From Wikipedia, the free encyclopedia

*This article is about the operating system. For the kernel, see*[*Linux kernel*](https://en.wikipedia.org/wiki/Linux_kernel)*. For other uses, see*[*Linux (disambiguation)*](https://en.wikipedia.org/wiki/Linux_(disambiguation))*.*

|  |  |
| --- | --- |
| **Linux** | |
| [Tux the penguin](https://en.wikipedia.org/wiki/File:Tux.svg)  [Tux](https://en.wikipedia.org/wiki/Tux) the [penguin](https://en.wikipedia.org/wiki/Penguin), mascot of Linux[[1]](https://en.wikipedia.org/wiki/Linux#cite_note-LinuxOnLine2008-1) | |
| [**Developer**](https://en.wikipedia.org/wiki/Software_developer) | Community |
| [**Written in**](https://en.wikipedia.org/wiki/Programming_language) | Primarily [C](https://en.wikipedia.org/wiki/C_(programming_language)) and [assembly](https://en.wikipedia.org/wiki/Assembly_language) |
| **OS family** | [Unix-like](https://en.wikipedia.org/wiki/Unix-like) |
| **Working state** | Current |
| **Source model** | Mainly [open-source](https://en.wikipedia.org/wiki/Open-source), [proprietary software](https://en.wikipedia.org/wiki/Proprietary_software) is also available. |
| **Initial release** | September 17, 1991; 26 years ago |
| **Marketing target** | [Personal computers](https://en.wikipedia.org/wiki/Personal_computer), [mobile devices](https://en.wikipedia.org/wiki/Mobile_device), [embedded devices](https://en.wikipedia.org/wiki/Embedded_device), [servers](https://en.wikipedia.org/wiki/Server_(computing)), [mainframes](https://en.wikipedia.org/wiki/Mainframe_computer), [supercomputers](https://en.wikipedia.org/wiki/Supercomputer) |
| [**Available in**](https://en.wikipedia.org/wiki/Natural_language) | Multilingual |
| **Platforms** | [Alpha](https://en.wikipedia.org/wiki/DEC_Alpha), [ARC](https://en.wikipedia.org/wiki/ARC_(processor)), [ARM](https://en.wikipedia.org/wiki/ARM_architecture), [Blackfin](https://en.wikipedia.org/wiki/Blackfin" \o "Blackfin), [C6x](https://en.wikipedia.org/wiki/C6x), [ETRAX CRIS](https://en.wikipedia.org/wiki/ETRAX_CRIS), [FR-V](https://en.wikipedia.org/wiki/FR-V), [H8/300](https://en.wikipedia.org/wiki/H8/300), [Hexagon](https://en.wikipedia.org/wiki/Qualcomm_Hexagon), [Itanium](https://en.wikipedia.org/wiki/Itanium), [M32R](https://en.wikipedia.org/wiki/M32R), [m68k](https://en.wikipedia.org/wiki/M68k), [META](https://en.wikipedia.org/wiki/Imagination_META), [Microblaze](https://en.wikipedia.org/wiki/Microblaze), [MIPS](https://en.wikipedia.org/wiki/MIPS_architecture), [MN103](https://en.wikipedia.org/wiki/MN103), [Nios II](https://en.wikipedia.org/wiki/Nios_II), [OpenRISC](https://en.wikipedia.org/wiki/OpenRISC), [PA-RISC](https://en.wikipedia.org/wiki/PA-RISC), [PowerPC](https://en.wikipedia.org/wiki/PowerPC), [RISC-V](https://en.wikipedia.org/wiki/RISC-V), [s390](https://en.wikipedia.org/wiki/S390), [S+core](https://en.wikipedia.org/wiki/S%2Bcore), [SuperH](https://en.wikipedia.org/wiki/SuperH), [SPARC](https://en.wikipedia.org/wiki/SPARC), [TILE64](https://en.wikipedia.org/wiki/TILE64), [Unicore32](https://en.wikipedia.org/wiki/Unicore32), [x86](https://en.wikipedia.org/wiki/X86), [Xtensa](https://en.wikipedia.org/wiki/Xtensa) |
| [**Kernel**](https://en.wikipedia.org/wiki/Kernel_(operating_system))**type** | [Monolithic](https://en.wikipedia.org/wiki/Monolithic_kernel) ([Linux kernel](https://en.wikipedia.org/wiki/Linux_kernel)) |
| [**Userland**](https://en.wikipedia.org/wiki/User_space#USERLAND) | [GNU](https://en.wikipedia.org/wiki/GNU) and various others[[a]](https://en.wikipedia.org/wiki/Linux#cite_note-7) |
| **Default**[**user interface**](https://en.wikipedia.org/wiki/User_interface) | Many |
| [**License**](https://en.wikipedia.org/wiki/Software_license) | [GPLv2](https://en.wikipedia.org/wiki/GPLv2)[[7]](https://en.wikipedia.org/wiki/Linux#cite_note-8) and other free and open-source licenses (the name "Linux" is a trademark[[b]](https://en.wikipedia.org/wiki/Linux#cite_note-10)) |

**Linux** ([/ˈlɪnəks/](https://en.wikipedia.org/wiki/Help:IPA/English) ([About this sound](https://en.wikipedia.org/wiki/File:Linus-linux.ogg) [listen](https://upload.wikimedia.org/wikipedia/commons/0/03/Linus-linux.ogg)) [*LIN-əks*](https://en.wikipedia.org/wiki/Help:Pronunciation_respelling_key))[[9]](https://en.wikipedia.org/wiki/Linux#cite_note-pronunciation-2-11)[[10]](https://en.wikipedia.org/wiki/Linux#cite_note-Foldoc09Jun06-12) is a family of [free and open-source software](https://en.wikipedia.org/wiki/Free_and_open-source_software) [operating systems](https://en.wikipedia.org/wiki/Operating_system) built around the [Linux kernel](https://en.wikipedia.org/wiki/Linux_kernel). Typically, Linux is [packaged](https://en.wikipedia.org/wiki/Package_management_system) in a form known as a [Linux distribution](https://en.wikipedia.org/wiki/Linux_distribution) (or *distro* for short) for both desktop and server use. The defining component of a Linux distribution is the [Linux kernel](https://en.wikipedia.org/wiki/Linux_kernel),[[11]](https://en.wikipedia.org/wiki/Linux#cite_note-13) an [operating system kernel](https://en.wikipedia.org/wiki/Kernel_(computing)) first released on September 17, 1991, by [Linus Torvalds](https://en.wikipedia.org/wiki/Linus_Torvalds).[[12]](https://en.wikipedia.org/wiki/Linux#cite_note-14)[[13]](https://en.wikipedia.org/wiki/Linux#cite_note-15)[[14]](https://en.wikipedia.org/wiki/Linux#cite_note-16)

Linux was originally developed for [personal computers](https://en.wikipedia.org/wiki/Personal_computer) based on the [Intel x86](https://en.wikipedia.org/wiki/Intel_x86) architecture, but has since been [ported](https://en.wikipedia.org/wiki/Porting) to more [platforms](https://en.wikipedia.org/wiki/Computer_hardware_platforms) than any other operating system.[[15]](https://en.wikipedia.org/wiki/Linux#cite_note-17)Because of the dominance of the Linux kernel-based [Android](https://en.wikipedia.org/wiki/Android_(operating_system)) OS on [smartphones](https://en.wikipedia.org/wiki/Smartphone), Linux has the [largest](https://en.wikipedia.org/wiki/Usage_share_of_operating_systems) [installed base](https://en.wikipedia.org/wiki/Installed_base) of all [general-purpose operating systems](https://en.wikipedia.org/wiki/General-purpose_operating_system).[[16]](https://en.wikipedia.org/wiki/Linux#cite_note-marketshare.hitslink.com-18) Linux is also the leading operating system on [servers](https://en.wikipedia.org/wiki/Server_(computing)) and other [big iron](https://en.wikipedia.org/wiki/Big_iron) systems such as [mainframe computers](https://en.wikipedia.org/wiki/Mainframe_computer), and the only OS used on [TOP500](https://en.wikipedia.org/wiki/TOP500) [supercomputers](https://en.wikipedia.org/wiki/Supercomputer) (since November 2017, having before gradually eliminated all competitors).[[17]](https://en.wikipedia.org/wiki/Linux#cite_note-19)[[18]](https://en.wikipedia.org/wiki/Linux#cite_note-rules_supercomputers-20) It is used by around 2.3% of [desktop computers](https://en.wikipedia.org/wiki/Desktop_computer).[[19]](https://en.wikipedia.org/wiki/Linux#cite_note-Netmarketshare.com-21)[[20]](https://en.wikipedia.org/wiki/Linux#cite_note-22) The [Chromebook](https://en.wikipedia.org/wiki/Chromebook), which runs the Linux kernel-based [Chrome OS](https://en.wikipedia.org/wiki/Chrome_OS), dominates the US [K–12](https://en.wikipedia.org/wiki/K%E2%80%9312) education market and represents nearly 20% of the sub-$300 [notebook](https://en.wikipedia.org/wiki/Laptop) sales in the US.[[21]](https://en.wikipedia.org/wiki/Linux#cite_note-23) Linux also runs on [embedded systems](https://en.wikipedia.org/wiki/Embedded_system)—devices whose [operating system](https://en.wikipedia.org/wiki/Operating_system) is typically built into the [firmware](https://en.wikipedia.org/wiki/Firmware) and is highly tailored to the system. This includes [TiVo](https://en.wikipedia.org/wiki/TiVo) and similar [DVR](https://en.wikipedia.org/wiki/Digital_video_recorder) devices, network [routers](https://en.wikipedia.org/wiki/Router_(computing)), facility automation controls, televisions,[[22]](https://en.wikipedia.org/wiki/Linux#cite_note-24)[[23]](https://en.wikipedia.org/wiki/Linux#cite_note-25) [video game consoles](https://en.wikipedia.org/wiki/Video_game_console) and [smartwatches](https://en.wikipedia.org/wiki/Smartwatch).[[24]](https://en.wikipedia.org/wiki/Linux#cite_note-LinuxDevices-26) Many smartphones and [tablet computers](https://en.wikipedia.org/wiki/Tablet_computer) run Android and other Linux derivatives.[[25]](https://en.wikipedia.org/wiki/Linux#cite_note-27)

The development of Linux is one of the most prominent examples of free and open-source [software](https://en.wikipedia.org/wiki/Software) collaboration. The underlying [source code](https://en.wikipedia.org/wiki/Source_code) may be used, modified and distributed—commercially or non-commercially—by anyone under the terms of its respective licenses, such as the [GNU General Public License](https://en.wikipedia.org/wiki/GNU_General_Public_License).

Some of the most popular and mainstream Linux distributions[[26]](https://en.wikipedia.org/wiki/Linux#cite_note-28)[[27]](https://en.wikipedia.org/wiki/Linux#cite_note-29)[[28]](https://en.wikipedia.org/wiki/Linux#cite_note-30) are [Arch Linux](https://en.wikipedia.org/wiki/Arch_Linux), [CentOS](https://en.wikipedia.org/wiki/CentOS), [Debian](https://en.wikipedia.org/wiki/Debian" \o "Debian), [Fedora](https://en.wikipedia.org/wiki/Fedora_(operating_system)), [Gentoo Linux](https://en.wikipedia.org/wiki/Gentoo_Linux), [Linux Mint](https://en.wikipedia.org/wiki/Linux_Mint), [Mageia](https://en.wikipedia.org/wiki/Mageia" \o "Mageia), [openSUSE](https://en.wikipedia.org/wiki/OpenSUSE" \o "OpenSUSE) and [Ubuntu](https://en.wikipedia.org/wiki/Ubuntu_(operating_system)), together with commercial distributions such as [Red Hat Enterprise Linux](https://en.wikipedia.org/wiki/Red_Hat_Enterprise_Linux) and [SUSE Linux Enterprise Server](https://en.wikipedia.org/wiki/SUSE_Linux_Enterprise_Server). Distributions include the Linux kernel, supporting [utilities](https://en.wikipedia.org/wiki/System_software) and [libraries](https://en.wikipedia.org/wiki/Library_(computer_science)), many of which are provided by the [GNU Project](https://en.wikipedia.org/wiki/GNU_Project), and usually a large amount of application software to fulfil the distribution's intended use. Desktop Linux distributions include a windowing system, such as [X11](https://en.wikipedia.org/wiki/X11), [Mir](https://en.wikipedia.org/wiki/Mir_(software)) or a [Wayland](https://en.wikipedia.org/wiki/Wayland_(display_server_protocol)) implementation, and an accompanying [desktop environment](https://en.wikipedia.org/wiki/Desktop_environment) such as [GNOME](https://en.wikipedia.org/wiki/GNOME) or [KDE Plasma](https://en.wikipedia.org/wiki/KDE_Plasma); some distributions may also include a less resource-intensive desktop, such as [LXDE](https://en.wikipedia.org/wiki/LXDE) or [Xfce](https://en.wikipedia.org/wiki/Xfce" \o "Xfce). Distributions intended to run on servers may omit all graphical environments from the standard install, and instead include other software to set up and operate a [solution stack](https://en.wikipedia.org/wiki/Solution_stack) such as [LAMP](https://en.wikipedia.org/wiki/LAMP_(software_bundle)). Because Linux is freely redistributable, anyone may create a distribution for any intended use. Many Linux distributions use the word "Linux" in their name. The [Free Software Foundation](https://en.wikipedia.org/wiki/Free_Software_Foundation) uses the name "[GNU](https://en.wikipedia.org/wiki/GNU)/Linux" to refer to the operating system family, as well as specific distributions, to emphasize that most Linux distributions are not just the Linux kernel, and that they have in common not only the kernel, but also numerous utilities and libraries, a large proportion of which are from the GNU project. This has led to some [controversy](https://en.wikipedia.org/wiki/GNU/Linux_naming_controversy).[[29]](https://en.wikipedia.org/wiki/Linux#cite_note-gnu_linux_faq-31)[[30]](https://en.wikipedia.org/wiki/Linux#cite_note-linux-and-gnu-32)

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  [hide]

* [1History](https://en.wikipedia.org/wiki/Linux#History)
  + [1.1Precursors](https://en.wikipedia.org/wiki/Linux#Precursors)
  + [1.2Creation](https://en.wikipedia.org/wiki/Linux#Creation)
  + [1.3Naming](https://en.wikipedia.org/wiki/Linux#Naming)
  + [1.4Commercial and popular uptake](https://en.wikipedia.org/wiki/Linux#Commercial_and_popular_uptake)
  + [1.5Current development](https://en.wikipedia.org/wiki/Linux#Current_development)
* [2Design](https://en.wikipedia.org/wiki/Linux#Design)
  + [2.1User interface](https://en.wikipedia.org/wiki/Linux#User_interface)
  + [2.2Video input infrastructure](https://en.wikipedia.org/wiki/Linux#Video_input_infrastructure)
* [3Development](https://en.wikipedia.org/wiki/Linux#Development)
  + [3.1Community](https://en.wikipedia.org/wiki/Linux#Community)
  + [3.2Programming on Linux](https://en.wikipedia.org/wiki/Linux#Programming_on_Linux)
* [4Hardware support](https://en.wikipedia.org/wiki/Linux#Hardware_support)
* [5Uses](https://en.wikipedia.org/wiki/Linux#Uses)
  + [5.1Desktop](https://en.wikipedia.org/wiki/Linux#Desktop)
  + [5.2Netbooks](https://en.wikipedia.org/wiki/Linux#Netbooks)
  + [5.3Servers, mainframes and supercomputers](https://en.wikipedia.org/wiki/Linux#Servers,_mainframes_and_supercomputers)
  + [5.4Smart devices](https://en.wikipedia.org/wiki/Linux#Smart_devices)
  + [5.5Embedded devices](https://en.wikipedia.org/wiki/Linux#Embedded_devices)
  + [5.6Gaming](https://en.wikipedia.org/wiki/Linux#Gaming)
  + [5.7Specialized uses](https://en.wikipedia.org/wiki/Linux#Specialized_uses)
* [6Market share and uptake](https://en.wikipedia.org/wiki/Linux#Market_share_and_uptake)
* [7Copyright, trademark and naming](https://en.wikipedia.org/wiki/Linux#Copyright,_trademark_and_naming)
* [8See also](https://en.wikipedia.org/wiki/Linux#See_also)
* [9Notes](https://en.wikipedia.org/wiki/Linux#Notes)
* [10References](https://en.wikipedia.org/wiki/Linux#References)
* [11External links](https://en.wikipedia.org/wiki/Linux#External_links)

Design[[edit](https://en.wikipedia.org/w/index.php?title=Linux&action=edit&section=7)]

A Linux-based system is a modular [Unix-like](https://en.wikipedia.org/wiki/Unix-like) operating system, deriving much of its basic design from principles established in Unix during the 1970s and 1980s. Such a system uses a [monolithic kernel](https://en.wikipedia.org/wiki/Monolithic_kernel), the [Linux kernel](https://en.wikipedia.org/wiki/Linux_kernel), which handles process control, networking, access to the [peripherals](https://en.wikipedia.org/wiki/Peripheral), and [file systems](https://en.wikipedia.org/wiki/File_system). [Device drivers](https://en.wikipedia.org/wiki/Device_drivers) are either integrated directly with the kernel, or added as modules that are loaded while the system is running.[[59]](https://en.wikipedia.org/wiki/Linux#cite_note-61)

The GNU [userland](https://en.wikipedia.org/wiki/Userland_(computing)" \o "Userland (computing)) is a key part of most systems based on the Linux kernel, with Android being the notable exception. The Project's [implementation](https://en.wikipedia.org/wiki/GNU_C_Library) of the [C library](https://en.wikipedia.org/wiki/C_standard_library) functions as a wrapper for the system calls of the Linux kernel necessary to the kernel-userspace interface, the [toolchain](https://en.wikipedia.org/wiki/GNU_toolchain) is a broad collection of programming tools vital to Linux development (including the [compilers](https://en.wikipedia.org/wiki/GNU_Compiler_Collection) used to build the Linux kernel itself), and the [coreutils](https://en.wikipedia.org/wiki/GNU_Core_Utilities" \o "GNU Core Utilities) implement many basic [Unix tools](https://en.wikipedia.org/wiki/Unix_commands). The project also develops [a popular](https://en.wikipedia.org/wiki/Bash_(shell)) [CLI](https://en.wikipedia.org/wiki/Command-line_interface) [shell](https://en.wikipedia.org/wiki/Shell_(computing)). The [graphical user interface](https://en.wikipedia.org/wiki/Graphical_user_interface) (or GUI) used by most Linux systems is built on top of an implementation of the [X Window System](https://en.wikipedia.org/wiki/X_Window_System).[[60]](https://en.wikipedia.org/wiki/Linux#cite_note-oreilly-anatomy-62) More recently, the Linux community seeks to advance to [Wayland](https://en.wikipedia.org/wiki/Wayland_(display_server_protocol)" \o "Wayland (display server protocol))as the new display server protocol in place of [X11](https://en.wikipedia.org/wiki/X11). Many other open-source software projects contribute to Linux systems.

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| **Various layers within Linux, also showing separation between the [userland](https://en.wikipedia.org/wiki/User_space" \o "User space) and**[**kernel space**](https://en.wikipedia.org/wiki/Kernel_space) | | | | | | |
| **User mode** | **User applications** | For example, [bash](https://en.wikipedia.org/wiki/Bourne-again_shell), [LibreOffice](https://en.wikipedia.org/wiki/LibreOffice" \o "LibreOffice), [GIMP](https://en.wikipedia.org/wiki/GIMP), [Blender](https://en.wikipedia.org/wiki/Blender_(software)), [0 A.D.](https://en.wikipedia.org/wiki/0_A.D._(video_game)), [Mozilla Firefox](https://en.wikipedia.org/wiki/Mozilla_Firefox), etc. | | | | |
| Low-level system components: | **System**[**daemons**](https://en.wikipedia.org/wiki/Daemon_(computing)): [*systemd*](https://en.wikipedia.org/wiki/Systemd)*,*[*runit*](https://en.wikipedia.org/wiki/Runit)*, logind, networkd, [PulseAudio](https://en.wikipedia.org/wiki/PulseAudio" \o "PulseAudio), ...* | [**Windowing system**](https://en.wikipedia.org/wiki/Windowing_system): [*X11*](https://en.wikipedia.org/wiki/X11)*,*[*Wayland*](https://en.wikipedia.org/wiki/Wayland_(display_server_protocol))*, [SurfaceFlinger](https://en.wikipedia.org/wiki/SurfaceFlinger" \o "SurfaceFlinger) (Android)* | **Other libraries:** [*GTK+*](https://en.wikipedia.org/wiki/GTK%2B)*, [Qt](https://en.wikipedia.org/wiki/Qt_(software)" \o "Qt (software)),*[*EFL*](https://en.wikipedia.org/wiki/Enlightenment_Foundation_Libraries)*,*[*SDL*](https://en.wikipedia.org/wiki/Simple_DirectMedia_Layer)*,*[*SFML*](https://en.wikipedia.org/wiki/Simple_and_Fast_Multimedia_Library)*,*[*FLTK*](https://en.wikipedia.org/wiki/FLTK)*, [GNUstep](https://en.wikipedia.org/wiki/GNUstep" \o "GNUstep)*, etc. | | **Graphics**: [*Mesa*](https://en.wikipedia.org/wiki/Mesa_(computer_graphics)), [*AMD Catalyst*](https://en.wikipedia.org/wiki/AMD_Catalyst), ... |
| [**C standard library**](https://en.wikipedia.org/wiki/C_standard_library) | open(), exec(), sbrk(), socket(), fopen(), calloc(), ... (up to 2000 [subroutines](https://en.wikipedia.org/wiki/Subroutine)) [*glibc*](https://en.wikipedia.org/wiki/GNU_C_Library) aims to be [POSIX](https://en.wikipedia.org/wiki/POSIX)/[SUS](https://en.wikipedia.org/wiki/Single_UNIX_Specification)-compatible, *[uClibc](https://en.wikipedia.org/wiki/UClibc" \o "UClibc)* targets embedded systems, [*bionic*](https://en.wikipedia.org/wiki/Bionic_(software)) written for [Android](https://en.wikipedia.org/wiki/Android_(operating_system)), etc. | | | | |
| **Kernel mode** | [**Linux kernel**](https://en.wikipedia.org/wiki/Linux_kernel) | [stat](https://en.wikipedia.org/wiki/Stat_(system_call)), [splice](https://en.wikipedia.org/wiki/Splice_(system_call)), [dup](https://en.wikipedia.org/wiki/Dup_(system_call)), [read](https://en.wikipedia.org/wiki/Read_(system_call)), [open](https://en.wikipedia.org/wiki/Open_(system_call)), [ioctl](https://en.wikipedia.org/wiki/Ioctl" \o "Ioctl), [write](https://en.wikipedia.org/wiki/Write_(system_call)), [mmap](https://en.wikipedia.org/wiki/Mmap" \o "Mmap), [close](https://en.wikipedia.org/wiki/Close_(system_call)), [exit](https://en.wikipedia.org/wiki/Exit_(system_call)), etc. (about 380 system calls) The Linux kernel [System Call Interface](https://en.wikipedia.org/wiki/System_call) (SCI, aims to be [POSIX](https://en.wikipedia.org/wiki/POSIX)/[SUS](https://en.wikipedia.org/wiki/Single_UNIX_Specification)-compatible) | | | | |
| [Process scheduling](https://en.wikipedia.org/wiki/Scheduling_(computing)) subsystem | IPC subsystem | [Memory management](https://en.wikipedia.org/wiki/Memory_management) subsystem | Virtual files subsystem | Network subsystem |
| Other components: [ALSA](https://en.wikipedia.org/wiki/Advanced_Linux_Sound_Architecture), [DRI](https://en.wikipedia.org/wiki/Direct_Rendering_Infrastructure), [evdev](https://en.wikipedia.org/wiki/Evdev" \o "Evdev), [LVM](https://en.wikipedia.org/wiki/Logical_Volume_Manager_(Linux)), [device mapper](https://en.wikipedia.org/wiki/Device_mapper), [Linux Network Scheduler](https://en.wikipedia.org/wiki/Linux_Network_Scheduler), [Netfilter](https://en.wikipedia.org/wiki/Netfilter" \o "Netfilter) [Linux Security Modules](https://en.wikipedia.org/wiki/Linux_Security_Modules): *[SELinux](https://en.wikipedia.org/wiki/Security-Enhanced_Linux" \o "Security-Enhanced Linux)*, [*TOMOYO*](https://en.wikipedia.org/wiki/TOMOYO_Linux), *[AppArmor](https://en.wikipedia.org/wiki/AppArmor" \o "AppArmor)*, [*Smack*](https://en.wikipedia.org/wiki/Smack_(Linux_security_module)) | | | | |
| **Hardware (**[**CPU**](https://en.wikipedia.org/wiki/Central_processing_unit)**,**[**main memory**](https://en.wikipedia.org/wiki/Random-access_memory)**,**[**data storage devices**](https://en.wikipedia.org/wiki/Computer_data_storage)**, etc.)** | | | | | | |

Installed components of a Linux system include the following:[[60]](https://en.wikipedia.org/wiki/Linux#cite_note-oreilly-anatomy-62)[[61]](https://en.wikipedia.org/wiki/Linux#cite_note-63)

* A [bootloader](https://en.wikipedia.org/wiki/Bootloader), for example [GNU GRUB](https://en.wikipedia.org/wiki/GNU_GRUB), [LILO](https://en.wikipedia.org/wiki/LILO_(boot_loader)), [SYSLINUX](https://en.wikipedia.org/wiki/SYSLINUX), or [Gummiboot](https://en.wikipedia.org/wiki/Gummiboot_(software)" \o "Gummiboot (software)). This is a program that loads the Linux kernel into the computer's [main memory](https://en.wikipedia.org/wiki/Main_memory), by being executed by the computer when it is turned on and after the [firmware](https://en.wikipedia.org/wiki/Firmware) initialization is performed.
* An [init](https://en.wikipedia.org/wiki/Init" \o "Init) program, such as the traditional [sysvinit](https://en.wikipedia.org/wiki/Sysvinit" \o "Sysvinit) and the newer [systemd](https://en.wikipedia.org/wiki/Systemd" \o "Systemd), [OpenRC](https://en.wikipedia.org/wiki/OpenRC" \o "OpenRC) and [Upstart](https://en.wikipedia.org/wiki/Upstart_(software)). This is the first [process](https://en.wikipedia.org/wiki/Process_(computing)) launched by the Linux kernel, and is at the root of the process tree: in other terms, all processes are launched through init. It starts processes such as system services and login prompts (whether graphical or in terminal mode).
* [Software libraries](https://en.wikipedia.org/wiki/Library_(computing)), which contain code that can be used by running processes. On Linux systems using [ELF](https://en.wikipedia.org/wiki/Executable_and_Linkable_Format)-format executable files, the [dynamic linker](https://en.wikipedia.org/wiki/Dynamic_linker) that manages use of dynamic libraries is known as ld-linux.so. If the system is set up for the user to compile software themselves, [header files](https://en.wikipedia.org/wiki/Header_file) will also be included to describe the [interface](https://en.wikipedia.org/wiki/Application_binary_interface) of installed libraries. Besides the most commonly used software library on Linux systems, the [GNU C Library](https://en.wikipedia.org/wiki/GNU_C_Library) (glibc), there are numerous other libraries, such as [SDL](https://en.wikipedia.org/wiki/Simple_DirectMedia_Layer) and [Mesa](https://en.wikipedia.org/wiki/Mesa_(computer_graphics)).
  + [C standard library](https://en.wikipedia.org/wiki/C_standard_library) is the library needed to run [C programs](https://en.wikipedia.org/wiki/C_(programming_language)) on a computer system, with the GNU C Library being the standard. For embedded systems, alternatives such as the [EGLIBC](https://en.wikipedia.org/wiki/EGLIBC) (a glibc fork once used by Debian) and [uClibc](https://en.wikipedia.org/wiki/UClibc" \o "UClibc) (which was designed for [uClinux](https://en.wikipedia.org/wiki/UClinux" \o "UClinux)) have been developed, although both are no longer maintained. Android uses its own C library, [Bionic](https://en.wikipedia.org/wiki/Bionic_(software)).
* Basic Unix commands, with GNU coreutils being the standard implementation. Alternatives exist for embedded systems, such as the copyleft [BusyBox](https://en.wikipedia.org/wiki/BusyBox" \o "BusyBox), and the BSD-licensed [Toybox](https://en.wikipedia.org/wiki/Toybox" \o "Toybox).
* [Widget toolkits](https://en.wikipedia.org/wiki/Widget_toolkit) are the libraries used to build [graphical user interfaces](https://en.wikipedia.org/wiki/Graphical_user_interface) (GUIs) for software applications. Numerous widget toolkits are available, including [GTK+](https://en.wikipedia.org/wiki/GTK%2B) and [Clutter](https://en.wikipedia.org/wiki/Clutter_(software)) developed by the [GNOME project](https://en.wikipedia.org/wiki/GNOME_project), [Qt](https://en.wikipedia.org/wiki/Qt_(software)" \o "Qt (software))developed by the [Qt Project](https://en.wikipedia.org/wiki/Qt_Project" \o "Qt Project) and led by [Digia](https://en.wikipedia.org/wiki/Digia" \o "Digia), and [Enlightenment Foundation Libraries](https://en.wikipedia.org/wiki/Enlightenment_Foundation_Libraries) (EFL) developed primarily by the [Enlightenment](https://en.wikipedia.org/wiki/Enlightenment_(software)) team.
* A [package management system](https://en.wikipedia.org/wiki/Package_manager), such as [dpkg](https://en.wikipedia.org/wiki/Dpkg" \o "Dpkg) and [RPM](https://en.wikipedia.org/wiki/RPM_Package_Manager). Alternatively packages can be compiled from binary or source [tarballs](https://en.wikipedia.org/wiki/Tar_(computing)" \o "Tar (computing)).
* User interface programs such as command shells or windowing environments.

**User interface**[[edit](https://en.wikipedia.org/w/index.php?title=Linux&action=edit&section=8)]

The [user interface](https://en.wikipedia.org/wiki/User_interface), also known as the [shell](https://en.wikipedia.org/wiki/Shell_(computing)), is either a [command-line interface](https://en.wikipedia.org/wiki/Command-line_interface) (CLI), a [graphical user interface](https://en.wikipedia.org/wiki/Graphical_user_interface) (GUI), or through controls attached to the associated hardware, which is common for [embedded systems](https://en.wikipedia.org/wiki/Embedded_systems). For desktop systems, the default mode is usually a graphical user interface, although the CLI is commonly available through [terminal emulator](https://en.wikipedia.org/wiki/Terminal_emulator) windows or on a separate [virtual console](https://en.wikipedia.org/wiki/Virtual_console_(PC)).

CLI shells are text-based user interfaces, which use text for both input and output. The dominant shell used in Linux is the [Bourne-Again Shell](https://en.wikipedia.org/wiki/Bourne-Again_Shell) (bash), originally developed for the [GNU project](https://en.wikipedia.org/wiki/GNU_project). Most low-level Linux components, including various parts of the [userland](https://en.wikipedia.org/wiki/Userland_(computing)" \o "Userland (computing)), use the CLI exclusively. The CLI is particularly suited for automation of repetitive or delayed tasks, and provides very simple [inter-process communication](https://en.wikipedia.org/wiki/Inter-process_communication).

On desktop systems, the most popular user interfaces are the [GUI shells](https://en.wikipedia.org/wiki/GUI_shell), packaged together with extensive [desktop environments](https://en.wikipedia.org/wiki/Desktop_environment), such as the [K Desktop Environment (KDE)](https://en.wikipedia.org/wiki/KDE), [GNOME](https://en.wikipedia.org/wiki/GNOME_desktop), [MATE](https://en.wikipedia.org/wiki/MATE_(software)), [Cinnamon](https://en.wikipedia.org/wiki/Cinnamon_(desktop_environment)), [Unity](https://en.wikipedia.org/wiki/Unity_(desktop_environment)), [LXDE](https://en.wikipedia.org/wiki/LXDE), [Pantheon](https://en.wikipedia.org/wiki/Elementary_OS) and [Xfce](https://en.wikipedia.org/wiki/Xfce" \o "Xfce), though a variety of additional user interfaces exist. Most popular user interfaces are based on the [X Window System](https://en.wikipedia.org/wiki/X_Window_System), often simply called "X". It provides [network transparency](https://en.wikipedia.org/wiki/Network_transparency) and permits a graphical application running on one system to be displayed on another where a user may interact with the application; however, certain extensions of the X Window System are not capable of working over the network.[[62]](https://en.wikipedia.org/wiki/Linux#cite_note-64) Several X display servers exist, with the reference implementation, [X.Org Server](https://en.wikipedia.org/wiki/X.Org_Server), being the most popular.

Several types of [window managers](https://en.wikipedia.org/wiki/Window_manager) exist for X11, including [tiling](https://en.wikipedia.org/wiki/Tiling_window_manager), [dynamic](https://en.wikipedia.org/wiki/Dynamic_window_manager), [stacking](https://en.wikipedia.org/wiki/Stacking_window_manager) and [compositing](https://en.wikipedia.org/wiki/Compositing_window_manager). Window managers provide means to control the placement and appearance of individual application windows, and interact with the X Window System. Simpler [X window managers](https://en.wikipedia.org/wiki/X_window_manager) such as [dwm](https://en.wikipedia.org/wiki/Dwm" \o "Dwm) or [ratpoison](https://en.wikipedia.org/wiki/Ratpoison" \o "Ratpoison) provide a [minimalist](https://en.wikipedia.org/wiki/Minimalism_(computing)) functionality, while more elaborate window managers such as [FVWM](https://en.wikipedia.org/wiki/FVWM), [Enlightenment](https://en.wikipedia.org/wiki/Enlightenment_(software)) or [Window Maker](https://en.wikipedia.org/wiki/Window_Maker)provide more features such as a built-in [taskbar](https://en.wikipedia.org/wiki/Taskbar) and [themes](https://en.wikipedia.org/wiki/Theme_(computing)), but are still lightweight when compared to desktop environments. Desktop environments include window managers as part of their standard installations, such as [Mutter](https://en.wikipedia.org/wiki/Mutter_(window_manager)) (GNOME), [KWin](https://en.wikipedia.org/wiki/KWin" \o "KWin) (KDE) or [Xfwm](https://en.wikipedia.org/wiki/Xfwm" \o "Xfwm) (xfce), although users may choose to use a different window manager if preferred.

[Wayland](https://en.wikipedia.org/wiki/Wayland_(display_server_protocol)) is a display server protocol intended as a replacement for the X11 protocol; as of 2014, it has not received wider adoption. Unlike X11, Wayland does not need an external window manager and compositing manager. Therefore, a Wayland compositor takes the role of the display server, window manager and compositing manager. Weston is the reference implementation of Wayland, while GNOME's Mutter and KDE's KWin are being ported to Wayland as standalone display servers. Enlightenment has already been successfully ported since version 19.

**Video input infrastructure**[[edit](https://en.wikipedia.org/w/index.php?title=Linux&action=edit&section=9)]

*Main article:*[*Video4Linux*](https://en.wikipedia.org/wiki/Video4Linux)

Linux currently has two modern kernel-userspace APIs for handling video input devices: [V4L2](https://en.wikipedia.org/wiki/Video4Linux) API for video streams and radio, and [DVB](https://en.wikipedia.org/wiki/Digital_Video_Broadcasting) API for digital TV reception.[[63]](https://en.wikipedia.org/wiki/Linux#cite_note-65)

Due to the complexity and diversity of different devices, and due to the large amount of formats and standards handled by those APIs, this infrastructure needs to evolve to better fit other devices. Also, a good userspace device library is the key of the success for having userspace applications to be able to work with all formats supported by those devices.[[64]](https://en.wikipedia.org/wiki/Linux#cite_note-66)[[65]](https://en.wikipedia.org/wiki/Linux#cite_note-67)