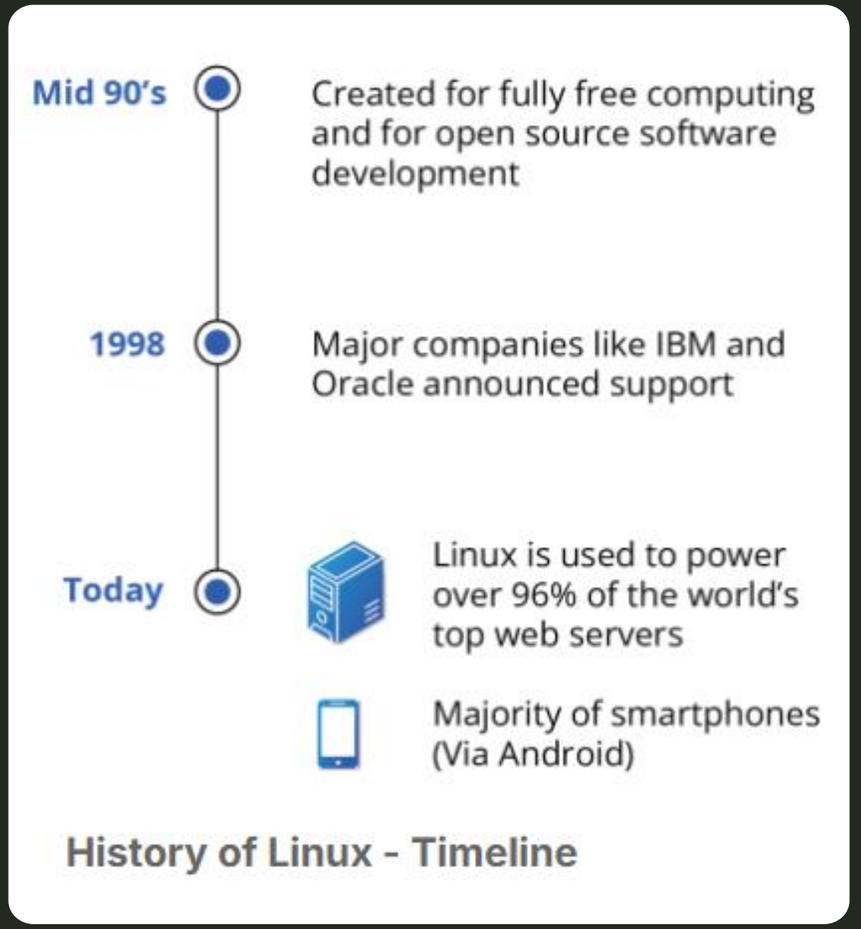
↘ Linus Torvalds was a student in Helsinki, Finland, in 1991, when he started a project: writing his own operating system kernel. He also collected together and/or developed the other essential ingredients required to construct an entire operating system with his kernel at the center. It wasn't long before this became known as the Linux kernel.

↘ In 1992, Linux was re-licensed using the General Public License (GPL) by GNU (a project of the Free Software Foundation or FSF, which promotes freely available software), which enabled it to build a worldwide community of developers. By combining the kernel with other system components from the GNU project, numerous other developers created complete systems called Linux Distributions, which first appeared in the mid-90s.

↘ The Linux distributions created in the mid-90s provided the basis for fully free (in the sense of freedom, not zero cost) computing and became a driving force in the open source software movement. In 1998, major companies like IBM and Oracle announced their support for the Linux platform and began major development efforts as well.

↘

Today, Linux powers more than half of the servers on the Internet, the majority of smartphones (via the Android system, which is built on top of Linux), more than 90 percent of the public cloud workload, and all of the world's most powerful supercomputers.



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Linux Philosophy

↘ Linux borrows heavily from the well-established family of UNIX operating systems. It was written to be a free and open source alternative; at the time, UNIX was designed for computers much more powerful than PCs, and furthermore, it was quite expensive.
↘ Files are stored in a hierarchical filesystem, with the top node of the system being the root or simply "/". Whenever possible, Linux makes its components available via files or objects that look like files. Processes, devices, and network sockets are all represented by file-like objects and can often be worked with using the same utilities used for regular files. Linux is a fully multitasking (i.e., multiple threads of execution are performed simultaneously), multiuser operating system with built-in networking and service processes known as daemons in the UNIX world.

↘ There are many ways to engage with the Linux community, even if you are not a developer:
↘ Post queries on relevant discussion forums.
↘ Subscribe to discussion threads.
↘ Join local Linux groups that meet in your area.

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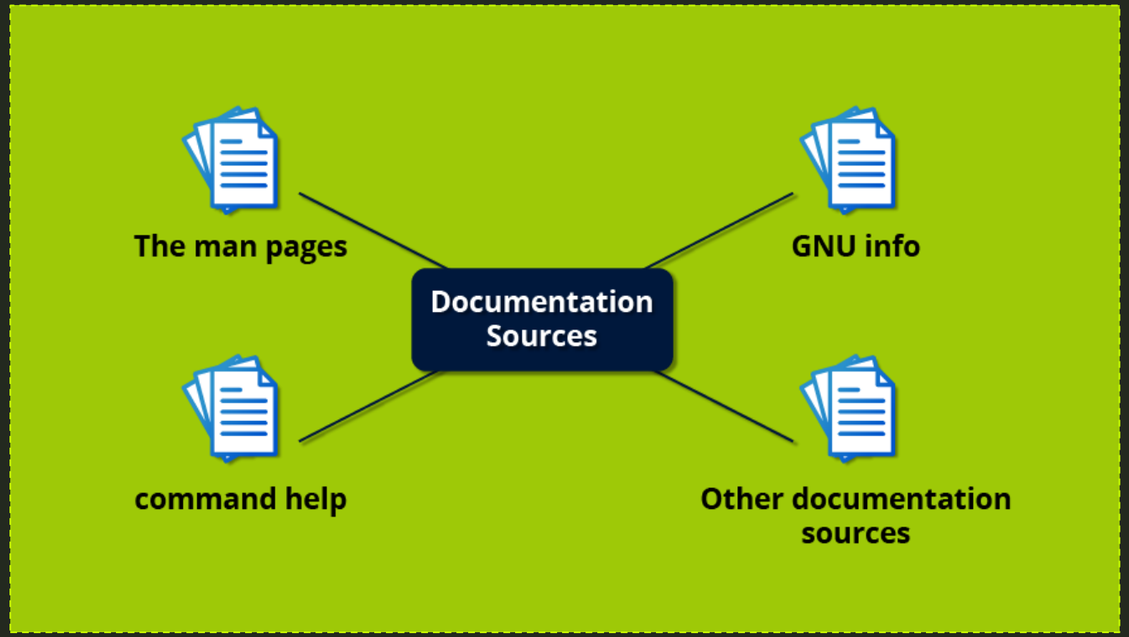
Documentation

Linux Documentation Sources

↘ Whether you are an inexperienced user or a veteran, you will not always know (or remember) the proper use of various programs and utilities: what command to use, what options should it take, what results to expect, etc. Thus, you will probably need to get help from consult help documentation regularly. Because Linux-based systems draw from a large variety of sources, there are numerous reservoirs of documentation and ways of getting help. Distributors consolidate this material and present it in a comprehensive and easy-to-use manner; this is an important function of any Linux distribution.



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The man Pages

↘ The man pages are the most often-used source of Linux documentation. They provide in-depth documentation about many programs and utilities, as well as other topics, including configuration files and programming APIs for system calls, library routines, and the kernel. They are present on all Linux distributions and are always at your fingertips.

↘ Typing man with a topic name as an argument retrieves the information stored in the topic's man pages.

↘ The man pages infrastructure was first introduced in the early UNIX versions, at the beginning of the 1970s. The name man is just an abbreviation for manual.

↘ man pages are often converted to other formats, such as PDF documents and web pages. To learn more, take a look at Linux man pages online. Many web pages have a graphical interface for help items, which may include man pages.

↘ Other sources of documentation include published books and many Internet sites.

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man

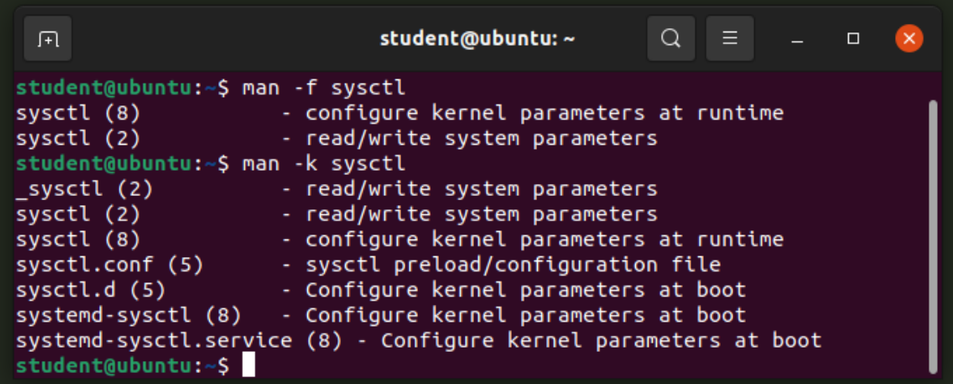
↘ The man program searches, formats, and displays the information contained in the man page system. Because many topics have copious amounts of relevant information, output is piped through a pager program (such as less) to be viewed one page at a time. At the same time, the information is formatted for a good visual display.

↘ A given topic may have multiple pages associated with it and there is a default order determining which one is displayed when no options or section number is specified. To list all pages on the topic, use the -f option. To list all pages that discuss a specific topic (even if the specified subject is not present in the name), use the –k option.

↘ man –f generates the same result as typing whatis.

↘ man –k generates the same result as typing apropos.

↘ The default order is specified in /etc/man_db.conf and is roughly (but not exactly) in ascending numerical order by section.



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Manual Chapters

↘ The man pages are divided into chapters numbered 1 through 9. In some cases, a letter is appended to the chapter number to identify a specific topic. For example, many pages describing part of the X Window API are in chapter 3X.

↘ The chapter number can be used to force man to display the page from a particular chapter. It is common to have multiple pages across multiple chapters with the same name, especially for names of library functions or system calls.

↘ With the -a parameter, man will display all pages with the given name in all chapters, one after the other, as in:
↘ $ man -a socket

↘ We will not cover everything in comprehensive detail; keep in mind most of the documentation in Linux is actually already on your system in the formof man pages, which we will discuss in great detail later. Whenever you do not understand something or want to know more about a command, program,topic, or utility, you can just type man <topic> at the command line. We will assume you are thinking this way and not constantly repeat, "For moreinformation, look at the man page for <topic>".

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Using info from the Command Line

↘ Typing **info** with no arguments in a terminal window displays an index of available topics. You can browse through the topic list using the regular movement keys: **arrows, Page Up, and Page Down.**

↘ You can view help for a particular topic by typing **info <topic name>**. The system then searches for the topic in all available **info** files.

↘ Some useful keys are: **q** to quit, **h** for help, and **Enter** to select a menu item.

↘ The topic which you view in an info page is called a **node**. The table lists the basic keystrokes for moving between nodes.

↘ Nodes are essentially sections and subsections in the documentation. You can move between nodes or view each node sequentially. Each node may contain menus and linked subtopics, or items.

↘ Items function like browser links and are identified by an asterisk (*) at the beginning of the item name. Named items (outside a menu) are identified with double-colons **(: :)** at the end of the item name. Items can refer to other nodes within the file or to other files.

KEY	FUNCTION
n	Go to the next node
p	Go to the previous node
u	Move one node up in the index

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The --help Option

↘ Another important source of Linux documentation is use of the **--help** option. Most commands have an available short description which can be viewed using the **--help** or the -h option along with the command or application. For example, to learn more about the **man** command, you can type:

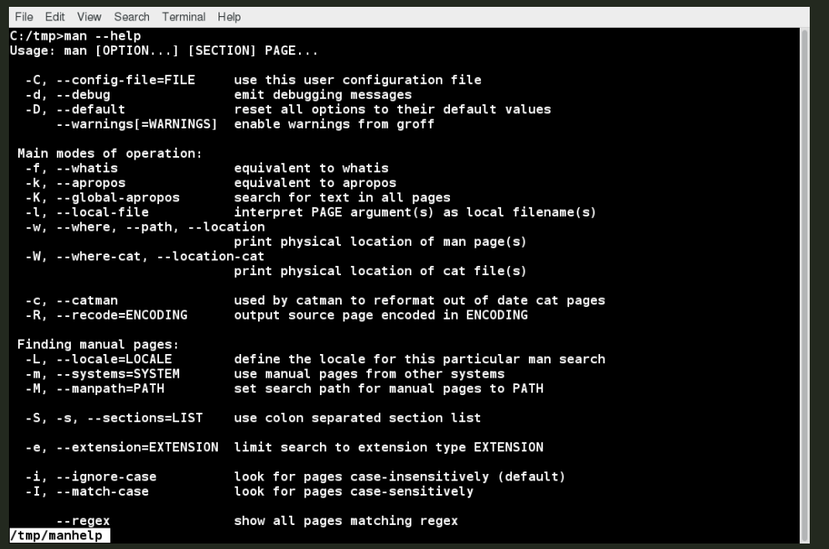
↘ $ man --help

↘ The **--help** option is useful as a quick reference and it displays information faster than the **man** or **info** pages.

↘ When run within a bash command shell, some popular commands (such as echo and cd) actually run especially built-in **bash** versions of the commands rather than the usual binaries found on the file system, say under **/bin** or **/usr/bin**. It is more efficient to do so as execution is faster because fewer resources are used (we will discuss command shells later). One should note that there can be some (usually small) differences in the two versions of the command.

↘ To view a synopsis of these built-in commands, you can simply type **help** as shown in the screenshot.

↘ For these built-in commands, **help** performs the same basic function as the -**h** and **--help** arguments perform for standalone programs.



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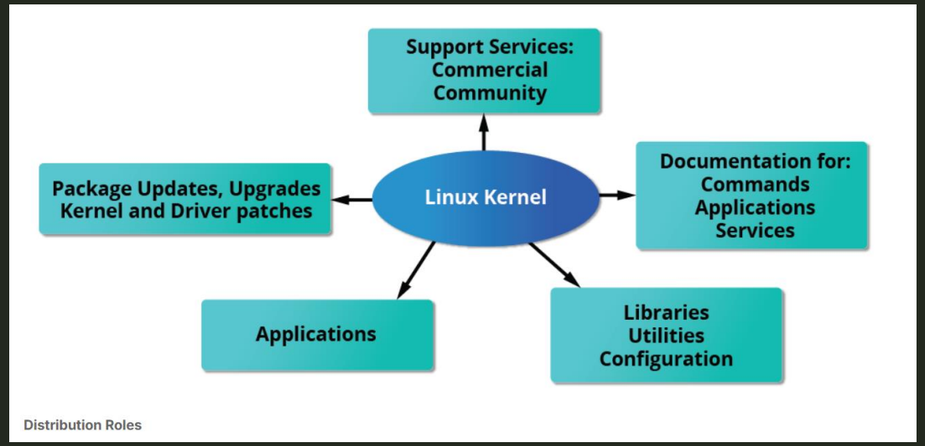
Linux Distributions

↘ The Linux kernel is the core of the operating system. A full Linux distribution consists of the kernel plus a number of other software tools for file-related operations, user management, and software package management. Each of these tools provides a part of the complete system. Each tool is often its own separate project, with its own developers working to perfect that piece of the system.

↘ Linux distributions may be based on different kernel versions. For example, the very popular RHEL 8 distribution is based on the 4.18 kernel, which is not new, but is extremely stable, while the newer RHEL 9 distribution is based on the much later 5.14 kernel.



Distribution Roles

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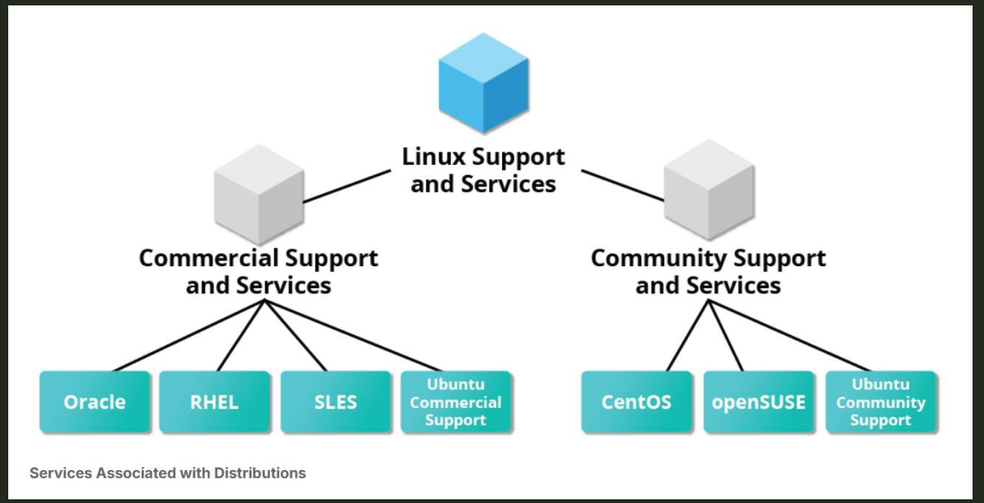
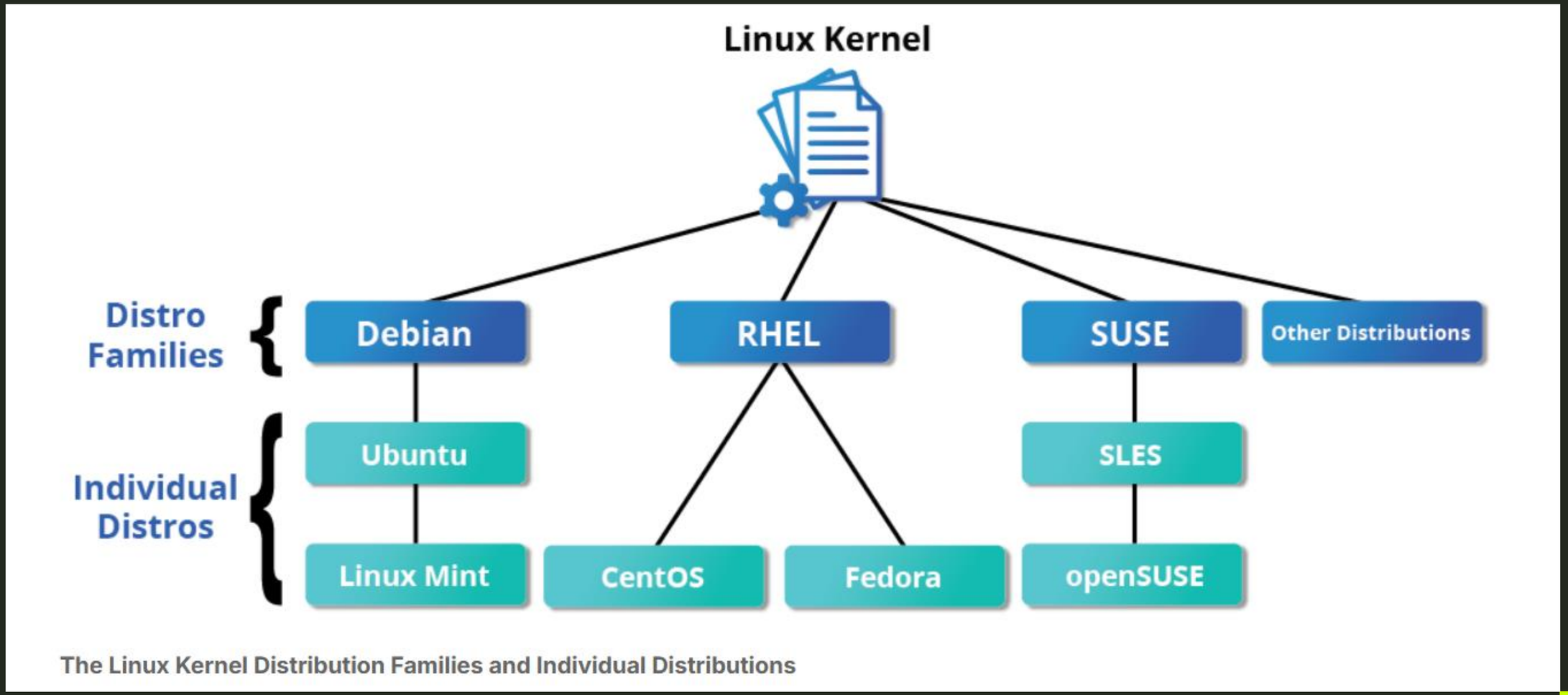
Linux Distributions

↘ The vast variety of Linux distributions are designed to cater to many different audiences and organizations according to their specific needs and tastes. However, large organizations, such as companies and governmental institutions, and other entities, tend to choose the major commercially-supported distributions from Red Hat, SUSE, and Canonical (Ubuntu).



Services Associated with Distributions



The Linux Kernel Distribution Families and Individual Distributions

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The Red Hat Family

↘ Red Hat Enterprise Linux (RHEL) heads the family that includes CentOS, CentOS Stream, Fedora and Oracle Linux.

↘ Fedora has a close relationship with RHEL and contains significantly more software than Red Hat's enterprise version. One reason for this is that a diverse community is involved in building Fedora, with many contributors who do not work for Red Hat. Furthermore, it is used as a testing platform for future RHEL releases.

↘ We will use CentOS Stream and CentOS more often for activities, demonstrations, and labs because there is no cost to the end user, and there is a longer release cycle than for Fedora (which releases a new version every six months or so).

↘ The basic version of CentOS is also virtually identical to RHEL, the most popular Linux distribution in enterprise environments. However, CentOS 8 has no scheduled updates after 2021. The replacement is CentOS 8 Stream. The difference between the two versions is CentOS Stream gets updates before RHEL, while CentOS gets them after. For most purposes this matters very little and not at all for this course. While there are alternatives to CentOS Stream that look more like the older CentOS, for this course we find CentOS 8 Stream works just fine.

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Key Facts About the Red Hat Family

↘ Some of the key facts about the Red Hat distribution family are:

↘ Fedora serves as an upstream testing platform for RHEL.

↘ CentOS is a close clone of RHEL; in fact, CentOS has been part of Red Hat since 2014.

↘ A heavily patched version 4.18 kernel is used in RHEL/CentOS 8 Stream, while version 5.14 is used in RHEL/CentOS 9 Stream.

↘ It supports multiple hardware platforms.

↘ It uses dnf, the RPM-based package manager (covered in detail later) to install, update, and remove packages in the system.

↘ RHEL is widely used by enterprises which host their own systems.

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The SUSE Family

↘ The relationship between SUSE (SUSE Linux Enterprise Server, or SLES) and openSUSE is similar to the one described between RHEL, CentOS, and Fedora.

↘ We use openSUSE as the reference distribution for the SUSE family, as it is available to end users at no cost. Because the two products are extremely similar, the material that covers openSUSE can typically be applied to SLES with few problems.

↘ Some of the key facts about the SUSE family are listed below:

↘ SUSE Linux Enterprise Server (SLES) is upstream for openSUSE.

↘ Kernel version 5.14 is used in openSUSE Leap 15.4.

↘ It uses the RPM-based zypper package manager (we cover it in detail later) to install, update, and remove packages in the system.

↘ It includes the YaST (Yet Another Setup Tool) application for system administration purposes.

↘ SLES is widely used in retail and many other sectors.

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The Debian Family

↘ The Debian distribution is upstream for several other distributions, including Ubuntu. In turn, Ubuntu is upstream for Linux Mint and a number of other distributions. It is commonly used on both servers and desktop computers. Debian is a pure open source community project (not owned by any corporation) and has a strong focus on stability.

↘ Debian provides by far the largest and most complete software repository to its users of any Linux distribution.
↘ Ubuntu aims at providing a good compromise between long term stability and ease of use. Since Ubuntu gets most of its packages from Debian's stable branch, it also has access to a very large software repository. For those reasons, we will use Ubuntu LTS (Long Term Support) as the reference to Debian family distributions for this course.
↘ Some key facts about the Debian family are listed below:
↘ The Debian family is upstream for Ubuntu, and Ubuntu is upstream for Linux Mint and others.
↘ Kernel version 5.19 is used in Ubuntu 22.04 LTS.
↘ It uses the DPKG-based APT package manager (using apt, apt-get, apt-cache, etc., which we cover in detail later) to install, update, and remove packages in the system.
↘ Ubuntu has been widely used for cloud deployments.
↘ While Ubuntu is built on top of Debian and is GNOME-based under the hood, it differs visually from the interface on standard Debian, as well as other distributions.

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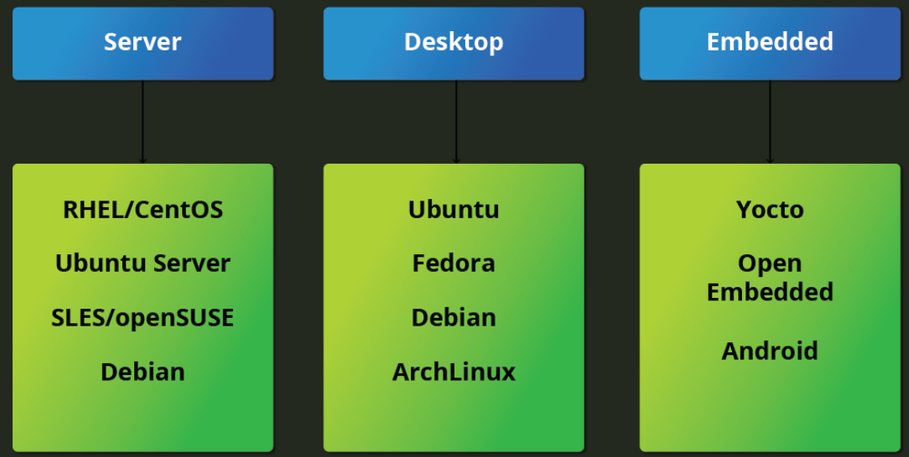
Choosing a Linux Distribution

↘ Some questions worth thinking about before deciding on a distribution include:
↘ What is the main function of the system (server or desktop)?
↘ What types of packages are important to the organization? For example, web server, word processing, etc.
↘ How much storage space is required, and how much is available? For example, when installing Linux on an embedded device, space is usually constrained.
↘ How often are packages updated?
↘ How long is the support cycle for each release? For example, LTS releases have long-term support.
↘ Do you need kernel customization from the vendor or a third party?
↘ What hardware are you running on? For example, it might be X86, RISC-V, ARM, PPC, etc.
↘ Do you need long-term stability? Or can you accept (or need) a more volatile cutting-edge system running the latest software versions?



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Summary

↘ Linux borrows heavily from the UNIX operating system, with which its creators were well-versed.

↘ Linux accesses many features and services through files and file-like objects.

↘ Linux is a fully multi-tasking, multi-user operating system, with built-in networking and service processes known as daemons.

↘ Linux is developed by a loose confederation of developers from all over the world, collaborating over the Internet, with Linus Torvalds at the head. Technical skill and a desire to contribute are the only qualifications for participating.

↘ The Linux community is a far reaching ecosystem of developers, vendors, and users that supports and advances the Linux operating system.

↘ Some of the common terms used in Linux are: kernel, distribution, boot loader, service, filesystem, X Window system, desktop environment, and command line.

↘ A full Linux distribution consists of the kernel plus a number of other software tools for file-related operations, user management, and software package management.

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Thank you!