Chrome OS

Chrome

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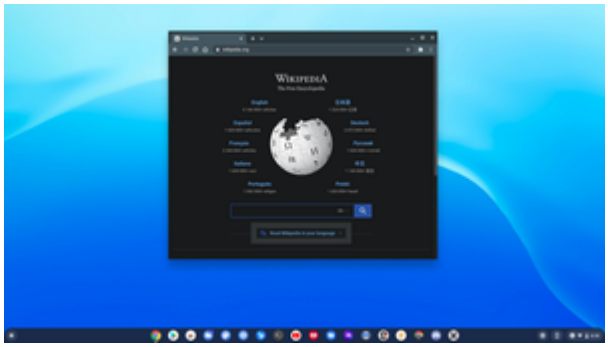
The Chrome OS logo as of July 2020



Chrome OS 87 Desktop

Developer	Google
Written in	C, C++, JavaScript, HTML5, Python, Rust
OS family	Linux[1]
Working state	Preinstalled on Chromebooks, Chromeboxes, Chromebits, Chromebases, Chromeblets
Initial release	June 15, 2011
Latest release	89.0.4389.82 (March 11, 2021[2]) [±]
Latest preview	**Beta** 90.0.4430.19 (March 11, 2021[3]) [±] **Dev** 90.0.4430.11 (March 5, 2021[3]) [±]
Update method	Rolling release
Package manager	Portage[a]
Platforms	ARM32, ARM64, x86, x86-64
Kernel type	Monolithic (Linux kernel)[5]
Userland	Aura Shell (Ash), Ozone (display manager); X11apps can be enabled in

	recent ChromeOS
Default user interface	Google Chrome
License	Proprietary[6]
Official website	www.google.com/chromebook/chrome-os

OS (sometimes styled as **chromeOS**) is a Gentoo Linux-based operating system designed by Google. It is derived from the free software Chromium OS and uses the Google Chrome web browser as its principal user interface. However, Chrome OS is proprietary software.

Google announced the project in July 2009, conceiving it as an operating system in which both applications and user data reside in the cloud: hence Chrome OS primarily runs web applications.[7] Source code and a public demo came that November. The first Chrome OS laptop, known as a Chromebook, arrived in May 2011. Initial Chromebook shipments from Samsung and Acer occurred in July 2011.

Chrome OS has an integrated media player and file manager. It supports Chrome Apps, which resemble native applications, as well as remote access to the desktop. Reception was initially skeptical, with some observers arguing that a browser running on any operating system was functionally equivalent. As more Chrome OS machines have entered the market, the operating system is now seldom evaluated apart from the hardware that runs it.

Android applications started to become available for the operating system in 2014, and in 2016, access to Android apps in Google Play's entirety was introduced on supported Chrome OS devices. Support for a Linux terminal and applications, known as Project Crostini,[8] was released to the stable channel in Chrome OS 69. This was made possible via a lightweight Linux kernel that runs containers inside a virtual machine.

Chrome OS is only available pre-installed on hardware from Google manufacturing partners, but there are unofficial methods that allow it to be installed in other equipment.[9] Its open-source upstream, Chromium OS, can be compiled from downloaded source code. Early on, Google provided design goals for Chrome OS, but has not otherwise released a technical description.

Contents

History

Google announced Chrome OS on July 7, 2009,[1] describing it as an operating system in which both applications and user data reside in the cloud. To ascertain marketing requirements, the company relied on informal metrics, including monitoring the usage patterns of some 200 Chrome OS machines used by Google employees. Developers also noted their own usage patterns. Matthew Papakipos, former[10] engineering director for the Chrome OS project, put three machines in his house and found himself logging in for brief sessions: to make a single search query or send a short email.[11]

Chrome OS was initially intended for secondary devices like netbooks, not as a user's primary PC.[12][13] While Chrome OS supports hard disk drives, Google has requested that its hardware partners use solid-state drives "for performance and reliability reasons"[14] as well as the lower capacity requirements inherent in an operating system that accesses applications and most user data on remote servers. In November 2009 Matthew Papakipos, engineering director for the Chrome OS, claimed that the Chrome OS consumes one-sixtieth as much drive space as Windows 7.[15] The recovery images Google provides for Chrome OS range between 1 and 3 GB.[16]

On November 19, 2009, Google released Chrome OS's source code as the Chromium OS project.[17] At a November 19, 2009, news conference, Sundar Pichai, at the time Google's vice president overseeing Chrome, demonstrated an early version of the operating system. He previewed a desktop which looked very similar to the Chrome browser, and in addition to the regular browser tabs, also had application tabs, which take less space and can be pinned for easier access. At the conference, the operating system booted up in seven seconds, a time

Google said it would work to reduce.[14][12][18][19] Additionally, Chris Kenyon, vice president of OEM services at Canonical Ltd, announced that Canonical was under contract to contribute engineering resources to the project with the intent to build on existing open-source components and tools where feasible.[20]

Early Chromebooks

In 2010, Google released the unbranded Cr-48 Chromebook in a pilot program.[21][22] The launch date for retail hardware featuring Chrome OS was delayed from late 2010[23] until the next year. On 11 May 2011, Google announced two Chromebooks from Acer and Samsung at Google I/O.[24][25] The Samsung model was released on 15 June 2011, but the Acer was delayed until mid-July.[26][27] In August 2011, Netflix announced official support for Chrome OS through its streaming service, allowing Chromebooks to watch streaming movies and TV shows via Netflix. At the time, other devices had to use Microsoft Silverlight to play videos from Netflix.[28] Later in that same month, Citrix released a client application for Chrome OS, allowing Chromebooks to access Windowsapplications and desktops remotely.[29] Dublin City University became the first educational institution in Europe to provide Chromebooks for its students when it announced an agreement with Google in September 2011.[30]

Expansion


Samsung Chromebook

By 2012, demand for Chromebooks had begun to grow, and Google announced a new range of devices, designed and manufactured by Samsung. In so doing, they also released the first Chromebox, the Samsung Series 3, which was Chrome OS's entrance into the world of desktop computers.[31] Although they were faster than the previous range of devices, they were still underpowered compared to other desktops and laptops of the time, fitting in more closely with the Netbook market. Only months later, in October, Samsung and Google released a new Chromebook at a significantly lower price point ($250, compared to the previous Series 5 Chromebooks' $450).[32] It was the first Chromebook to use an ARM processor, one from Samsung's Exynos line. In order to reduce the price, Google and Samsung also reduced the memory and screen resolution of the device. An advantage of using the ARM processor, however, was that the Chromebook didn't require a fan. Acer followed quickly after with the C7 Chromebook, priced even lower ($199), but containing an Intel Celeronprocessor.[33] One notable way Acer reduced the cost of the C7 was to use a laptop hard disk rather than a solid-state drive.

In April 2012, Google made the first update to Chrome OS's user interface since the operating system had launched, introducing a hardware-accelerated window manager called "Aura" along with a conventional taskbar. The additions marked a departure from the operating system's original concept of a single browser with tabs and gave Chrome OS the look and feel of a more conventional desktop operating system. "In a way, this almost feels as if Google is admitting defeat here", wrote Frederic Lardinois on TechCrunch. He argued that Google had traded its original version of simplicity for greater functionality. "That’s not necessarily a bad thing, though, and may just help Chrome OS gain more mainstream acceptance as new users will surely find it to be a more familiar experience."[34] Lenovo and HP followed Samsung and Acer in manufacturing Chromebooks in early 2013 with their own models.[35] Lenovo specifically targeted their Chromebook at students, headlining their press release with "Lenovo Introduces Rugged ThinkPad Chromebook for Schools".[36][37]

When Google released Google Drive, they also included Drive integration in the next version of Chrome OS (version 20), released in July 2012.[38] While Chrome OS had supported Flash since 2010,[39] by the end of 2012 it had been fully sandboxed, preventing issues with Flash from affecting other parts of Chrome OS.[40] This affected all versions of Chrome including Chrome OS.

Chromebook Pixel

Up to this point, Google had never made their own Chrome OS device. Instead, Chrome OS devices were much more similar to their Nexus line of Android phones, with each Chrome OS device being designed, manufactured, and marketed by third-party manufacturers, but with Google controlling the software. However, in February 2013 this changed when Google released the Chromebook Pixel.[41] The Chromebook Pixel was a departure from previous devices. Not only was it entirely Google-branded, but it contained an Intel i5 processor, a high-resolution (2,560x1,700) touchscreen display, and came at a price more competitive with business laptops.[42]

Chromebook Pixel (Wi-Fi) open

Controversial popularity

By the end of 2013, analysts were undecided on the future of Chrome OS. Although there had been articles predicting the demise of Chrome OS since 2009,[43][44][45][46][47] Chrome OS device sales continued to increase substantially year-over-year. In mid-2014, Time Magazine published an article titled "Depending on Who's Counting, Chromebooks are Either an Enormous Hit or Totally Irrelevant", which detailed the differences in opinion.[48] This controversy was further spurred by the fact that Intel seemed to decide Chrome OS was a beneficial market for it, holding their own Chrome OS events where they announced new Intel-based Chromebooks, Chromeboxes, and an all-in-one from LG called the Chromebase.[49]

Seizing the opportunity created by the end of life for Windows XP, Google pushed hard to sell Chromebooks to businesses, offering significant discounts in early 2014.[50]

Pwnium competition

In March 2014, Google hosted a hacking contest aimed at computer security experts called "Pwnium". Similar to the Pwn2Own contest, they invited hackers from around the world to find exploits in Chrome OS, with prizes available for attacks. Two exploits were demonstrated there, and a third was demonstrated at that year's Pwn2Own competition. Google patched the issues within a week.[51]

Material Design and App Runtime for Chrome

Although the Google Native Client has been available on Chrome OS since 2010,[52] there originally were few Native Client apps available, and most Chrome OS apps were still web apps. However, in June 2014, Google announced at Google I/O that Chrome OS would both synchronise with Android phones to share notifications and begin to run Android apps, installed directly from Google Play.[53] This, along with the broadening selection of Chromebooks,[54] provided an interesting future for Chrome OS.

At the same time, Google was also moving towards the then-new Material Design design language for its products, which it would bring to its web products as well as Android Lollipop.[55] One of the first Material Design items to come to Chrome OS was a new default wallpaper,[56] though Google did release some screenshots of a Material Design experiment for Chrome OS that never made it into the stable version.[57]

Functionality for SMBs and Enterprise

Chrome Enterprise

Chrome Enterprise, launched in 2017, includes Chrome OS, Chrome Browser, Chrome devices and their management capabilities intended for business use. Businesses can access the standard Chrome OS features and unlock advanced features for business with the Chrome Enterprise Upgrade.[58][59] Standard features include the ability to sync bookmarks and browser extensions across devices, cloud or native printing, multi-layered security, remote desktop, and automatic updates.[60] Advanced features include Active Directory integration, unified endpoint management, advanced security protection, access to device policies and Google Admin console, guest access, kiosk mode, and whitelisting or blacklisting third-party apps managed on Google Play.[61][62]

The education sector was an early adopter of Chromebooks, Chrome OS, and cloud-based computing. Chromebooks are widely used in classrooms and the advantages of cloud-based systems have been gaining an increased share of the market in other sectors as well, including financial services, healthcare and retail.[63] “The popularity of cloud computing and cloud-based services highlights the degree to which companies and business processes have become both internet-enabled and dependent.”[64] IT managers cite a number of advantages of the cloud that have motivated the move. Among them are advanced security, because data is not physically on a single machine that can be lost or stolen.[65] Deploying and managing cloud-native devices is easier because no hardware and software upgrades or virus definition updates are needed and patching of OS and software updates is simpler. Simplified and centralized management decreases operational costs.

Employees can securely access files and work on any machine, increasing the shareability of Chrome devices. Google's Grab and Go program with Chrome Enterprise allows businesses deploying Chromebooks to provide employees access to a bank of fully charged computers that can be checked out and returned after a period of time.[66]

From Chromebooks to Chromebox

In an early attempt to expand its enterprise offerings, Google released Chromebox for Meetings in February 2014. Chromebox for Meetings is a kit for conference rooms containing a Chromebox, a camera, a unit containing both a noise-cancelling microphone and speakers, and a remote control. It supports Google Hangouts meetings, Vidyovideo conferences, and conference calls from UberConference.[67][68]

Several partners announced Chromebox for Meetings models with Google, and in 2016 Google announced an all-in-one Chromebase for Meetings for smaller meeting rooms.[69] Google targeted the consumer hardware market with the release of the Chromebook in 2011 and Chromebook Pixel in 2013, and sought access to the enterprise market with the 2017 release of the Pixelbook. The second-generation Pixelbook was released in 2019.[70]

Enterprise Response to Chrome devices

Google has partnered on Chrome devices with several leading OEMs, including Acer, ASUS, Dell, HP, Lenovo, and Samsung.

In August 2019, Dell announced that two of its popular business-focused laptops would run Chrome OS and come with Chrome Enterprise Upgrade. The Latitude 5300 2-in-1 Chromebook Enterprise and Latitude 5400 Chromebook Enterprise were the result of a two-year partnership between Dell and Google.[71] The machines come with a bundle of Dell's cloud-based support services that would enable enterprise IT managers to deploy them in environments that also rely on Windows.[72] The new laptop line “delivers the search giant’s Chrome OS operating system in a form tailored for security-conscious organizations.”[73] Other OEMs that have launched devices with Chrome Enterprise Upgrade include Acer and HP.[74]

With a broader range of hardware available, Chrome OS became an option for enterprises wishing to avoid a migration to Windows 10 before Windows 7 support was discontinued by Microsoft.[75]

Hardware

Laptops running Chrome OS are known collectively as "Chromebooks". The first was the CR-48, a reference hardware design that Google gave to testers and reviewers beginning in December 2010. Retail machines followed in May 2011. A year later, in May 2012, a desktop design marketed as a "Chromebox" was released by Samsung. In March 2015 a partnership with AOPEN was announced and the first commercial Chromebox was developed.[76]


A Chromebook

In early 2014, LG Electronics introduced the first device belonging to the new all-in-one form factor called "Chromebase". Chromebase devices are essentially Chromebox hardware inside a monitor with a built-in camera, microphone and speakers.

The Chromebit is an HDMI dongle running Chrome OS. When placed in an HDMI slot on a television set or computer monitor, the device turns that display into a personal computer. The device was announced in March 2015 and shipped that November.[77]

Chrome OS supports dual-monitor setups, on devices with a video-out port.

Software

The software and updates are limited in their support lifetime.[78][79] Each device model manufactured to run Chrome OS has a different end-of-life date, with all new devices released in 2020 and beyond guaranteed to receive a minimum of 8 years from their date of initial release.[80]

As of Version 78, the device's end of life for software updates is listed in "About Chrome OS"-"Additional Details".[81]

Applications

Initially, Chrome OS was almost a pure web thin client operating system that relied primarily on servers to host web applications and related data storage.[82][83] Google gradually began encouraging developers to create "packaged applications", and later, Chrome Apps. The latter employ HTML5, CSS, Adobe Shockwave,

and JavaScript to provide a user experience closer to a native application.[84][85]

In September 2014, Google launched App Runtime for Chrome (beta), which allowed certain ported[86] Android applications to run on Chrome OS. Runtime was launched with four Android applications: Duolingo, Evernote, Sight Words, and Vine.[87] In 2016, Google made Google Play available for Chrome OS, making most Android apps available for supported Chrome OS devices.[88]

Google announced in 2018 that Chrome OS would be getting support for desktop Linux apps.[89] This capability was released to the stable channel (as on option for most machines) with Chrome 69 in October 2018, but was still marked as beta.[90]

By default X11 is not used,[91] while X11 apps can be run[92] Project Crostini makes X11 work (through (Wayland).[93]

Chrome Apps

From 2013 until January 2020, Google encouraged developers to build not just conventional Web applications for Chrome OS, but Chrome Apps (formerly known as Packaged apps).[94] In January 2020, Google's Chrome team announced its intent to phase out support for Chrome Apps and in favour of "Progressive web applications" (PWA) and Chrome extensions instead.[95] In March 2020, Google stopped accepting new public Chrome Apps for the web store.[96] According to Google, general support for Chrome Apps on Chrome OS will remain enabled, without requiring any policy setting, through June 2022.[96]

From a user's perspective, Chrome Apps resemble conventional native applications: they can be launched outside of the Chrome browser, are offline by default, can manage multiple windows, and interact with other applications. Technologies employed include HTML5, JavaScript, and CSS.[97][98][99]

Integrated media player, file manager

Google integrates a media player into both Chrome OS and the Chrome browser, enabling users to play back MP3s, view JPEGs, and handle other multimedia files while offline.[100] It supports DRM videos.[101]

Chrome OS also includes an integrated file manager, resembling those found on other operating systems, with the ability to display directories and the files they contain from both Google Drive and local storage, as well as to preview and manage file contents using a variety of Web applications, including Google Docs and Box.[102] Since January 2015, Chrome OS can also integrate additional storage sources into the file manager, relying on installed extensions that use the File System Provider API.[103]

Remote application access and virtual desktop access

In June 2010, Google software engineer Gary Kačmarčík wrote that Chrome OS would access remote applications through a technology unofficially called *"Chromoting"*, which would resemble Microsoft's Remote Desktop Connection.[100] The name has since been changed to *"Chrome Remote Desktop"*, and is like "running an application via Remote Desktop Services or by first connecting to a host machine by using RDP or VNC".[104]Initial roll-outs of Chrome OS laptops (Chromebooks) indicate an interest in enabling users to access virtual desktops.[105][106]

Android applications

At Google I/O 2014, a proof of concept showing Android applications, including Flipboard, running on Chrome OS was presented. In September 2014, Google introduced a beta version of the App Runtime for Chrome (ARC), which allows selected Android applications to be used on Chrome OS, using a Native Client-based environment that provides the platforms necessary to run Android software. Android applications do not require any modifications to run on Chrome OS, but may be modified to better support a mouse and keyboard environment. At its introduction, Chrome OS support was only available for selected Android applications.[107]

In 2016, Google introduced the ability to run Android apps on supported Chrome OS devices, with access to Google Play in its entirety. The previous Native Client-based solution was dropped in favor of a containercontaining Android's frameworks and dependencies (initially based on Android Marshmallow), which allows Android apps to have direct access to the Chrome OS platform, and allow the OS to interact with Android contracts such as sharing. Engineering director Zelidrag Hornung explained that ARC had been scrapped due to its limitations, including its incompatibility with the Android Native Development Toolkit (NDK), and that it was unable to pass Google's own compatibility test suite.[108][109]

Linux Apps

Since 2013, it has been possible to run Linux applications in Chrome OS through the use of Crouton, a third-party set of scripts that allows access to a Linux distribution such as Ubuntu.[110] However, in 2018 Google announced that desktop Linux apps were officially coming to Chrome OS.[111] The main benefit claimed by Google of their official Linux application support is that it can run without enabling developer mode, keeping many of the security features of Chrome OS. It was noticed in the Chromium OS source code in early 2018.[112][113] Early parts of Crostini were made available for the Google Pixelbook via the dev channel in February 2018 as part of Chrome OS version 66,[114][115] and it was enabled by default via the beta channel for testing on a variety of chromebooks in August 2018 with version 69.[116]

Architecture

Google's project for supporting Linux applications in Chrome OS is called Crostini, named for the Italian bread-based starter, and as a pun on Crouton. Crostini runs a virtual machine through a virtual machine monitor called crosvm, which uses Linux's built-in KVM virtualization tool. Although crosvm supports multiple virtual machines, the one used for running Linux apps, Termina, contains a basic Chrome OS kernel and userland utilities, in which it runs containers based on Linux containers (specifically LXD).[8]

Architecture

Chrome OS is built on top of the Linux kernel. Originally based on Ubuntu, its base was changed to Gentoo Linuxin February 2010.[117] For Project Crostini, as of Chrome OS 80, Debian 10 (Buster) is used.[118] In preliminary design documents for the Chromium OS open-source project, Google described a three-tier architecture: firmware, browser and window manager, and system-level software and userland services.[119]

- The firmware contributes to fast boot time by not probing for hardware, such as floppy disk drives, that are no longer common on computers, especially netbooks. The firmware also contributes to security by verifying each step in the boot process and incorporating system recovery.[119]
- System-level software includes the Linux kernel that has been patched to improve boot performance. Userland software has been trimmed to essentials, with management by Upstart, which can launch services in parallel, re-spawn crashed jobs, and defer services in the interest of faster booting.[119]

- The window manager handles user interaction with multiple client windows (much like other X window managers).[119]

Security

In March 2010, Google software security engineer Will Drewry discussed Chrome OS security. Drewry described Chrome OS as a "hardened" operating system featuring auto-updating and sandbox features that would reduce malware exposure. He said that Chrome OS netbooks would be shipped with Trusted Platform Module (TPM), and include both a "trusted bootpath" and a physical switch under the battery compartment that actuates a developer mode. That mode drops some specialized security functions but increases developer flexibility. Drewry also emphasized that the open-source nature of the operating system would contribute greatly to its security by allowing constant developer feedback.[120]

At a December 2010 press conference, Google claimed that Chrome OS would be the most secure consumer operating system due in part to a verified boot ability, in which the initial boot code, stored in read-only memory, checks for system compromises.[121] In the following nine years, Chrome OS has been affected by 55 documented security flaws of any severity,[122] compared with over 1,100 affecting Microsoft Windows 10 in the five years to the end of 2019[123] and over 2,200 affecting Apple OS X in 20 years.[124]

Shell access

Chrome OS includes the Chrome Shell, or "crosh",[125] which documents minimal functionality such as ping at crosh start-up.

In developer mode, a full-featured bash[126] shell (which is supposed to be used for development purposes[127]) can be opened via VT-2, and is also accessible using the crosh command `shell`.[128] To access full privileges in shell (e.g. sudo) a root password is requested. For some time the default was "chronos" in Chrome OS and "facepunch" in Chrome OS Vanilla[129] and later the default was empty, and instructions on updating it were displayed at each login.

Open source

Chrome OS is partially developed under the open-source Chromium OS project.[130] As with other open-source projects, developers can modify the code from Chromium OS and build their own versions, whereas Chrome OS code is only supported by Google and its partners and only runs on hardware designed for the purpose. Unlike Chromium OS, Chrome OS is automatically updated to the latest version.[14]

Chrome OS on Windows

On Windows 8 exceptions allow the default desktop web browser to offer a variant that can run inside its full-screen "Metro" shell and access features such as the Share charm, without necessarily needing to be written with Windows Runtime. Chrome's "Windows 8 mode" was previously a tablet-optimized version of the standard Chrome interface. In October 2013, the mode was changed on Developer channel to offer a variant of the Chrome OS desktop.[131][132][133][134][135]

Design

Early in the project, Google provided publicly many details of the Chrome OS's design goals and direction,[136] although the company has not followed up with a technical description of the completed operating system.

User interface

Design goals for Chrome OS's user interface included using minimal screen space by combining applications and standard Web pages into a single tab strip, rather than separating the two. Designers considered a reduced window management scheme that would operate only in full-screen mode. Secondary tasks would be handled with "panels": floating windows that dock to the bottom of the screen for tasks like chat and music players. Split screens were also under consideration for viewing two pieces of content side-by-side. Chrome OS would follow the Chrome browser's practice of leveraging HTML5's offline modes, background processing, and notifications. Designers proposed using search and pinned tabs as a way to quickly locate and access applications.[137]

Version 19 window manager and graphics engine

On April 10, 2012, a new build of Chrome OS offered a choice between the original full-screen window interface and overlapping, re-sizable windows, such as found on Microsoft Windows and Apple's macOS.[138] The feature was implemented through the Ash window manager, which runs atop the Aura hardware-accelerated graphics engine. The April 2012 upgrade also included the ability to display smaller, overlapping browser windows, each with its own translucent tabs, browser tabs that can be "torn" and dragged to new positions or merged with another tab strip, and a mouse-enabled shortcut list across the bottom of the screen. One icon on the task bar shows a list of installed applications and bookmarks. Writing in CNET, Stephen Shankland argued that with overlapping windows, "Google is anchoring itself into the past" as both iOS and Microsoft's Metro interface are largely or entirely full-screen. Even so, "Chrome OS already is different enough that it's best to preserve any familiarity that can be preserved".[138][139][140]

Printing

Google Cloud Print is a Google service that helps any application on any device to print on supported printers. While the cloud provides virtually any connected device with information access, the task of "developing and maintaining print subsystems for every combination of hardware and operating system—from desktops to netbooks to mobile devices—simply isn't feasible."[141][142] The cloud service requires installation of a piece of software called proxy, as part of the Chrome OS. The proxy registers the printer with the service, manages the print jobs, provides the printer driver functionality, and gives status alerts for each job.[143]

In 2016, Google included "Native CUPS Support" in Chrome OS as an experimental feature that may eventually become an official feature. With CUPS support turned on, it becomes possible to use most USB printers even if they do not support Google Cloud Print.[144][145]

Google has announced that Google Cloud Print will no longer be supported after December 31, 2020 and that the online service will not be available as of January 1, 2021.[146]

Link handling

Chrome OS was designed with the intention of storing user documents and files on remote servers. Both Chrome OS and the Chrome browser may introduce difficulties to end users when handling specific file types offline; for example, when opening an image or document residing on a local storage device, it may be unclear

whether and which specific Web application should be automatically opened for viewing, or the handling should be performed by a traditional application acting as a preview utility. Matthew Papakipos, Chrome OS engineering director, noted in 2010 that Windows developers have faced the same fundamental problem: "Quicktime is fighting with Windows Media Player, which is fighting with Chrome."[11]

Release channels and updates

Chrome OS uses the same release system as Google Chrome: there are three distinct channels: Stable, Beta, and Developer preview (called the "Dev" channel). The stable channel is updated with features and fixes that have been thoroughly tested in the Beta channel, and the Beta channel is updated approximately once a month with stable and complete features from the Developer channel. New ideas get tested in the Developer channel, which can be very unstable at times.[147][148] A fourth canary channel was confirmed to exist by Google Developer Francois Beaufort and hacker Kenny Strawn, by entering the Chrome OS shell in developer mode, typing the command `shell` to access the bash shell, and finally entering the command `update_engine_client -channel canary-channel -update`. It is possible to return to the verified boot mode after entering the canary channel, but the channel updater disappears and the only way to return to another channel is using the "powerwash" factory reset.[149]

Reception

At its debut, Chrome OS was viewed as a competitor to Microsoft, both directly to Microsoft Windows and indirectly the company's word processing and spreadsheet applications—the latter through Chrome OS's reliance on cloud computing.[150][151] But Chrome OS engineering director Matthew Papakipos argued that the two operating systems would not fully overlap in functionality because Chrome OS is intended for netbooks, which lack the computational power to run a resource-intensive program like Adobe Photoshop.[11]

Some observers claimed that other operating systems already filled the niche that Chrome OS was aiming for, with the added advantage of supporting native applications in addition to a browser. Tony Bradley of *PC World* wrote in November 2009:

> We can already do most, if not all, of what Chrome OS promises to deliver. Using a Windows 7 or Linux-based netbook, users can simply not install anything but a web browser and connect to the vast array of Google products and other web-based services and applications. Netbooks have been successful at capturing the low-end PC market, and they provide a web-centric computing experience today. I am not sure why we should get excited that a year from now we'll be able to do the same thing, but locked into doing it from the fourth-place web browser.[152]

By 2017, the Chrome browser had risen to become the number one browser used worldwide.[153]

In 2016, Chromebooks were the most popular computer in the US K–12 education market.[154]

In 2020, Chromebooks became the second most-popular end-user oriented OS (growing from 6.4% in 2019 to 10.8% in 2020). The majority of growth came at Windows expense (which fell from 85.4% in 2019 to 80.5% in 2021).[155]

Relationship to Android

Google's offering of two open-source operating systems, Android[156] and Chrome OS, has drawn some criticism despite the similarity between this situation and that of Apple Inc.'s two operating systems, macOS and iOS. Steve Ballmer, Microsoft CEO at the time, accused Google of not being able to make up its mind.[157] Steven Levy wrote that "the dissonance between the two systems was apparent" at Google I/O 2011. The event featured a daily press conference in which each team leader, Android's Andy Rubin and Chrome's Sundar Pichai, "unconvincingly tried to explain why the systems weren't competitive."[158] Google co-founder Sergey Brin addressed the question by saying that owning two promising operating systems was "a problem that most companies would love to face".[158]Brin suggested that the two operating systems "will likely converge over time."[159] The speculation over convergence increased in March 2013 when Chrome OS chief Pichai replaced Rubin as the senior vice president in charge of Android, thereby putting Pichai in charge of both.[160]

The relationship between Android and Chrome OS became more substantial at Google I/O 2014, where developers demonstrated native Android software running on Chrome OS through a Native Client-based runtime.[107][161] In September 2014, Google introduced a beta version of the App Runtime for Chrome (ARC), which allows selected Android applications to be used on Chrome OS, using a Native Client-based environment that provides the platforms necessary to run Android software. Android applications do not require any modifications to run on Chrome OS, but may be modified to better support a mouse and keyboard environment. At its introduction, Chrome OS support was only available for selected Android applications.[107] In October 2015, The Wall Street Journal reported that Chrome OS would be folded into Android so that a single OS would result by 2017. The resulting OS would be Android, but it would be expanded to run on laptops.[162][163] Google responded that while the company has "been working on ways to bring together the best of both operating systems, there's no plan to phase out Chrome OS."[164]

In 2016, Google introduced the ability to run Android apps on supported Chrome OS devices, with access to Google Play in its entirety. The previous Native Client-based solution was dropped in favor of a containercontaining Android's frameworks and dependencies (initially based on Android Marshmallow), which allows Android apps to have direct access to the Chrome OS platform, and allow the OS to interact with Android contracts such as sharing. Engineering director Zelidrag Hornung explained that ARC had been scrapped due to its limitations, including its incompatibility with the Android Native Development Toolkit (NDK), and that it was unable to pass Google's own compatibility test suite.[108][109]

See also

- Comparison of operating systems
- Google Fuchsia
- List of operating systems
- QWERTY#Chrome OS for information on typing diacritics (accents) and special symbols
- Timeline of operating systems

Notes

a. While it is possible to run Portage in Chrome OS, this requires enabling development mode which removes integrity checking for the filesystem.[4]

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External links

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- Official blog
- Release blog
- Chromium OS project page
- What is Google Chrome OS? on YouTube
- Official announcement
- Google Chrome OS Live Webcast; November 19, 2009