Development: Android is developed by Google until the latest changes and updates are ready to be released, at which point the source code is made available to the Android Open Source Project (AOSP), an open source initiative led by Google. The AOSP code can be found without modification on select devices, mainly the Nexus and Pixel series of devices. The source code is, in turn, customized and adapted by original equipment manufacturers (OEMs) to run on their hardware. Also, Android's source code does not contain the often proprietary device drivers that are needed for certain hardware components. As a result, most Android devices, including Google's own, ultimately ship with a combination of free and open source and proprietary software, with the software required for accessing Google services falling into the latter category. Android's source code is released by Google under an open source license, and its open nature has encouraged a large community of developers and enthusiasts to use the open-source code as a foundation for community-driven projects, which deliver updates to older devices, add new features for advanced users or bring Android to devices originally shipped with other operating systems. These community-developed releases often bring new features and updates to devices faster than through the official manufacturer/carrier channels, with a comparable level of quality; provide continued support for older devices that no longer receive official updates; or bring Android to devices that were officially released running other operating systems, such as the HP TouchPad. Community releases often come pre-rooted and contain modifications not provided by the original vendor, such as the ability to overclock or over/undervolt the device's processor. CyanogenMod was the most widely used community firmware, now discontinued and succeeded by LineageOS.Historically, device manufacturers and mobile carriers have typically been unsupportive of third-party firmware development. Manufacturers express concern about improper functioning of devices running unofficial software and the support costs resulting from this. Moreover, modified firmware such as CyanogenMod sometimes offer features, such as tethering, for which carriers would otherwise charge a premium. As a result, technical obstacles including locked bootloaders and restricted access to root permissions are common in many devices. However, as community-developed software has grown more popular, and following a statement by the Librarian of Congress in the United States that permits the jailbreaking of mobile devices, manufacturers and carriers have softened their position regarding third party development, with some, including HTC, Motorola, Samsung and Sony, providing support and encouraging development. As a result of this, over time the need to circumvent hardware restrictions to install unofficial firmware has lessened as an increasing number of devices are shipped with unlocked or unlockable bootloaders, similar to Nexus series of phones, although usually requiring that users waive their devices' warranties to do so. However, despite manufacturer acceptance, some carriers in the US still require that phones are locked down, frustrating developers and customers.
Features: Since Android devices are usually battery-powered, Android is designed to manage processes to keep power consumption at a minimum. When an application is not in use the system suspends its operation so that, while available for immediate use rather than closed, it does not use battery power or CPU resources. Android manages the applications stored in memory automatically: when memory is low, the system will begin invisibly and automatically closing inactive processes, starting with those that have been inactive for the longest amount of time. Lifehacker reported in 2011 that third-party task killer applications were doing more harm than good.
Introduction: Android is a mobile operating system developed by Google, based on a

modified version of the Linux kernel and other open source software and designed primarily for touchscreen mobile devices such as smartphones and tablets. In addition, Google has further developed Android TV for televisions, Android Auto for cars, and Wear OS for wrist watches, each with a specialized user interface. Variants of Android are also used on game consoles, digital cameras, PCs and other electronics. Initially developed by Android Inc., which Google bought in 2005, Android was unveiled in 2007, with the first commercial Android device launched in September 2008. The operating system has since gone through multiple major releases, with the current version being 9.0 "Pie", released in August 2018. The core Android source code is known as Android Open Source Project (AOSP), and is primarily licensed under the Apache License. Android is also associated with a suite of proprietary software developed by Google, including core apps for services such as Gmail and Google Search, as well as the application store and digital distribution platform Google Play, and associated development platform. These apps are licensed by manufacturers of Android devices certified under standards imposed by Google, but AOSP has been used as the basis of competing Android ecosystems, such as Amazon.com's Fire OS, which utilize their own equivalents to the Google Mobile Services. Android has been the best-selling OS worldwide on smartphones since 2011 and on tablets since 2013. As of May 2017, it has over two billion monthly active users, the largest installed base of any operating system, and as of June 2018, the Google Play store features over 3.3 million apps.
Security and privacy: Android applications run in a sandbox, an isolated area of the system that does not have access to the rest of the system's resources, unless access permissions are explicitly granted by the user when the application is installed, however this may not be possible for pre-installed apps. It is not possible, for example, to turn off the microphone access of the pre-installed camera app without disabling the camera completely. This is valid also in Android versions 7 and 8.Since February 2012, Google has used its Google Bouncer malware scanner to watch over and scan apps available in the Google Play store. A Verify Apps feature was introduced in November 2012, as part of the Android 4.2 Jelly Bean operating system version, to scan all apps, both from Google Play and from third-party sources, for malicious behavior. Originally only doing so during installation, Verify Apps received an update in 2014 to constantly scan apps, and in 2017 the feature was made visible to users through a menu in Settings.Before installing an application, the Google Play store displays a list of the requirements an app needs to function. After reviewing these permissions, the user can choose to accept or refuse them, installing the application only if they accept. In Android 6.0 Marshmallow, the permissions system was changed; apps are no longer automatically granted all of their specified permissions at installation time. An opt-in system is used instead, in which users are prompted to grant or deny individual permissions to an app when they are needed for the first time. Applications remember the grants, which can be revoked by the user at any time. Pre-installed apps, however, are not always part of this approach. In some cases it may not be possible to deny certain permissions to pre-installed apps, nor be possible to disable them. The Google Play Services app cannot be uninstalled, nor disabled. Any force stop attempt, result in the app restarting itself. The new permissions model is used only by applications developed for Marshmallow using its software development kit (SDK), and older apps will continue to use the previous all-or-nothing approach. Permissions can still be revoked for those apps, though this might prevent them from working properly, and a warning is displayed to that effect.In September 2014, Jason Nova of Android

Authority reported on a study by the German security company Fraunhofer AISEC in antivirus software and malware threats on Android. Nova wrote that The Android operating system deals with software packages by sandboxing them; this does not allow applications to list the directory contents of other apps to keep the system safe. By not allowing the antivirus to list the directories of other apps after installation, applications that show no inherent suspicious behavior when downloaded are cleared as safe. If then later on parts of the app are activated that turn out to be malicious, the antivirus will have no way to know since it is inside the app and out of the antivirus' jurisdiction. The study by Fraunhofer AISEC, examining antivirus software from Avast, AVG, Bitdefender, ESET, F-Secure, Kaspersky, Lookout, McAfee (formerly Intel Security), Norton, Sophos, and Trend Micro, revealed that the tested antivirus apps do not provide protection against customized malware or targeted attacks, and that the tested antivirus apps were also not able to detect malware which is completely unknown to date but does not make any efforts to hide its malignity.In August 2013, Google announced Android Device Manager (renamed Find My Device in May 2017), a service that allows users to remotely track, locate, and wipe their Android device, with an Android app for the service released in December. In December 2016, Google introduced a Trusted Contacts app, letting users request location-tracking of loved ones during emergencies.
Hardware: The main hardware platform for Android is ARM (the ARMv7 and ARMv8-A architectures), with x86 and x86-64 architectures also officially supported in later versions of Android. The unofficial Android-x86 project provided support for x86 architectures ahead of the official support. The ARMv5TE and MIPS32/64 architectures were also historically supported but removed in later Android releases. Since 2012, Android devices with Intel processors began to appear, including phones and tablets. While gaining support for 64-bit platforms, Android was first made to run on 64-bit x86 and then on ARM64. Since Android 5.0 Lollipop, 64-bit variants of all platforms are supported in addition to the 32-bit variants.Requirements for the minimum amount of RAM for devices running Android 7.1 range from in practice 2 GB for best hardware, down to 1 GB for the most common screen, to absolute minimum 512 MB for the lowest spec 32-bit smartphone. The recommendation for Android 4.4 is to have at least 512 MB of RAM, while for low RAM devices 340 MB is the required minimum amount that does not include memory dedicated to various hardware components such as the baseband processor. Android 4.4 requires a 32-bit ARMv7, MIPS or x86 architecture processor (latter two through unofficial ports), together with an OpenGL ES 2.0 compatible graphics processing unit (GPU). Android supports OpenGL ES 1.1, 2.0, 3.0, 3.1 and as of latest major version, 3.2 and since Android 7.0 Vulkan (and version 1.1 available for some devices). Some applications may explicitly require a certain version of the OpenGL ES, and suitable GPU hardware is required to run such applications.Android devices incorporate many optional hardware components, including still or video cameras, GPS, orientation sensors, dedicated gaming controls, accelerometers, gyroscopes, barometers, magnetometers, proximity sensors, pressure sensors, thermometers, and touchscreens. Some hardware components are not required, but became standard in certain classes of devices, such as smartphones, and additional requirements apply if they are present. Some other hardware was initially required, but those requirements have been relaxed or eliminated altogether. For example, as Android was developed initially as a phone OS, hardware such as microphones were required, while over time the phone function became optional. Android used to require an autofocus camera, which was relaxed to a fixed-focus camera if present

at all, since the camera was dropped as a requirement entirely when Android started to be used on set-top boxes. In addition to running on smartphones and tablets, several vendors run Android natively on regular PC hardware with a keyboard and mouse. In addition to their availability on commercially available hardware, similar PC hardware-friendly versions of Android are freely available from the Android-x86 project, including customized Android 4.4. Using the Android emulator that is part of the Android SDK, or third-party emulators, Android can also run non-natively on x86 architectures. Chinese companies are building a PC and mobile operating system, based on Android, to compete directly with Microsoft Windows and Google Android. The Chinese Academy of Engineering noted that more than a dozen companies were customising Android following a Chinese ban on the use of Windows 8 on government PCs.
Other uses: Google has developed several variations of Android for specific use cases, including Android Wear, later renamed Wear OS, for wearable devices such as wrist watches, Android TV for televisions, and Android Things for smart devices and Internet of things. Additionally, by providing infrastructure that combines dedicated hardware and dedicated applications running on regular Android, Google have opened up the platform for its use in particular usage scenarios, such as Android Auto for cars, and Daydream, a Virtual Reality platform.The open and customizable nature of Android allows device makers to use it on other electronics as well, including laptops, netbooks, and desktop computers, cameras, headphones, home automation systems, game consoles, media players, satellites, routers, printers, payment terminals, automated teller machines, and robots. Additionally, Android has been installed and run on a variety of less-technical objects, including calculators, single-board computers, feature phones, electronic dictionaries, alarm clocks, refrigerators, landline telephones, coffee machines, bicycles, and mirrors.Ouya, a video game console running Android, became one of the most successful Kickstarter campaigns, crowdfunding US$8.5m for its development, and was later followed by other Android-based consoles, such as Nvidia's Shield Portable – an Android device in a video game controller form factor.In 2011, Google demonstrated Android@Home, a home automation technology which uses Android to control a range of household devices including light switches, power sockets and thermostats. Prototype light bulbs were announced that could be controlled from an Android phone or tablet, but Android head Andy Rubin was cautious to note that turning a lightbulb on and off is nothing new, pointing to numerous failed home automation services. Google, he said, was thinking more ambitiously and the intention was to use their position as a cloud services provider to bring Google products into customers' homes. Parrot unveiled an Android-based car stereo system known as Asteroid in 2011, followed by a successor, the touchscreen-based Asteroid Smart, in 2012. In 2013, Clarion released its own Android-based car stereo, the AX1. In January 2014, at the Consumer Electronics Show (CES), Google announced the formation of the Open Automotive Alliance, a group including several major automobile makers (Audi, General Motors, Hyundai, and Honda) and Nvidia, which aims to produce Android-based in-car entertainment systems for automobiles, [bringing] the best of Android into the automobile in a safe and seamless way. Android comes preinstalled on a few laptops (a similar functionality of running Android applications is also available in Google's Chrome OS) and can also be installed on personal computers by end users. On those platforms Android provides additional functionality for physical keyboards and mice, together with the Alt-Tab key combination for switching applications quickly with a keyboard. In December 2014,

one reviewer commented that Android's notification system is vastly more complete and robust than in most environments and that Android is absolutely usable as one's primary desktop operating system.In October 2015, The Wall Street Journal reported that Android will serve as Google's future main laptop operating system, with the plan to fold Chrome OS into it by 2017. Google's Sundar Pichai, who led the development of Android, explained that mobile as a computing paradigm is eventually going to blend with what we think of as desktop today. Also, back in 2009, Google co-founder Sergey Brin himself said that Chrome OS and Android would likely converge over time. Lockheimer, who replaced Pichai as head of Android and Chrome OS, responded to this claim with an official Google blog post stating that While we've been working on ways to bring together the best of both operating systems, there's no plan to phase out Chrome OS [which has] guaranteed auto-updates for five years. That is unlike Android where support is shorter with EOL dates [being..] at least 3 years [into the future] for Android tablets for education.At Google I/O in May 2016, Google announced Daydream, a virtual reality platform that relies on a smartphone and provides VR capabilities through a virtual reality headset and controller designed by Google itself. The platform is built into Android starting with Android Nougat, differentiating from standalone support for VR capabilities. The software is available for developers, and was released in 2016.
Licensing: The source code for Android is open-source: it is developed in private by Google, with the source code released publicly when a new version of Android is released. Google publishes most of the code (including network and telephony stacks) under the non-copyleft Apache License version 2.0. which allows modification and redistribution. The license does not grant rights to the Android trademark, so device manufacturers and wireless carriers have to license it from Google under individual contracts. Associated Linux kernel changes are released under the copyleft GNU General Public License version 2, developed by the Open Handset Alliance, with the source code publicly available at all times. Typically, Google collaborates with a hardware manufacturer to produce a flagship device (part of the Nexus series) featuring the new version of Android, then makes the source code available after that device has been released. The only Android release which was not immediately made available as source code was the tablet-only 3.0 Honeycomb release. The reason, according to Andy Rubin in an official Android blog post, was because Honeycomb was rushed for production of the Motorola Xoom, and they did not want third parties creating a really bad user experience by attempting to put onto smartphones a version of Android intended for tablets.Only the base Android operating system (including some applications) is open-source software, whereas most Android devices ship with a substantial amount of proprietary software, such as Google Mobile Services, which includes applications such as Google Play Store, Google Search, and Google Play Services – a software layer that provides APIs for the integration with Google-provided services, among others. These applications must be licensed from Google by device makers, and can only be shipped on devices which meet its compatibility guidelines and other requirements. Custom, certified distributions of Android produced by manufacturers (such as TouchWiz and HTC Sense) may also replace certain stock Android apps with their own proprietary variants and add additional software not included in the stock Android operating system. There may also be binary blob drivers required for certain hardware components in the device.Richard Stallman and the Free Software Foundation have been critical of Android and have recommended the usage of alternatives such as Replicant, because drivers and firmware vital for the proper

functioning of Android devices are usually proprietary, and because the Google Play Store application can forcibly install or uninstall applications and, as a result, invite non-free software; although the Free Software Foundation has not found Google to use it for malicious reasons. Google licenses their Google Mobile Services software, along with Android trademarks, only to hardware manufacturers for devices that meet Google's compatibility standards specified in the Android Compatibility Program document. Thus, forks of Android that make major changes to the operating system itself do not include any of Google's non-free components, stay incompatible with applications that require them, and must ship with an alternative software marketplace in lieu of Google Play Store. Examples of such Android forks are Amazon's Fire OS (which is used on the Kindle Fire line of tablets, and oriented toward Amazon services), the Nokia X Software Platform (a fork used by the Nokia X family, oriented primarily toward Nokia and Microsoft services), and other forks that exclude Google apps due to the general unavailability of Google services in certain regions (such as China). In 2014, Google also began to require that all Android devices which license the Google Mobile Services software display a prominent Powered by Android logo on their boot screens. Google has also enforced preferential bundling and placement of Google Mobile Services on devices, including mandated bundling of the entire main suite of Google applications, and that shortcuts to Google Search and the Play Store app must be present on or near the main home screen page in its default configuration.Some stock applications and components in AOSP code that were formerly used by earlier versions of Android, such as Search, Music, Calendar, and the location API, were abandoned by Google in favor of non-free replacements distributed through Play Store (Google Search, Google Play Music, and Google Calendar) and Google Play Services, which are no longer open-source. Moreover, open-source variants of some applications also exclude functions that are present in their non-free versions, such as Photosphere panoramas in Camera, and a Google Now page on the default home screen (exclusive to the proprietary version Google Now Launcher, whose code is embedded within that of the main Google application). These measures are likely intended to discourage forks and encourage commercial licensing in line with Google requirements, as the majority of the operating system's core functionality (and in turn, third-party software), are dependent on proprietary components licensed exclusively by Google, and it would take significant development resources to develop an alternative suite of software and APIs to replicate or replace them. Apps that do not utilize Google components would also be at a functional disadvantage, as they can only utilize APIs contained within the OS itself.In March 2018, it was reported that Google had begun to block uncertified Android devices from utilizing Google Mobile Services software, and display a warning indicating that the device manufacturer has preloaded Google apps and services without certification from Google. Users of custom ROMs are able to register their device ID to their Google account to remove this block.Members of the Open Handset Alliance, which include the majority of Android OEMs, are also contractually forbidden from producing Android devices based on forks of the OS; in 2012, Acer Inc. was forced by Google to halt production on a device powered by Alibaba Group's Aliyun OS with threats of removal from the OHA, as Google deemed the platform to be an incompatible version of Android. Alibaba Group defended the allegations, arguing that the OS was a distinct platform from Android (primarily using HTML5 apps), but incorporated portions of Android's platform to allow backwards compatibility with third-party Android software. Indeed, the devices did ship with an application store which offered Android apps; however, the majority of them were

pirated.
Reception: Android received a lukewarm reaction when it was unveiled in 2007. Although analysts were impressed with the respected technology companies that had partnered with Google to form the Open Handset Alliance, it was unclear whether mobile phone manufacturers would be willing to replace their existing operating systems with Android. The idea of an open-source, Linux-based development platform sparked interest, but there were additional worries about Android facing strong competition from established players in the smartphone market, such as Nokia and Microsoft, and rival Linux mobile operating systems that were in development. These established players were skeptical: Nokia was quoted as saying we don't see this as a threat, and a member of Microsoft's Windows Mobile team stated I don't understand the impact that they are going to have.Since then Android has grown to become the most widely used smartphone operating system and one of the fastest mobile experiences available. Reviewers have highlighted the open-source nature of the operating system as one of its defining strengths, allowing companies such as Nokia (Nokia X family), Amazon (Kindle Fire), Barnes & Noble (Nook), Ouya, Baidu and others to fork the software and release hardware running their own customised version of Android. As a result, it has been described by technology website Ars Technica as practically the default operating system for launching new hardware for companies without their own mobile platforms. This openness and flexibility is also present at the level of the end user: Android allows extensive customisation of devices by their owners and apps are freely available from non-Google app stores and third party websites. These have been cited as among the main advantages of Android phones over others.Despite Android's popularity, including an activation rate three times that of iOS, there have been reports that Google has not been able to leverage their other products and web services successfully to turn Android into the money maker that analysts had expected. The Verge suggested that Google is losing control of Android due to the extensive customization and proliferation of non-Google apps and services – Amazon's Kindle Fire line uses Fire OS, a heavily modified fork of Android which does not include or support any of Google's proprietary components, and requires that users obtain software from its competing Amazon Appstore instead of Play Store. In 2014, in an effort to improve prominence of the Android brand, Google began to require that devices featuring its proprietary components display an Android logo on the boot screen.Android has suffered from fragmentation, a situation where the variety of Android devices, in terms of both hardware variations and differences in the software running on them, makes the task of developing applications that work consistently across the ecosystem harder than rival platforms such as iOS where hardware and software varies less. For example, according to data from OpenSignal in July 2013, there were 11,868 models of Android device, numerous different screen sizes and eight Android OS versions simultaneously in use, while the large majority of iOS users have upgraded to the latest iteration of that OS. Critics such as Apple Insider have asserted that fragmentation via hardware and software pushed Android's growth through large volumes of low end, budget-priced devices running older versions of Android. They maintain this forces Android developers to write for the lowest common denominator to reach as many users as possible, who have too little incentive to make use of the latest hardware or software features only available on a smaller percentage of devices. However, OpenSignal, who develops both Android and iOS apps, concluded that although fragmentation can make development trickier, Android's wider global reach also increases the potential

reward. In general, paid Android applications can easily be pirated. In a May 2012 interview with Eurogamer, the developers of Football Manager stated that the ratio of pirated players vs legitimate players was 9:1 for their game Football Manager Handheld. However, not every developer agreed that piracy rates were an issue; for example, in July 2012 the developers of the game Wind-up Knight said that piracy levels of their game were only 12%, and most of the piracy came from China, where people cannot purchase apps from Google Play.In 2010, Google released a tool for validating authorized purchases for use within apps, but developers complained that this was insufficient and trivial to crack. Google responded that the tool, especially its initial release, was intended as a sample framework for developers to modify and build upon depending on their needs, not as a finished piracy solution. Android Jelly Bean introduced the ability for paid applications to be encrypted, so that they may work only on the device for which they were purchased.

Mascot: The mascot of Android is a green android robot, as related to the software's name. Although it has no official name, the Android team at Google reportedly call it Bugdroid. Due to Android's high popularity in the 2010s, it has become one of the most recognizable icons in the technology world. It was designed by then-Google graphic designer Irina Blok on November 5, 2007 when Android was announced. Contrary to reports that she was tasked with a project to create an icon, Blok confirmed in an interview that she independently developed it and made it open source. The robot design was initially not presented to Google, but it quickly became commonplace in the Android development team, with various different variations of it created by the developers there who liked the figure, as it was free under a Creative Commons license. Its popularity amongst the development team eventually led to Google adopting it as an official icon as part of the Android logo when it launched to consumers in 2008.

Legal issues: The success of Android has made it a target for patent and copyright litigation between technology companies, both Android and Android phone manufacturers having been involved in numerous patent lawsuits. On August 12, 2010, Oracle sued Google over claimed infringement of copyrights and patents related to the Java programming language. Oracle originally sought damages up to $6.1 billion, but this valuation was rejected by a United States federal judge who asked Oracle to revise the estimate. In response, Google submitted multiple lines of defense, counterclaiming that Android did not infringe on Oracle's patents or copyright, that Oracle's patents were invalid, and several other defenses. They said that Android's Java runtime environment is based on Apache Harmony, a clean room implementation of the Java class libraries, and an independently developed virtual machine called Dalvik. In May 2012, the jury in this case found that Google did not infringe on Oracle's patents, and the trial judge ruled that the structure of the Java APIs used by Google was not copyrightable. The parties agreed to zero dollars in statutory damages for a small amount of copied code. On May 9, 2014, the Federal Circuit partially reversed the district court ruling, ruling in Oracle's favor on the copyrightability issue, and remanding the issue of fair use to the district court.In December 2015, Google announced that the next major release of Android (Android Nougat) would switch to OpenJDK, which is the official open-source implementation of the Java platform, instead of using the now-discontinued Apache Harmony project as its runtime. Code reflecting this change was also posted to the AOSP source repository. In its announcement, Google claimed this was part of an effort to create a common code base between Java on Android and other platforms. Google later admitted in a court filing that this was part of an effort to address the disputes with

Oracle, as its use of OpenJDK code is governed under the GNU General Public License (GPL) with a linking exception, and that any damages claim associated with the new versions expressly licensed by Oracle under OpenJDK would require a separate analysis of damages from earlier releases. In June 2016, a United States federal court ruled in favor of Google, stating that its use of the APIs was fair use.In addition to lawsuits against Google directly, various proxy wars have been waged against Android indirectly by targeting manufacturers of Android devices, with the effect of discouraging manufacturers from adopting the platform by increasing the costs of bringing an Android device to market. Both Apple and Microsoft have sued several manufacturers for patent infringement, with Apple's ongoing legal action against Samsung being a particularly high-profile case. In January 2012, Microsoft said they had signed patent license agreements with eleven Android device manufacturers, whose products account for 70 percent of all Android smartphones sold in the US and 55% of the worldwide revenue for Android devices. These include Samsung and HTC. Samsung's patent settlement with Microsoft included an agreement to allocate more resources to developing and marketing phones running Microsoft's Windows Phone operating system. Microsoft has also tied its own Android software to patent licenses, requiring the bundling of Microsoft Office Mobile and Skype applications on Android devices to subsidize the licensing fees, while at the same time helping to promote its software lines.Google has publicly expressed its frustration for the current patent landscape in the United States, accusing Apple, Oracle and Microsoft of trying to take down Android through patent litigation, rather than innovating and competing with better products and services. In August 2011, Google purchased Motorola Mobility for US$12.5 billion, which was viewed in part as a defensive measure to protect Android, since Motorola Mobility held more than 17,000 patents. In December 2011, Google bought over a thousand patents from IBM. In 2013, FairSearch, a lobbying organization supported by Microsoft, Oracle and others, filed a complaint regarding Android with the European Commission, alleging that its free-of-charge distribution model constituted anti-competitive predatory pricing. The Free Software Foundation Europe, whose donors include Google, disputed the Fairsearch allegations. On April 20, 2016, the EU filed a formal antitrust complaint against Google based upon the FairSearch allegations, arguing that its leverage over Android vendors, including the mandatory bundling of the entire suite of proprietary Google software, hindering the ability for competing search providers to be integrated into Android, and barring vendors from producing devices running forks of Android, constituted anti-competitive practices. In August 2016, Google was fined US$6.75 million by the Russian Federal Antimonopoly Service (FAS) under similar allegations by Yandex. The European Commission issued its decision on July 18, 2018, determining that Google had conduct three antitrust operations related to Android: bundling Google's search and Chrome as part of Android, blocking phone manufacturers from using forked versions of Android, and established deals with phone manufacturers and network provides to exclusively bundle the Google search application on handsets (a practice Google ended by 2014). The EU fined Google for €4.3 billion (about US$5 billion) and required the company to end this conduct within 90 days. Google plans to appeal the ruling. History: Android Inc. was founded in Palo Alto, California, in October 2003 by Andy Rubin, Rich Miner, Nick Sears, and Chris White. Rubin described the Android project as tremendous potential in developing smarter mobile devices that are more aware of its owner's location and preferences. The early intentions of the company were to develop an advanced operating system for digital cameras, and this was the basis of

its pitch to investors in April 2004. The company then decided that the market for cameras was not large enough for its goals, and by five months later it had diverted its efforts and was pitching Android as a handset operating system that would rival Symbian and Microsoft Windows Mobile.Rubin had difficulty attracting investors early on, and Android was facing eviction from its office space. Steve Perlman, a close friend of Rubin, brought him $10,000 in cash in an envelope, and shortly thereafter wired an undisclosed amount as seed funding. Perlman refused a stake in the company, and has stated I did it because I believed in the thing, and I wanted to help Andy.In July 2005, Google acquired Android Inc. for at least $50 million. Its key employees, including Rubin, Miner and White, joined Google as part of the acquisition. Not much was known about the secretive Android at the time, with the company having provided few details other than that it was making software for mobile phones. At Google, the team led by Rubin developed a mobile device platform powered by the Linux kernel. Google marketed the platform to handset makers and carriers on the promise of providing a flexible, upgradeable system. Google had lined up a series of hardware components and software partners and signaled to carriers that it was open to various degrees of cooperation.Speculation about Google's intention to enter the mobile communications market continued to build through December 2006. An early prototype had a close resemblance to a BlackBerry phone, with no touchscreen and a physical QWERTY keyboard, but the arrival of 2007's Apple iPhone meant that Android had to go back to the drawing board. Google later changed its Android specification documents to state that Touchscreens will be supported, although the Product was designed with the presence of discrete physical buttons as an assumption, therefore a touchscreen cannot completely replace physical buttons. By 2008, both Nokia and BlackBerry announced touch-based smartphones to rival the iPhone 3G, and Android's focus eventually switched to just touchscreens. The first commercially available smartphone running Android was the HTC Dream, also known as T-Mobile G1, announced on September 23, 2008. On November 5, 2007, the Open Handset Alliance, a consortium of technology companies including Google, device manufacturers such as HTC, Motorola and Samsung, wireless carriers such as Sprint and T-Mobile, and chipset makers such as Qualcomm and Texas Instruments, unveiled itself, with a goal to develop the first truly open and comprehensive platform for mobile devices. Within a year, the Open Handset Alliance faced two other open source competitors, the Symbian Foundation and the LiMo Foundation, the latter also developing a Linux-based mobile operating system like Google. In September 2007, InformationWeek covered an Evalueserve study reporting that Google had filed several patent applications in the area of mobile telephony.Since 2008, Android has seen numerous updates which have incrementally improved the operating system, adding new features and fixing bugs in previous releases. Each major release is named in alphabetical order after a dessert or sugary treat, with the first few Android versions being called Cupcake, Donut, Eclair, and Froyo, in that order. During its announcement of Android KitKat in 2013, Google explained that Since these devices make our lives so sweet, each Android version is named after a dessert, although a Google spokesperson told CNN in an interview that It’s kind of like an internal team thing, and we prefer to be a little bit — how should I say — a bit inscrutable in the matter, I’ll say.In 2010, Google launched its Nexus series of devices, a lineup in which Google partnered with different device manufacturers to produce new devices and introduce new Android versions. The series was described as having played a pivotal role in Android's history by introducing new software

iterations and hardware standards across the board, and became known for its bloat-free software with timely ... updates. At its developer conference in May 2013, Google announced a special version of the Samsung Galaxy S4, where, instead of using Samsung's own Android customization, the phone ran stock Android and was promised to receive new system updates fast. The device would become the start of the Google Play edition program, and was followed by other devices, including the HTC One Google Play edition, and Moto G Google Play edition. In 2015, Ars Technica wrote that Earlier this week, the last of the Google Play edition Android phones in Google's online storefront were listed as no longer available for sale and that Now they're all gone, and it looks a whole lot like the program has wrapped up. From 2008 to 2013, Hugo Barra served as product spokesperson, representing Android at press conferences and Google I/O, Google's annual developer-focused conference. He left Google in August 2013 to join Chinese phone maker Xiaomi. Less than six months earlier, Google's then-CEO Larry Page announced in a blog post that Andy Rubin had moved from the Android division to take on new projects at Google, and that Sundar Pichai would become the new Android lead. Pichai himself would eventually switch positions, becoming the new CEO of Google in August 2015 following the company's restructure into the Alphabet conglomerate, making Hiroshi Lockheimer the new head of Android.In June 2014, Google announced Android One, a set of hardware reference models that would allow [device makers] to easily create high-quality phones at low costs, designed for consumers in developing countries. In September, Google announced the first set of Android One phones for release in India. However, Recode reported in June 2015 that the project was a disappointment, citing reluctant consumers and manufacturing partners and misfires from the search company that has never quite cracked hardware. Plans to relaunch Android One surfaced in August 2015, with Africa announced as the next location for the program a week later. A report from The Information in January 2017 stated that Google is expanding its low-cost Android One program into the United States, although The Verge notes that the company will presumably not produce the actual devices itself.Google introduced the Pixel and Pixel XL smartphones in October 2016, marketed as being the first phones made by Google, and exclusively featured certain software features, such as the Google Assistant, before wider rollout. The Pixel phones replaced the Nexus series, with a new generation of Pixel phones launched in October 2017.