Continue

Handheld mobile device For other uses, see Smartphone (disambiguation). A Nexus 6, an Android smartphone, displaying the Main Page of the English Wikipedia A smartphone is a mobile phone with advanced computing capabilities. It typically has a touchscreen interface, allowing users to access a wide range of applications and services, such as web browsing, email, and social media, as well as multimedia playback and streaming. Smartphones have built-in cameras, GPS navigation, and support for various communication methods, including voice calls, text messaging, and internet-based messaging apps. Smartphones are distinguished from older-design feature phones by their more advanced hardware capabilities and extensive mobile operating systems, access to the internet, business applications, mobile payments, and multimedia functionality, including music, video, gaming, radio, and television. Smartphones typically feature metal–oxide–semiconductor (MOS) integrated circuit (IC) chips, various sensors, and support for multiple wireless communication protocols. Examples of smartphone sensors include accelerometers, barometers, gyroscopes, and magnetometers; they can be used by both pre-installed and third-party software to enhance functionality. Wireless communication standards supported by smartphones include LTE, 5G NR, Wi-Fi, Bluetooth, and satellite navigation. By the mid-2020s, manufacturers began integrating satellite messaging and emergency services, expanding their utility in remote areas without reliable cellular coverage. Smartphones have largely replaced personal digital assistant (PDA) devices, handheld/palm-sized PCs, portable media players (PMP),[1] point-and-shoot cameras, camcorders, and, to a lesser extent, handheld video game consoles, e-reader devices, pocket calculators, and GPS tracking units. Following the rising popularity of the iPhone in the late 2000s, the majority of smartphones have featured thin, slate-like form factors with large, capacitive touch screens with support for multi-touch gestures rather than physical keyboards. Most modern smartphones have the ability for users to download or purchase additional applications from a centralized app store. They often have support for cloud storage and cloud synchronization, and virtual assistants. Since the early 2010s, improved hardware and faster wireless communication have bolstered the growth of the smartphone industry. As of 2014[update], over a billion smartphones are sold globally every year. In 2019 alone, 1.54 billion smartphone units were shipped worldwide.[2] As of 2020[update], 75.05 percent of the world population were smartphone users.[3] It has been suggested that this section be split out into another article titled History of smartphones. (Discuss) (December 2024) See also: Mobile operating system § Timeline Early smartphones were marketed primarily towards the enterprise market, attempting to bridge the functionality of standalone PDA devices with support for cellular telephony, but were limited by their bulky form, short battery life, slow analog cellular networks, and the immaturity of wireless data services. These issues were eventually resolved with the exponential scaling and miniaturization of MOS transistors down to sub-micron levels (Moore's law), the improved lithium-ion battery, faster digital mobile data networks (Edholm's law), and more mature software platforms that allowed mobile device ecosystems to develop independently of data providers. In the 2000s, NTT DoCoMo's i-mode platform, BlackBerry, Nokia's Symbian platform, and Windows Mobile began to gain market traction, with models often featuring QWERTY keyboards or resistive touchscreen input and emphasizing access to push email and wireless internet. Main article: IBM Simon IBM Simon and charging base (1994)[4] In the early 1990s, IBM engineer Frank Canova considered that chip-and-wireless technology was becoming small enough to use in handheld devices.[5] The first commercially available device that could be properly referred to as a "smartphone" began as a prototype called "Angler" developed by Canova in 1992 while at IBM and demonstrated in November of that year at the COMDEX computer industry trade show.[6][7][8] A refined version was marketed to consumers in 1994 by BellSouth under the name Simon Personal Communicator. In addition to placing and receiving cellular calls, the touchscreen-equipped Simon could send and receive faxes and emails. It included an address book, calendar, appointment scheduler, calculator, world time clock, and notepad, as well as other visionary mobile applications such as maps, stock reports and news.[9] The IBM Simon was manufactured by Mitsubishi Electric, which integrated features with its own cellular radio technologies.[10] It featured a liquid-crystal display (LCD) and PC Card support.[11] The Simon was commercially unsuccessful, particularly due to its bulky form factor and limited battery life,[12] using NiCad batteries rather than the nickel–metal hydride batteries commonly used in mobile phones in the 1990s, or lithium-ion batteries used in modern smartphones.[13] The term "smart phone" (in two words) was not coined until a year after the introduction of the Simon, appearing in print as early as 1995, describing AT&T's PhoneWriter Communicator.[14][non-primary source needed] The term "smartphone" (as one word) was first used by Ericsson in 1997 to describe a new device concept, the GS88.[15] Main article: Personal digital assistant Beginning in the mid-to-late 1990s, many people who had mobile phones carried a separate dedicated PDA device, running early versions of operating systems such as Palm OS, Newton OS, Symbian or Windows CE/Pocket PC. These operating systems would later evolve into early mobile operating systems. Most of the "smartphones" in this era were hybrid devices that combined these existing familiar PDA OSes with basic phone hardware. The results were devices that were bulkier than either dedicated mobile phones or PDAs, but allowed a limited amount of cellular Internet access. PDA and mobile phone manufacturers competed in reducing the size of devices. The bulk of these smartphones combined with their high cost and expensive data plans, plus other drawbacks such as expansion limitations and decreased battery life compared to separate standalone devices, generally limited their popularity to "early adopters" and business users who needed portable connectivity. In March 1996, Hewlett-Packard released the OmniGo 700LX, a modified HP 200LX palmtop PC with a Nokia 2110 mobile phone piggybacked onto it and ROM-based software to support it. It had a 640 × 200 resolution CGA compatible four-shade gray-scale LCD screen and could be used to place and receive calls, and to create and receive text messages, emails and faxes. It was also 100% DOS 5.0 compatible, allowing it to run thousands of existing software titles, including early versions of Windows. The Nokia 9110 Communicator, opened for access to keyboard In August 1996, Nokia released the Nokia 9000 Communicator, a digital cellular PDA based on the Nokia 2110 with an integrated system based on the PEN/GEOS 3.0 operating system from Geoworks. The two components were attached by a hinge in what became known as a clamshell design, with the display above and a physical QWERTY keyboard below. The PDA provided e-mail; calendar, address book, calculator and notebook applications; text-based Web browsing; and could send and receive faxes. When closed, the device could be used as a digital cellular telephone. In June 1999, Qualcomm released the "pdQ Smartphone", a CDMA digital PCS smartphone with an integrated Palm PDA and Internet connectivity.[16] Subsequent landmark devices included: The Ericsson R380 (December 2000)[17] by Ericsson Mobile Communications,[18] the first phone running the operating system later named Symbian (it ran EPOC Release 5, which was renamed Symbian OS at Release 6). It had PDA functionality and limited Web browsing on a resistive touchscreen utilizing a stylus.[19] While it was marketed as a "smartphone",[20] users could not install their own software on the device. The Kyocera 6035 (February 2001),[21] a dual-nature device with a separate Palm OS PDA operating system and CDMA mobile phone firmware. It supported limited Web browsing with the PDA software treating the phone hardware as an attached modem.[22][23] The Nokia 9210 Communicator (June 2001),[24] the first phone running Symbian (Release 6) with Nokia's Series 80 platform (v1.0). This was the first Symbian phone platform allowing the installation of additional applications. Like the Nokia 9000 Communicator, it is a large clamshell device with a full physical QWERTY keyboard inside. Handspring's Treo 180 (2002), the first smartphone that fully integrated the Palm OS on a GSM mobile phone having telephony, SMS messaging and Internet access built into the OS. The 180 model had a thumb-type keyboard and the 180g version had a Graffiti handwriting recognition area, instead.[25] Main articles: Japanese mobile phone culture and Mobile phone industry in Japan In 1999, Japanese wireless provider NTT DoCoMo launched i-mode, a new mobile internet platform which provided data transmission speeds up to 9.6 kilobits per second, and access web services available through the platform such as online shopping. NTT DoCoMo's i-mode used cHTML, a language which restricted some aspects of traditional HTML in favor of increasing data speed for the devices. Limited functionality, small screens and limited bandwidth allowed for phones to use the slower data speeds available. The rise of i-mode helped NTT DoCoMo accumulate an estimated 40 million subscribers by the end of 2001, and ranked first in market capitalization in Japan and second globally.[26] Japanese cell phones increasingly diverged from global standards and trends to offer other forms of advanced services and smartphone-like functionality that were specifically tailored to the Japanese market, such as mobile payments and shopping, near-field communication (NFC) allowing mobile wallet functionality to replace smart cards for transit fares, loyalty cards, identity cards, event tickets, coupons, money transfer, etc., downloadable content like musical ringtones, games, and comics, and 1seg mobile television.[27][28] Phones built by Japanese manufacturers used custom firmware, however, and did not yet feature standardized mobile operating systems designed to cater to third-party application development, so their software and ecosystems were akin to very advanced feature phones. As with other feature phones, additional software and services required partnerships and deals with providers. The degree of integration between phones and carriers, unique phone features, non-standardized platforms, and tailoring to Japanese culture made it difficult for Japanese manufacturers to export their phones, especially when demand was so high in Japan that the companies did not feel the need to look elsewhere for additional profits.[29][30][31] The rise of 3G technology in other markets and non-Japanese phones with powerful standardized smartphone operating systems, app stores, and advanced wireless network capabilities allowed non-Japanese phone manufacturers to finally break in to the Japanese market, gradually adopting Japanese phone features like emojis, mobile payments, NFC, etc. and spreading them to the rest of the world. Several BlackBerry smartphones, which were highly popular in the mid-late 2000s Phones that made effective use of any significant data connectivity were still rare outside Japan until the introduction of the Danger Hiptop in 2002, which saw moderate success among U.S. consumers as the T-Mobile Sidekick. Later, in the mid-2000s, business users in the U.S. started to adopt devices based on Microsoft's Windows Mobile, and then BlackBerry smartphones from Research In Motion. American users popularized the term "CrackBerry" in 2006 due to the BlackBerry's addictive nature.[32] In the U.S., the high cost of data plans and relative rarity of devices with Wi-Fi capabilities that could avoid cellular data network usage kept adoption of smartphones mainly to business professionals and "early adopters". Outside the U.S. and Japan, Nokia was seeing success with its smartphones based on Symbian, originally developed by Psion for their personal organisers, and it was the most popular smartphone OS in Europe during the middle to late 2000s. Initially, Nokia's Symbian smartphones were focused on business with the Eseries,[33] similar to Windows Mobile and BlackBerry devices at the time. From 2002 onwards, Nokia started producing consumer-focused smartphones, popularized by the entertainment-focused Nseries. Until 2010, Symbian was the world's most widely used smartphone operating system.[34] The touchscreen personal digital assistant (PDA)–derived nature of adapted operating systems like Palm OS, the "Pocket PC" versions of what was later Windows Mobile, and the UIQ interface that was originally designed for pen-based PDAs on Symbian OS devices resulted in some early smartphones having stylus-based interfaces. These allowed for virtual keyboards and handwriting input, thus also allowing easy entry of Asian characters.[35] By the mid-2000s, the majority of smartphones had a physical QWERTY keyboard. Most used a "keyboard bar" form factor, like the BlackBerry line, Windows Mobile smartphones, Palm Treos, and some of the Nokia Eseries. A few hid their full physical QWERTY keyboard in a sliding form factor, like the Danger Hiptop line. Some even had only a numeric keypad using T9 text input, like the Nokia Nseries and other models in the Nokia Eseries. Resistive touchscreens with stylus-based interfaces could still be found on a few smartphones, like the Palm Treos, which had dropped their handwriting input after a few early models that were available in versions with Graffiti instead of a keyboard. The LG Prada with a large capacitive touchscreen introduced in 2006 The original Apple iPhone; following its introduction in 2007, the common smartphone form factor shifted to large touchscreen software interfaces without physical keypads[36] The late 2000s and early 2010s saw a shift in smartphone interfaces away from devices with physical keyboards and keypads to ones with large finger-operated capacitive touchscreens.[36] The first phone of any kind with a large capacitive touchscreen was the LG Prada, announced by LG in December 2006.[37] This was a fashionable feature phone created in collaboration with Italian luxury designer Prada with a 3" 240 x 400 pixel screen, a 2-Megapixel digital camera with 144p video recording ability, an LED flash, and a miniature mirror for self portraits.[38][39] In January 2007, Apple Computer introduced the iPhone.[40][41][42] It had a 3.5" capacitive touchscreen with twice the common resolution of most smartphone screens at the time,[43] and introduced multi-touch to phones, which allowed gestures such as "pinching" to zoom in or out on photos, maps, and web pages. The iPhone was notable as being the first device of its kind targeted at the mass market to abandon the use of a stylus, keyboard, or keypad typical of contemporary smartphones, instead using a large touchscreen for direct finger input as its main means of interaction.[35] The iPhone's operating system was also a shift away from older operating systems (which older phones supported and which were adapted from PDAs and feature phones) to an operative system powerful enough to not require using a limited, stripped down web browser that can only render pages specially formatted using technologies such as WML, cHTML, or XHTML and instead ran a version of Apple's Safari browser that could render full websites[44][45][46] not specifically designed for mobile phones.[47] Later Apple shipped a software update that gave the iPhone a built-in on-device App Store allowing direct wireless downloads of third-party software.[48][49] This kind of centralized App Store and free developer tools[50][51] quickly became the new main paradigm for all smartphone platforms for software development, distribution, discovery, installation, and payment, in place of expensive developer tools that required official approval to use and a dependence on third-party sources providing applications for multiple platforms.[36] The advantages of a design with software powerful enough to support advanced applications and a large capacitive touchscreen affected the development of another smartphone OS platform, Android, with a more BlackBerry-like prototype device scrapped in favor of a touchscreen device with a slide-out physical keyboard, as Google's engineers thought at the time that a touchscreen could not completely replace a physical keyboard and buttons.[52][53][54] Android is based around a modified Linux kernel, again providing more power than mobile operating systems adapted from PDAs and feature phones. The first Android device, the horizontal-sliding HTC Dream, was released in September 2008.[55] In 2012, Asus started experimenting with a convertible docking system named PadFone, where the standalone handset can when necessary be inserted into a tablet-sized screen unit with integrated supportive battery and used as such. In 2013 and 2014, Samsung experimented with the hybrid combination of compact camera and smartphone, releasing the Galaxy S4 Zoom and K Zoom, each equipped with integrated 10× optical zoom lens and manual parameter settings (including manual exposure and focus) years before these were widely adapted among smartphones. The S4 Zoom additionally has a rotary knob ring around the lens and a tripod mount. While screen sizes have increased, manufacturers have attempted to make smartphones thinner at the expense of utility and sturdiness, since a thinner frame is more vulnerable to bending and has less space for components, namely battery capacity.[56][57] A Meizu MX4 with Flyme OS The iPhone and later touchscreen-only Android devices together popularized the slate form factor, based on a large capacitive touchscreen as the sole means of interaction, and led to the decline of earlier, keyboard- and keypad-focused platforms.[36] Later, navigation keys such as the home, back, menu, task and search buttons have also been increasingly replaced by nonphysical touch keys, then virtual, simulated on-screen navigation keys, commonly with access combinations such as a long press of the task key to simulate a short menu key press, as with home button to search.[58] More recent "bezel-less" types have their screen surface space extended to the unit's front bottom to compensate for the display area lost for simulating the navigation keys. While virtual keys offer more potential customizability, their location may be inconsistent among systems depending on screen rotation and software used. Multiple vendors attempted to update or replace their existing smartphone platforms and devices to better-compete with Android and the iPhone; Palm unveiled a new platform known as webOS for its Palm Pre in late-2009 to replace Palm OS, which featured a focus on a task-based "card" metaphor and seamless synchronization and integration between various online services (as opposed to the then-conventional concept of a smartphone needing a PC to serve as a "canonical, authoritative repository" for user data).[59][60] HP acquired Palm in 2010 and released several other webOS devices, including the Pre 3 and HP TouchPad tablet. As part of a proposed divestment of its consumer business to focus on enterprise software, HP abruptly ended development of future webOS devices in August 2011, and sold the rights to webOS to LG Electronics in 2013, for use as a smart TV platform.[61][62] Research in Motion introduced the vertical-sliding BlackBerry Torch and BlackBerry OS 6 in 2010, which featured a redesigned user interface, support for gestures such as pinch-to-zoom, and a new web browser based on the same WebKit rendering engine used by the iPhone.[63][64] The following year, RIM released BlackBerry OS 7 and new models in the Bold and Torch ranges, which included a new Bold with a touchscreen alongside its keyboard, and the Torch 9860—the first BlackBerry phone to not include a physical keyboard.[65] In 2013, it replaced the legacy BlackBerry OS with a revamped, QNX-based platform known as BlackBerry 10, with the all-touch BlackBerry Z10 and keyboard-equipped Q10 as launch devices.[66] In 2010, Microsoft unveiled a replacement for Windows Mobile known as Windows Phone, featuring a new touchscreen-centric user interface built around flat design and typography, a home screen with "live tiles" containing feeds of updates from apps, as well as integrated Microsoft Office apps.[67] In February 2011, Nokia announced that it had entered into a major partnership with Microsoft, under which it would exclusively use Windows Phone on all of its future smartphones, and integrate Microsoft's Bing search engine and Bing Maps (which, as part of the partnership, would also license Nokia Maps data) into all future devices. The announcement led to the abandonment of both Symbian, as well as MeeGo—a Linux-based mobile platform it was co-developing with Intel.[68][69][70] Nokia's low-end Lumia 520 saw strong demand and helped Windows Phone gain niche popularity in some markets,[71] overtaking BlackBerry in global market share in 2013.[72][73] In mid-June 2012, Meizu released its mobile operating system, Flyme OS. Many of these attempts to compete with Android and iPhone were short-lived. Over the course of the decade, the two platforms became a clear duopoly in smartphone sales and market share, with BlackBerry, Windows Phone, and other operating systems eventually stagnating to little or no measurable market share.[74][75] In 2015, BlackBerry began to pivot away from its in-house mobile platforms in favor of producing Android devices, focusing on a security-enhanced distribution of the software. The following year, the company announced that it would also exit the hardware market to focus more on software and its enterprise middleware,[76] and began to license the BlackBerry brand and its Android distribution to third-party OEMs such as TCL for future devices.[77][78] In September 2013, Microsoft announced its intent to acquire Nokia's mobile device business for $7.1 billion, as part of a strategy under CEO Steve Ballmer for Microsoft to be a "devices and services" company.[79] Despite the growth of Windows Phone and the Lumia range (which accounted for nearly 90% of all Windows Phone devices sold),[80] the platform never had significant market share in the key U.S. market,[71] and Microsoft was unable to maintain Windows Phone's momentum in the years that followed, resulting in dwindling interest from users and app developers.[81] After Balmer was succeeded by Satya Nadella (who has placed a larger focus on software and cloud computing) as CEO of Microsoft, it took a $7.6 billion write-off on the Nokia assets in July 2015, and laid off nearly the entire Microsoft Mobile unit in May 2016.[82][83][79] Prior to the completion of the sale to Microsoft, Nokia released a series of Android-derived smartphones for emerging markets known as Nokia X, which combined an Android-based platform with elements of Windows Phone and Nokia's feature phone platform Asha, using Microsoft and Nokia services rather than Google.[84] Further information: Digital camera and Camera phone Xiaomi 13 Ultra featured a Leica Summicron camera system Oppo Find X6 features software-based tuning co-developed with Hasselblad The first commercial camera phone was the Kyocera Visual Phone VP-210, released in Japan in May 1999.[85] It was called a "mobile videophone" at the time,[86] and had a 110,000-pixel front-facing camera.[85] It could send up to two images per second over Japan's Personal Handy-phone System (PHS) cellular network, and store up to 20 JPEG digital images, which could be sent over e-mail.[85] The first mass-market camera phone was the J-SH04, a Sharp J-Phone model sold in Japan in November 2000.[87][88] It could instantly transmit pictures via cell phone telecommunication.[89] By the mid-2000s, higher-end cell phones commonly had integrated digital cameras. In 2003 camera phones outsold stand-alone digital cameras, and in 2006 they outsold film and digital stand-alone cameras. Five billion camera phones were sold in five years, and by 2007 more than half of the installed base of all mobile phones were camera phones. Sales of separate cameras peaked in 2008.[90] Many early smartphones did not have cameras at all, and earlier models that had them had low performance and insufficient image and video quality that could not compete with budget pocket cameras and fulfill user's needs.[91] By the beginning of the 2010s almost all smartphones had an integrated digital camera. The decline in sales of stand-alone cameras accelerated due to the increasing use of smartphones with rapidly improving camera technology for casual photography, easier image manipulation, and abilities to directly share photos through the use of apps and web-based services.[92][93][94][95] By 2011, cell phones with integrated cameras were selling hundreds of millions per year. In 2015, digital camera sales were 35.395 million units or only less than a third of digital camera sales numbers at their peak and also slightly less than film camera sold number at their peak.[96][97] Contributing to the rise in popularity of smartphones being used over dedicated cameras for photography, smaller pocket cameras have difficulty producing bokeh in images, but nowadays, some smartphones have dual-lens cameras that reproduce the bokeh effect easily, and can even rearrange the level of bokeh after shooting. This works by capturing multiple images with different focus settings, then combining the background of the main image with a macro focus shot. In 2007, the Nokia N95 was notable as a smartphone that had a 5.0 Megapixel (MP) camera, when most others had cameras with around 3 MP or less than 2 MP. Some specialized feature phones like the LG Viewty, Samsung SGH-G800, and Sony Ericsson K850i, all released later that year, also had 5.0 MP cameras. By 2010, 5.0 MP cameras were common; a few smartphones had 8.0 MP cameras and the Nokia N8, Sony Ericsson Satio,[98] and Samsung M8910 Pixon12[99] feature phone had 12 MP. The main camera of the 2009 Nokia N86 uniquely features a three-level aperture lens.[100] The Altek Leo, a 14-megapixel smartphone with 3x optical zoom lens and 720p HD video camera was released in late 2010.[101] In 2011, the same year the Nintendo 3DS was released, HTC unveiled the Evo 3D, a 3D phone with a dual five-megapixel rear camera setup for spatial imaging, among the earliest mobile phones with more than one rear camera. The 2012 Samsung Galaxy S3 introduced the ability to capture photos using voice commands.[102] In 2012, Nokia announced and released the Nokia 808 PureView, featuring a 41-megapixel 1/1.2-inch sensor and a high-resolution f/2.4 Zeiss all-aspherical one-group lens. The high resolution enables four times of lossless digital zoom at 1080p and six times at 720p resolution, using image sensor cropping.[103] The 2013 Nokia Lumia 1020 has a similar high-resolution camera setup, with the addition of optical image stabilization and manual camera settings years before common among high-end mobile phones, although lacking expandable storage that could be of use for accordingly high file sizes. Mobile optical image stabilization was first introduced by Nokia in 2012 with the Lumia 920, and the earliest known smartphone with an optically stabilized front camera is the HTC 10 from 2016.[104] Optical image stabilization enables prolonged exposure times for low-light photography and smoothing out handheld video shaking, since the appearance of shakes magnifies over a larger display such as a monitor or television set, which would be detrimental to the watching experience. Since 2012, smartphones have become increasingly able to capture photos while filming. The resolution of those photos resolution may vary between devices. Samsung has used the highest image sensor resolution at the video's aspect ratio, which at 16:9 is 6 Megapixels (3264 × 1836) on the Galaxy S3 and 9.6 Megapixels (4128 × 2322) on the Galaxy S4.[105][106] The earliest iPhones with such functionality, iPhone 5 and 5s, captured simultaneous photos at 0.9 Megapixels (1280 × 720) while filming.[107] Starting in 2013 on the Xperia Z1, Sony experimented with real-time augmented reality camera effects such as floating text, virtual plants, volcano, and a dinosaur walking in the scenery.[108] Apple later did similarly in 2017 with the iPhone X.[109] In the same year, iOS 7 introduced the later widely implemented viewfinder intuition, where exposure value can be adjusted through vertical swiping, after focus and exposure has been set by tapping, and even while locked after holding down for a brief moment.[110] On some devices, this intuition may be restricted by software in video/slow motion modes and for front camera. In 2013, Samsung unveiled the Galaxy S4 Zoom smartphone with the grip shape of a compact camera and a 10× optical zoom lens, as well as a rotary knob ring around the lens, as used on higher-end compact cameras, and an ISO 1222 tripod mount. It is equipped with manual parameter settings, including for focus and exposure. The successor 2014 Samsung Galaxy K Zoom brought resolution and performance enhancements, but lacks the rotary knob and tripod mount to allow for a more smartphone-like shape with less protruding lens.[111] The 2014 Panasonic Lumix DMC-CM1 was another attempt at mixing mobile phone with compact camera, so much so that it inherited the Lumix brand. While lacking optical zoom, its image sensor has a format of 1", as used in high-end compact cameras such as the Lumix DMC-LX100 and Sony CyberShot DSC-RX100 series, with multiple times the surface size of a typical mobile camera image sensor, as well as support for light sensitivities of up to ISO 25600, well beyond the typical mobile camera light sensitivity range. As of 2021[update], no successor has been released.[112][113] In 2013 and 2014, HTC experimentally traded in pixel count for pixel surface size on their One M7 and M8, both with only four megapixels, marketed as UltraPixel, citing improved brightness and less noise in low light, though the more recent One M8 lacks optical image stabilization.[114] The One M8 additionally was one of the earliest smartphones to be equipped with a dual camera setup. Its software allows generating visual spatial effects such as 3D panning, weather effects, and focus adjustment ("UFocus"), simulating the postphotographic selective focusing capability of images produced by a light-field camera.[115] HTC returned to a high-megapixel single-camera setup on the 2015 One M9. Meanwhile, in 2014, LG Mobile started experimenting with time-of-flight camera functionality, where a rear laser beam that measures distance accelerates autofocus. Phase-detection autofocus was increasingly adapted throughout the mid-2010s, allowing for quicker and more accurate focusing than contrast detection. In 2016, Apple introduced the iPhone 7 Plus, one of the phones to popularize a dual camera setup. The iPhone 7 Plus included a main 12 MP camera along with a 12 MP telephoto camera.[116] In early 2018 Huawei released a new flagship phone, the Huawei P20 Pro, one of the first triple camera lens setups with Leica optics.[117] In late 2018, Samsung released a new mid-range smartphone, the Galaxy A9 (2018) with the world's first quad camera setup. The Nokia 9 PureView was released in 2019 featuring a penta-lens camera system.[118] 2019 saw the commercialization of high resolution sensors, which use pixel binning to capture more light. 48 MP and 64 MP sensors developed by Sony and Samsung are commonly used by several manufacturers. 108 MP sensors were first implemented in late 2019 and early 2020. Timeline (rear camera) Resolution First year 720p (HD) 2009 720p at 60fps 2012 1080p (Full HD) 2011 1080p at 60fps 2013 2160p (4K) 2013 2160p at 60fps 2017 4320p (8K) 2020 With stronger getting chipsets to handle computing workload demands at higher pixel rates, mobile video resolution and framerate has caught up with dedicated consumer-grade cameras over years. In 2009, the Samsung Omnia HD became the first mobile phone with 720p HD video recording. In the same year, Apple brought video recording initially to the iPhone 3GS, at 480p, whereas the 2007 original iPhone and 2008 iPhone 3G lacked video recording entirely. 720p was more widely adapted in 2010, on smartphones such as the original Samsung Galaxy S, Sony Ericsson Xperia X10, iPhone 4, and HTC Desire HD. The early 2010s brought a steep increase in mobile video resolution. 1080p mobile video recording was achieved in 2011 on the Samsung Galaxy S2, HTC Sensation, and iPhone 4s. In 2012 and 2013, select devices with 720p filming at 60 frames per second were released: the Asus PadFone 2 and HTC One M7, unlike flagships of Samsung, Sony, and Apple. However, the 2013 Samsung Galaxy S4 Zoom does support it. In 2013, the Samsung Galaxy Note 3 introduced 2160p (4K) video recording at 30 frames per second, as well as 1080p doubled to 60 frames per second for smoothness. Other vendors adapted 2160p recording in 2014, including the optically stabilized LG G3. Apple first implemented it in late 2015 on the iPhone 6s and 6s Plus. The framerate at 2160p was widely doubled to 60 in 2017 and 2018, starting with the iPhone 8, Galaxy S9, LG G7, and OnePlus 6. Sufficient computing performance of chipsets and image sensor resolution and its reading speeds have enabled mobile 4320p (8K) filming in 2020, introduced with the Samsung Galaxy S20 and Redmi K30 Pro, though some upper resolution levels were foregone (skipped) throughout development, including 1440p (2.5K), 2880p (5K), and 3240p (6K), except 1440p on Samsung Galaxy front cameras. Mid-class Among mid-range smartphone series, the introduction of higher video resolutions was initially delayed by two to three years compared to flagship counterparts. 720p was widely adapted in 2012, including with the Samsung Galaxy S3 Mini, Sony Xperia go, and 1080p in 2013 on the Samsung Galaxy S4 Mini and HTC One mini. The proliferation of video resolutions beyond 1080p has been postponed by several years. The mid-class Sony Xperia M5 supported 2160p filming in 2016, whereas Samsung's mid-class series such as the Galaxy J and A series were strictly limited to 1080p in resolution and 30 frames per second at any resolution for six years until around 2019, whether and how much for technical reasons is unclear. Setting A lower video resolution setting may be desirable to extend recording time by reducing space storage and power consumption. The camera software of some smartphones is equipped with separate controls for resolution, frame rate, and bit rate. An example of a smartphone with these controls is the LG V10.[119] A distinction between different camera software is the method used to store high frame rate video footage, with more recent phones[a] retaining both the image sensor's original output frame rate and audio, while earlier phones do not record audio and stretch the video so it can be played back slowly at default speed. While the stretched encoding method used on earlier phones enables slow motion playback on video player software that lacks manual playback speed control, typically found on older devices, if the aim were to achieve a slow motion effect, the real-time method used by more recent phones offers greater versatility for video editing, where slowed down portions of the footage can be freely selected by the user, and exported into a separate video. A rudimentary video editing software for this purpose is usually pre-installed. The video can optionally be played back at normal (real-time) speed, acting as usual video. Development The earliest smartphone known to feature a slow motion mode is the 2009 Samsung i8000 Omnia II, which can record at QVGA (320×240) at 120 fps (frames per second). Slow motion is not available on the Galaxy S1, Galaxy S2, Galaxy Note 1, and Galaxy S3 flagships. In early 2012, the HTC One X allowed 768×432 pixel slow motion filming at an undocumented frame rate. The output footage has been measured as a third of real-time speed.[120] In late 2012, the Galaxy Note 2 brought back slow motion, with D1 (720 × 480) at 120 fps. In early 2013, the Galaxy S4 and HTC One M7 recorded at that frame rate with 800 × 450, followed by the Note 3 and iPhone 5s with 720p (1280 × 720) in late 2013, the latter of which retaines audio and original sensor frame rate, as with all later iPhones. In early 2014, the Sony Xperia Z2 and HTC One M8 adapted this resolution as well. In late 2014, the iPhone 6 doubled the frame rate to 240 fps, and in late 2015, the iPhone 6s added support for 1080p (1920 × 1080) at 120 frames per second. In early 2015, the Galaxy S6 became the first Samsung mobile phone to retain the sensor framerate and audio, and in early 2016, the Galaxy S7 became the first Samsung mobile phone with 240 fps recording, also at 720p. In early 2015, the MT6795 chipset by MediaTek promised 1080p@480 fps video recording. The project's status remains indefinite.[121] Since early 2017, starting with the Sony Xperia XZ, smartphones have been released with a slow motion mode that unsustainably records at framerates multiple times as high, by temporarily storing frames on the image sensor's internal burst memory. Such a recording lasts a few real-time seconds at most. In late 2017, the iPhone 8 brought 1080p at 240 fps, as well as 2160p at 60 fps, followed by the Galaxy S9 in early 2018. In mid-2018, the OnePlus 6 brought 720p at 480 fps, sustainable for one minute. In early 2021, the OnePlus 9 Pro became the first phone with 2160p at 120 fps. The first smartphones to record HDR video were the early 2013 Sony Xperia Z and mid-2013 Xperia Z Ultra, followed by the early 2014 Galaxy S5, all at 1080p. Mobile phones with multiple microphones usually allow video recording with stereo audio for spaciality, with Samsung, Sony, and HTC initially implementing it in 2012 on their Samsung Galaxy S3, Sony Xperia S, and HTC One X.[105][122][123] Apple implemented stereo audio starting with the 2018 iPhone Xs family and iPhone XR.[124] Emphasis is being put on the front camera since the mid-2010s, where front cameras have reached resolutions as high as typical rear cameras, such as the 2015 LG G4 (8 megapixels), Sony Xperia C5 Ultra (13 megapixels), and 2016 Sony Xperia XA Ultra (16 megapixels, optically stabilized). The 2015 LG V10 brought a dual front camera system where the second has a wider angle for group photography. Samsung implemented a front-camera sweep panorama (panorama selfie) feature since the Galaxy Note 4 to extend the field of view. In 2012, the Galaxy S3 and iPhone 5 brought 720p HD front video recording (at 30 fps). In early 2013, the Samsung Galaxy S4, HTC One M7 and Sony Xperia Z brought 1080p Full HD at that framerate, and in late 2014, the Galaxy Note 4 introduced 1440p video recording on the front camera. Apple adapted 1080p front camera video with the late 2016 iPhone 7. In 2019, smartphones started adapting 2160p 4K video recording on the front camera, six years after rear camera 2160p commenced with the Galaxy Note 3. A Moto G7 Power; its display uses a tall aspect ratio and includes a "notch". In the early 2010s, larger smartphones with screen sizes of at least 140 millimetres (5.5 in) diagonal, dubbed "phablets", began to achieve popularity, with the 2011 Samsung Galaxy Note series gaining notably wide adoption.[125][126] In 2013, Huawei launched the Huawei Mate series, sporting a 155 millimetres (6.1 in) HD (1280 x 720) IPS+ LCD display, which was considered to be quite large at the time.[127] Some companies began to release smartphones in 2013 incorporating flexible displays to create curved form factors, such as the Samsung Galaxy Round and LG G Flex.[128][129][130] By 2014, 1440p displays began to appear on high-end smartphones.[131] In 2015, Sony released the Xperia Z5 Premium, featuring a 4K resolution display, although only images and videos could actually be rendered at that resolution (all other software was shown at 1080p).[132] New trends for smartphone displays began to emerge in 2017, with both LG and Samsung releasing flagship smartphones (LG G6 and Galaxy S8), utilizing displays with taller aspect ratios than the common 16:9 ratio, and a high screen-to-body ratio, also known as a "bezel-less design". These designs allow the display to have a larger diagonal measurement, but with a slimmer width than 16:9 displays with an equivalent screen size.[133][134][135] Another trend popularized in 2017 were displays containing tab-like cut-outs at the top-centre—colloquially known as a "notch"—to contain the front-facing camera, and sometimes other sensors typically located along the top bezel of a device.[136][137] These designs allow for "edge-to-edge" displays that take up nearly the entire height of the device, with little to no bezel along the top, and sometimes a minimal bottom bezel as well. This design characteristic appeared almost simultaneously on the Sharp Aquos S2 and the Essential Phone,[138] which featured small circular tabs for their cameras, followed just a month later by the iPhone X, which used a wider tab to contain a camera and facial scanning system known as Face ID.[139] The 2016 LG V10 had a precursor to the concept, with a portion of the screen wrapped around the camera area in the top-left corner, and the resulting area marketed as a "second" display that could be used for various supplemental features.[140] A Samsung Galaxy S20 Plus, featuring a "hole-punch" camera Other variations of the practice later emerged, such as a "hole-punch" camera (such as those of the Honor View 20, and Samsung's Galaxy A8s and Galaxy S10)—eschewing the tabbed "notch" for a circular or rounded-rectangular cut-out within the screen instead,[141] while Oppo released the first "all-screen" phones with no notches at all,[142] including one with a mechanical front camera that pops up from the top of the device (Find X),[143] and a 2019 prototype for a front-facing camera that can be embedded and hidden below the display, using a special partially-translucent screen structure that allows light to reach the image sensor below the panel.[144] The first implementation was the ZTE Axon 20 5G, with a 32 MP sensor manufactured by Visionox.[145] Displays supporting refresh rates higher than 60 Hz (such as 90 Hz or 120 Hz) also began to appear on smartphones in 2017; initially confined to "gaming" smartphones such as the Razer Phone (2017) and Asus ROG Phone (2018), they later became more common on flagship phones such as the Pixel 4 (2019) and Samsung Galaxy S21 series (2021). Higher refresh rates allow for smoother motion and lower input latency, but often at the cost of battery life. As such, the device may offer a means to disable high refresh rates, or be configured to automatically reduce the refresh rate when there is low on-screen motion.[146][147] An early implementation of multiple simultaneous tasks on a smartphone display are the picture-in-picture video playback mode ("pop-up play") and "live video list" with playing video thumbnails of the 2012 Samsung Galaxy S3, the former of which was later delivered to the 2011 Samsung Galaxy Note through a software update.[148][149] Later that year, a split-screen mode was implemented on the Galaxy Note 2, later retrofitted on the Galaxy S3 through the "premium suite upgrade".[150] The earliest implementation of desktop and laptop-like windowing was on the 2013 Samsung Galaxy Note 3.[151] Main article: Foldable smartphone Smartphones utilizing flexible displays were theorized as possible once manufacturing costs and production processes were feasible.[152] In November 2018, the startup company Royole unveiled the first commercially available foldable smartphone, the Royole FlexPai. Also that month, Samsung presented a prototype phone featuring an "Infinity Flex Display" at its developers conference, with a smaller, outer display on its "cover", and a larger, tablet-sized display when opened. Samsung stated that it also had to develop a new polymer material to coat the display as opposed to glass.[153][154][155] Samsung officially announced the Galaxy Fold, based on the previously demonstrated prototype, in February 2019 for an originally-scheduled release in late-April.[156] Due to various durability issues with the display and hinge systems encountered by early reviewers, the release of the Galaxy Fold was delayed to September to allow for design changes.[157] In November 2019, Motorola unveiled a variation of the concept with its re-imagining of the Razr, using a horizontally-folding display to create a clamshell form factor inspired by its previous feature phone range of the same name.[158] Samsung would unveil a similar device known as the Galaxy Z Flip the following February.[159] The first smartphone with a fingerprint reader was the Motorola Atrix 4G in 2011.[160] In September 2013, the iPhone 5S was unveiled as the first smartphone on a major U.S. carrier since the Atrix to feature this technology.[161] Once again, the iPhone popularized this concept. One of the barriers of fingerprint reading amongst consumers was security concerns, however Apple was able to address these concerns by encrypting this fingerprint data onto the A7 Processor located inside the phone as well as make sure this information could not be accessed by third-party applications and is not stored in iCloud or Apple servers[162] In 2012, Samsung introduced the Galaxy S3 (GT-i9300) with retrofittable wireless charging, pop-up video playback, 4G-LTE variant (GT-i9305) quad-core processor. In 2013, Fairphone launched its first "socially ethical" smartphone at the London Design Festival to address concerns regarding the sourcing of materials in the manufacturing[163] followed by Shiftphone in 2015.[164] In late 2013, QSAlpha commenced production of a smartphone designed entirely around security, encryption and identity protection.[165] In October 2013, Motorola Mobility announced Project Ara, a concept for a modular smartphone platform that would allow users to customize and upgrade their phones with add-on modules that attached magnetically to a frame.[166][167] Ara was retained by Google following its sale of Motorola Mobility to Lenovo,[168] but was shelved in 2016.[169] That year, LG and Motorola both unveiled smartphones featuring a limited form of modularity for accessories; the LG G5 allowed accessories to be installed via the removal of its battery compartment,[170] while the Moto Z utilizes accessories attached magnetically to the rear of the device.[171] Microsoft, expanding upon the concept of Motorola's short-lived "Webtop", unveiled functionality for its Windows 10 operating system for phones that allows supported devices to be docked for use with a PC-styled desktop environment.[172][173] Samsung and LG used to be the "last standing" manufacturers to offer flagship devices with user-replaceable batteries. But in 2015, Samsung succumbed to the minimalism trend set by Apple, introducing the Galaxy S6 without a user-replaceable battery. In addition, Samsung was criticised for pruning long-standing features such as MHL, MicroUSB 3.0, water resistance and MicroSD card support, of which the latter two came back in 2016 with the Galaxy S7 and S7 Edge. As of 2015[update], the global median for smartphone ownership was 43%.[174] Statista forecast that 2.87 billion people would own smartphones in 2020.[175] Within the same decade, rapid deployment of LTE cellular network and general availability of smartphones have increased popularity of the streaming television services, and the corresponding mobile TV apps.[176] Major technologies that began to trend in 2016 included a focus on virtual reality and augmented reality experiences catered towards smartphones, the newly introduced USB-C connector, and improving LTE technologies.[177] In 2016, adjustable screen resolution known from desktop operating systems was introduced to smartphones for power saving, whereas variable screen refresh rates were popularized in 2020.[178][179] In 2018, the first smartphones featuring fingerprint readers embedded within OLED displays were announced, followed in 2019 by an implementation using an ultrasonic sensor on the Samsung Galaxy S10.[180][181] In 2019, the majority of smartphones released have more than one camera, are waterproof with IP67 and IP68 ratings, and unlock using facial recognition or fingerprint scanners.[182] This layout of the camera viewfinder was first introduced by Apple with iOS 7 in 2013. Towards the late 2010s, several other smartphone vendors have ditched their layouts and implemented variations of this layout. Designs first implemented by Apple have been replicated by other vendors several times. These include a sealed body that does not allow replacing the battery, a lack of the physical audio connector (since the iPhone 7 from 2016), a screen with a cut-out area at the top for the earphone and front-facing camera and sensors (colloquially known as "notch"; since the iPhone X from 2017), the exclusion of a charging wall adapter from the scope of delivery (since the iPhone 12 from 2019), and a camera user interface with circular and usually solid-colour shutter button and a camera mode selector using perpendicular text and separate camera modes for photo and video (since iOS 7 from 2013).[183][184][185][186][187][188] In 2020, the first smartphones featuring high-speed 5G network capability were announced.[189] Since 2020, smartphones have decreasingly been shipped with rudimentary accessories like a power adapter and headphones that have historically been almost invariably within the scope of delivery. This trend was initiated with Apple's iPhone 12, followed by Samsung and Xiaomi on the Galaxy S21 and Mi 11 respectively, months after having mocked the same through advertisements. The reason cited is reducing environmental footprint, though reaching raised charging rates supported by newer models demands a new charger shipped through separate packaging with its own environmental footprint.[190] Mobile/desktop convergence: the Librem 5 smartphone can be used as a basic desktop computer With the development of the PinePhone and Librem 5 in the 2020s, there are intensified efforts to make open source GNU/Linux for smartphones a major alternative to iOS and Android.[191][192][193] Moreover, associated software enabled convergence (beyond convergent[194] and hybrid apps) by allowing the smartphones to be used like a desktop computer when connected to a keyboard, mouse and monitor.[195][196][197][198] In the early 2020s, manufacturers began to integrate satellite connectivity into smartphone devices for use in remote areas, where local terrestrial communication infrastructures, such as landline and cellular networks, are not available. Due to the antenna limitations in the conventional phones, in the early stages of implementation satellite connectivity would be limited to the satellite messaging and satellite emergency services.[199][200] Smartphone with infrared transmitter on top for use as remote control Main article: Mobile phone features A typical smartphone contains a number of metal–oxide–semiconductor (MOS) integrated circuit (IC) chips,[201] which in turn contain billions of tiny MOS field-effect transistors (MOSFETs).[202] A typical smartphone contains the following MOS IC chips:[201] Application processor (CMOS system-on-a-chip) Flash memory (floating-gate MOS memory) Cellular modem (baseband RF CMOS) RF transceiver (RF CMOS) Phone camera image sensor (CMOS image sensor) Power management integrated circuit (power MOSFETs) Display driver (LCD or LED driver) Wireless communication chips (Wi-Fi, Bluetooth, GPS receiver) Sound chip (audio codec and power amplifier) Gyroscope Capacitive touchscreen controller (ASIC and DSP)[201][203][204] RF power amplifier (LDMOS)[205][206][207] Some are also equipped with an FM radio receiver, a hardware notification LED, and an infrared transmitter for use as remote control. A few models have additional sensors such as thermometer for measuring ambient temperature, hygrometer for humidity, and a sensor for ultraviolet ray measurement. A few smartphones designed around specific purposes are equipped with uncommon hardware such as a projector (Samsung Beam i8520 and Samsung Galaxy Beam i8530), optical zoom lenses (Samsung Galaxy S4 Zoom and Samsung Galaxy K Zoom), thermal camera, and even PMR446 (walkie-talkie radio) transceiver.[208][209] Smartphones have central processing units (CPUs), similar to those in computers, but optimised to operate in low power environments. In smartphones, the CPU is typically integrated in a CMOS (complementary metal–oxide–semiconductor) system-on-a-chip (SoC) application processor.[201] The performance of mobile CPU depends not only on the clock rate (generally given in multiples of hertz)[210] but also on the memory hierarchy. Because of these challenges, the performance of mobile phone CPUs is often more appropriately given by scores derived from various standardized tests to measure the real effective performance in commonly used applications. "Device options" menu of Samsung Mobile's TouchWiz user interface as of 2013, accessed by holding the power button for a second The HTC Desire, a 2010 smartphone with optical trackpad and search button Smartphones are typically equipped with a power button and volume buttons. Some pairs of volume buttons are unified. Some are equipped with a dedicated camera shutter button. Units for outdoor use may be equipped with an "SOS" emergency call and "PTT" (push-to-talk button). The presence of physical front-side buttons such as the home and navigation buttons has decreased throughout the 2010s, increasingly becoming replaced by capacitive touch sensors and simulated (on-screen) buttons.[211] As with classic mobile phones, early smartphones such as the Samsung Omnia II were equipped with buttons for accepting and declining phone calls. Due to the advancements of functionality besides phone calls, these have increasingly been replaced by navigation buttons such as "menu" (also known as "options"), "back", and "tasks". Some early 2010s smartphones such as the HTC Desire were additionally equipped with a "Search" button () for quick access to a web search engine or apps' internal search feature.[212] Since 2013, smartphones' home buttons started integrating fingerprint scanners, starting with the iPhone 5s and Samsung Galaxy S5. Functions may be assigned to button combinations. For example, screenshots can usually be taken using the home and power buttons, with a short press on iOS and one-second holding Android OS, the two most popular mobile operating systems. On smartphones with no physical home button, usually the volume-down button is instead pressed with the power button. Some smartphones have a screenshot and possibly screencast shortcuts in the navigation button bar or the power button menu.[213][214][215] Main article: Display device A smartphone touchscreen One of the main characteristics of smartphones is the screen. Depending on the device's design, the screen fills most or nearly all of the space on a device's front surface. Many smartphone displays have an aspect ratio of 16:9, but taller aspect ratios became more common in 2017, as well as the aim to eliminate bezels by extending the display surface to as close to the edges as possible. Screen sizes are measured in diagonal inches. Phones with screens larger than 5.2 inches are often called "phablets". Smartphones with screens over 4.5 inches in size are commonly difficult to use with only a single hand, since most thumbs cannot reach the entire screen surface; they may need to be shifted around in the hand, held in one hand and manipulated by the other, or used in place with both hands. Due to design advances, some modern smartphones with large screen sizes and "edge-to-edge" designs have compact builds that improve their ergonomics, while the shift to taller aspect ratios have resulted in phones that have larger screen sizes whilst maintaining the ergonomics associated with smaller 16:9 displays.[216][217][218] Liquid-crystal displays (LCDs) and organic light-emitting diode (OLED) displays are the most common. Some displays are integrated with pressure-sensitive digitizers, such as those developed by Wacom and Samsung,[219] and Apple's Force Touch system. A few phones, such as the YotaPhone prototype, are equipped with a low-power electronic paper rear display, as used in e-book readers. Tooltip in Kiwi Browser, a Google Chromium derivative, reveals the full URL by hovering over the tab list using the stylus on a Samsung Galaxy Note 4. Optical track pad sensor of an HTC Legend, 2010. Some devices are equipped with additional input methods such as a stylus for higher precision input and hovering detection or a self-capacitive touch screens layer for floating finger detection. The latter has been implemented on few phones such as the Samsung Galaxy S4, Note 3, S5, Alpha, and Sony Xperia Sola, making the Galaxy Note 3 the only smartphone with both so far. Hovering can enable preview tooltips such as on the video player's seek bar, in text messages, and quick contacts on the dial pad, as well as lock screen animations, and the simulation of a hovering mouse cursor on web sites.[220][221][222] Some styluses support hovering as well and are equipped with a button for quick access to relevant tools such as digital post-it notes and highlighting of text and elements when dragging while pressed, resembling drag selection using a computer mouse. Some series such as the Samsung Galaxy Note series and LG G Stylus series have an integrated tray to store the stylus in.[223] Few devices such as the iPhone 6s until iPhone Xs and Huawei Mate S are equipped with a pressure-sensitive touch screen, where the pressure may be used to simulate a gas pedal in video games, access to preview windows and shortcut menus, controlling the typing cursor, and a weight scale, the latest of which has been rejected by Apple from the App Store.[224][225] Some early 2010s HTC smartphones such as the HTC Desire (Bravo) and HTC Legend are equipped with an optical track pad for scrolling and selection.[226] Main article: Notification LED Many smartphones except Apple iPhones are equipped with low-power light-emitting diodes besides the screen that are able to notify the user about incoming messages, missed calls, low battery levels, and facilitate locating the mobile phone in darkness, with marginial power consumption. To distinguish between the sources of notifications, the colour combination and blinking pattern can vary. Usually three diodes in red, green, and blue (RGB) are able to create a multitude of colour combinations. Smartphones are equipped with a multitude of sensors to enable system features and third-party applications. Accelerometers and gyroscopes enable automatic control of screen rotation. Uses by third-party software include bubble level simulation. An ambient light sensor allows for automatic screen brightness and contrast adjustment, and an RGB sensor enables the adaption of screen colour. Many mobile phones are also equipped with a barometer sensor to measure air pressure, such as Samsung since 2012 with the Galaxy S3, and Apple since 2014 with the iPhone 6. It allows estimating and detecting changes in altitude. A magnetometer can act as a digital compass by measuring Earth's magnetic field. Samsung equips their flagship smartphones since the 2014 Galaxy S5 and Galaxy Note 4 with a heart rate sensor to assist in fitness-related uses and act as a shutter key for the front-facing camera.[227] So far, only the 2013 Samsung Galaxy S4 and Note 3 are equipped with an ambient temperature sensor and a humidity sensor, and only the Note 4 with an ultraviolet radiation sensor which could warn the user about excessive exposure.[228][229] A rear infrared laser beam for distance measurement can enable time-of-flight camera functionality with accelerated autofocus, as implemented on select LG mobile phones starting with LG G3 and LG V10. Due to their currently rare occurrence among smartphones, not much software to utilize these sensors has been developed yet. While eMMC (embedded multi media card) flash storage was most commonly used in mobile phones, its successor, UFS (Universal Flash Storage) with higher transfer rates emerged throughout the 2010s for upper-class devices.[230] Capacity While the internal storage capacity of mobile phones has been near-stagnant during the first half of the 2010s, it has increased steeper during its second half, with Samsung for example increasing the available internal storage options of their flagship class units from 32 GB to 512 GB within only 2½ years between 2016 and 2018.[231][232][233][234] Inserted memory and SIM cards Main article: MicroSD § Mobile phones The space for data storage of some mobile phones can be expanded using MicroSD memory cards, whose capacity has multiplied throughout the 2010s (→ SD card § 2009–2019: SDXC). Benefits over USB on the go storage and cloud storage include offline availability and privacy, not reserving and protruding from the charging port, no connection instability or latency,

no dependence on voluminous data plans, and preservation of the limited rewriting cycles of the device's permanent internal storage. Large amounts of data can be moved immediately between devices by changing memory cards, large-scale data backups can be created offline, and data can be read externally should the smartphone be inoperable.[235][236][237] In case of technical defects which make the device unusable or unbootable as a result of liquid damage, fall damage, screen damage, bending damage, malware, or bogus system updates,[238] etc., data stored on the memory card is likely rescueable externally, while data on the inaccessible internal storage would be lost. A memory card can usually[b] immediately be re-used in a different memory-card-enabled device with no necessity for prior file transfers. Some dual-SIM mobile phones are equipped with a hybrid slot, where one of the two slots can be occupied by either a SIM card or a memory card. Some models, typically of higher end, are equipped with three slots including one dedicated memory card slot, for simultaneous dual-SIM and memory card usage.[239] Physical location The location of both SIM and memory card slots vary among devices, where they might be located accessibly behind the back cover or else behind the battery, the latter of which denies hot swapping.[240][241] Mobile phones with non-removable rear cover typically house SIM and memory cards in a small tray on the handset's frame, ejected by inserting a needle tool into a pinhole.[242] Some earlier mid-range phones such as the 2011 Samsung Galaxy Fit and Ace have a sideways memory card slot on the frame covered by a cap that can be opened without tool.[243] Originally, mass storage access was commonly enabled to computers through USB. Over time, mass storage access was removed, leaving the Media Transfer Protocol as protocol for USB file transfer, due to its non-exclusive access ability where the computer is able to access the storage without it being locked away from the mobile phone's software for the duration of the connection, and no necessity for common file system support, as communication is done through an abstraction layer. However, unlike mass storage, Media Transfer Protocol lacks parallelism, meaning that only a single transfer can run at a time, for which other transfer requests need to wait to finish. This, for example, denies browsing photos and playing back videos from the device during an active file transfer. Some programs and devices lack support for MTP. In addition, the direct access and random access of files through MTP is not supported. Any file is wholly downloaded from the device before opened.[244] Some audio quality enhancing features, such as Voice over LTE and HD Voice have appeared and are often available on newer smartphones. Sound quality can remain a problem due to the design of the phone, the quality of the cellular network and compression algorithms used in long-distance calls.[245][246] Audio quality can be improved using a VoIP application over Wi-Fi.[247] Cellphones have small speakers so that the user can use a speakerphone feature and talk to a person on the phone without holding it to their ear. The small speakers can also be used to listen to digital audio files of music or speech or watch videos with an audio component, without holding the phone close to the ear. However, integrated speakers may be small and of restricted sound quality to conserve space. Some mobile phones such as the HTC One M8 and the Sony Xperia Z2 are equipped with stereophonic speakers to create spacial sound when in horizontal orientation.[248] The 3.5mm headphone receptible (coll. "headphone jack") allows the immediate operation of passive headphones, as well as connection to other external auxiliary audio appliances. Among devices equipped with the connector, it is more commonly located at the bottom (charging port side) than on the top of the device. The decline of the connector's availability among newly released mobile phones among all major vendors commenced in 2016 with its lack on the Apple iPhone 7. An adapter reserving the charging port can retrofit the plug. Battery-powered, wireless Bluetooth headphones are an alternative. Those tend to be costlier however due to their need for internal hardware such as a Bluetooth transceiver and a battery with a charging controller, and a Bluetooth coupling is required ahead of each operation.[249] Smartphones typically feature lithium-ion or lithium-polymer batteries due to their high energy densities. Batteries chemically wear down as a result of repeated charging and discharging throughout ordinary usage, losing both energy capacity and output power, which results in loss of processing speeds followed by system outages.[250] Battery capacity may be reduced to 80% after few hundred recharges, and the drop in performance accelerates with time.[251][252] Some mobile phones are designed with batteries that can be interchanged upon expiration by the end user, usually by opening the back cover. While such a design had initially been used in most mobile phones, including those with touch screen that were not Apple iPhones, it has largely been usurped throughout the 2010s by permanently built-in, non-replaceable batteries; a design practice criticized for planned obsolescence.[253] A high-capacity portable battery charger (power bank) Due to limitations of electrical currents that existing USB cables' copper wires could handle, charging protocols which make use of elevated voltages such as Qualcomm Quick Charge and MediaTek Pump Express have been developed to increase the power throughput for faster charging, to maximize the usage time without restricted ergonomy and to minimize the time a device needs to be attached to a power source. The smartphone's integrated charge controller (IC) requests the elevated voltage from a supported charger. "VOOC" by Oppo, also marketed as "dash charge", took the counter approach and increased current to cut out some heat produced from internally regulating the arriving voltage in the end device down to the battery's charging terminal voltage, but is incompatible with existing USB cables, as it requires the thicker copper wires of high-current USB cables. Later, USB Power Delivery (USB-PD) was developed with the aim to standardize the negotiation of charging parameters across devices of up to 100 Watts, but is only supported on cables with USB-C on both endings due to the connector's dedicated PD channels.[254] While charging rates have been increasing, with 15 watts in 2014,[255] 20 Watts in 2016,[256] and 45 watts in 2018,[257] the power throughput may be throttled down significantly during operation of the device.[258][c] Wireless charging has been widely adapted, allowing for intermittent recharging without wearing down the charging port through frequent reconnection, with Qi being the most common standard, followed by Powermat. Due to the lower efficiency of wireless power transmission, charging rates are below that of wired charging, and more heat is produced at similar charging rates. By the end of 2017, smartphone battery life has become generally adequate;[259] however, earlier smartphone battery life was poor due to the weak batteries that could not handle the significant power requirements of the smartphones' computer systems and color screens.[260][261][262] Smartphone users purchase additional chargers for use outside the home, at work, and in cars and by buying portable external "battery packs". External battery packs include generic models which are connected to the smartphone with a cable, and custom-made models that "piggyback" onto a smartphone's case. In 2016, Samsung had to recall millions of the Galaxy Note 7 smartphones due to an explosive battery issue.[263] For consumer convenience, wireless charging stations have been introduced in some hotels, bars, and other public spaces.[264] A technique to minimize power consumption is the panel self-refresh, whereby the image to be shown on the display is not sent at all times from the processor to the integrated controller (IC) of the display component, but only if the information on screen is changed. The display's integrated controller instead memorizes the last screen contents and refreshes the screen by itself. This technology was introduced around 2014 and has reduced power consumption by a few hundred milliwatts.[265] Main articles: Camera phone, Digital camera, and Videophone Cameras have become standard features of smartphones. As of 2019[update] phone cameras are now a highly competitive area of differentiation between models, with advertising campaigns commonly based on a focus on the quality or capabilities of a device's main cameras. Images are usually saved in the JPEG file format; some high-end phones since the mid-2010s also have RAW imaging capability.[266][267] Typically smartphones have at least one main rear-facing camera and a lower-resolution front-facing camera for "selfies" and video chat. Owing to the limited depth available in smartphones for image sensors and optics, rear-facing cameras are often housed in a "bump" that is thicker than the rest of the phone. Since increasingly thin mobile phones have more abundant horizontal space than the depth that is necessary and used in dedicated cameras for better lenses, there is additionally a trend for phone manufacturers to include multiple cameras, with each optimized for a different purpose (telephoto, wide angle, etc.). Viewed from back, rear cameras are commonly located at the top center or top left corner. A cornered location benefits by not requiring other hardware to be packed around the camera module while increasing ergonomy, as the lens is less likely to be covered when held horizontally. Modern advanced smartphones have cameras with optical image stabilisation (OIS), larger sensors, bright lenses, and even optical zoom plus RAW images. HDR, "Bokeh mode" with multi lenses and multi-shot night modes are now also familiar.[268] Many new smartphone camera features are being enabled via computational photography image processing and multiple specialized lenses rather than larger sensors and lenses, due to the constrained space available inside phones that are being made as slim as possible. Some mobile phones such as the Samsung i8000 Omnia 2, some Nokia Lumias and some Sony Xperias are equipped with a physical camera shutter button. Those with two pressure levels resemble the point-and-shoot intuition of dedicated compact cameras. The camera button may be used as a shortcut to quickly and ergonomically launch the camera software, as it is located more accessibly inside a pocket than the power button. Back covers of smartphones are typically made of polycarbonate, aluminium, or glass. Polycarbonate back covers may be glossy or matte, and possibly textured, like dotted on the Galaxy S5 or leathered on the Galaxy Note 3 and Note 4. While polycarbonate back covers may be perceived as less "premium" among fashion- and trend-oriented users, its utilitarian strengths and technical benefits include durability and shock absorption, greater elasticity against permanent bending like metal, inability to shatter like glass, which facilitates designing it removable; better manufacturing cost efficiency, and no blockage of radio signals or wireless power like metal.[269][270][271][272] A wide range of accessories are sold for smartphones, including cases, memory cards, screen protectors, chargers, wireless power stations, USB On-The-Go adapters (for connecting USB drives and or, in some cases, a HDMI cable to an external monitor), MHL adapters, add-on batteries, power banks, headphones, combined headphone-microphones (which, for example, allow a person to privately conduct calls on the device without holding it to the ear), and Bluetooth-enabled powered speakers that enable users to listen to media from their smartphones wirelessly. Cases range from relatively inexpensive rubber or soft plastic cases which provide moderate protection from bumps and good protection from scratches to more expensive, heavy-duty cases that combine a rubber padding with a hard outer shell. Some cases have a "book"-like form, with a cover that the user opens to use the device; when the cover is closed, it protects the screen. Some "book"-like cases have additional pockets for credit cards, thus enabling people to use them as wallets. Accessories include products sold by the manufacturer of the smartphone and compatible products made by other manufacturers. However, some companies, like Apple, stopped including chargers with smartphones in order to "reduce carbon footprint", etc., causing many customers to pay extra for charging adapters. Main article: Mobile operating system A mobile operating system (or mobile OS) is an operating system for phones, tablets, smartwatches, or other mobile devices. Globally, Android and IOS are the two most used mobile operating systems based on usage share, with the former having been the best selling OS globally on all devices since 2013. Mobile operating systems combine features of a personal computer operating system with other features useful for mobile or handheld use; usually including, and most of the following considered essential in modern mobile systems; a touchscreen, cellular, Bluetooth, Wi-Fi Protected Access, Wi-Fi, Global Positioning System (GPS) mobile navigation, video- and single-frame picture cameras, speech recognition, voice recorder, music player, near-field communication, and infrared blaster. By Q1 2018, over 383 million smartphones were sold with 85.9 percent running Android, 14.1 percent running iOS and a negligible number of smartphones running other OSes.[273] Android alone is more popular than the popular desktop operating system Windows, and in general, smartphone use (even without tablets) exceeds desktop use. Other well-known mobile operating systems are Flyme OS and Harmony OS. The Samsung Galaxy S24 Ultra has an artificial intelligence-powered feature Mobile devices with mobile communications abilities (e.g., smartphones) contain two mobile operating systems—the main user-facing software platform is supplemented by a second low-level proprietary real-time operating system which operates the radio and other hardware. Research has shown that these low-level systems may contain a range of security vulnerabilities permitting malicious base stations to gain high levels of control over the mobile device.[274] Main article: Mobile app A mobile app is a computer program designed to run on a mobile device, such as a smartphone. The term "app" is a short-form of the term "software application".[275] Main article: List of mobile app distribution platforms The introduction of Apple's App Store for the iPhone and iPod Touch in July 2008 popularized manufacturer-hosted online distribution for third-party applications (software and computer programs) focused on a single platform. There are a huge variety of apps, including video games, music products and business tools. Up until that point, smartphone application distribution depended on third-party sources providing applications for multiple platforms, such as GetJar, Handango, Handmark, and PocketGear. Following the success of the App Store, other smartphone manufacturers launched application stores, such as Google's Android Market (later renamed to the Google Play Store) and RIM's BlackBerry App World, Android-related app stores like Aptoide, Cafe Bazaar, F-Droid, GetJar, and Opera Mobile Store. In February 2014, 93% of mobile developers were targeting smartphones first for mobile app development.[276] This is a dynamic list and may never be able to satisfy particular standards for completeness. You can help by adding missing items with reliable sources. Asus Gionee Google Pixel Hisense Honor HTC Huawei Infinix iPhone iQOO Itel Lava Lenovo LG Meizu Motorola Nokia Nothing Nubia OnePlus Oppo POCO Realme Redmi Samsung Galaxy Sharp Sony Xperia TCL Tecno Umidigi Vivo Xiaomi ZTE Since 1996, smartphone shipments have had positive growth. In November 2011, 27% of all photographs created were taken with camera-equipped smartphones.[277] In September 2012, a study concluded that 4 out of 5 smartphone owners use the device to shop online.[278] Global smartphone sales surpassed the sales figures for feature phones in early 2013.[279] Worldwide shipments of smartphones topped 1 billion units in 2013, up 38% from 2012's 725 million, while comprising a 55% share of the mobile phone market in 2013, up from 42% in 2012. In 2013, smartphone sales began to decline for the first time.[280][281] In Q1 2016 for the first time the shipments dropped by 3 percent year on year. The situation was caused by the maturing China market.[282] A report by NPD shows that fewer than 10% of US citizens have spent $1,000 or more on smartphones, as they are too expensive for most people, without introducing particularly innovative features, and amid Huawei, Oppo and Xiaomi introducing products with similar feature sets for lower prices.[283][284][285] In 2019, smartphone sales declined by 3.2%, the largest in smartphone history, while China and India were credited with driving most smartphone sales worldwide.[286] It is predicted that widespread adoption of 5G will help drive new smartphone sales.[287][288] See also: List of best-selling mobile phones In 2011, Samsung had the highest shipment market share worldwide, followed by Apple. In 2013, Samsung had 31.3% market share, a slight increase from 30.3% in 2012, while Apple was at 15.3%, a decrease from 18.7% in 2012. Huawei, LG and Lenovo were at about 5% each, significantly better than 2012 figures, while others had about 40%, the same as the previous years figure. Only Apple lost market share, although their shipment volume still increased by 12.9%; the rest had significant increases in shipment volumes of 36 to 92%.[289] In Q1 2014, Samsung had a 31% share and Apple had 16%.[290] In Q4 2014, Apple had a 20.4% share and Samsung had 19.9%.[291] In Q2 2016, Samsung had a 22.3% share and Apple had 12.9%.[292] In Q1 2017, IDC reported that Samsung was first placed, with 80 million units, followed by Apple with 50.8 million, Huawei with 34.6 million, Oppo with 25.5 million and Vivo with 22.7 million.[293] Samsung's mobile business is half the size of Apple's, by revenue. Apple business increased very rapidly in the years 2013 to 2017.[294] Realme, a brand owned by Oppo, is the fastest-growing phone brand worldwide since Q2 2019. In China, Huawei and Honor, a brand owned by Huawei, have 46% of market share combined and posted 66% annual growth as of 2019[update], amid growing Chinese nationalism.[295] In 2019, Samsung had a 74% market share of 5G smartphones in South Korea.[296] In the first quarter of 2024, global smartphone shipments rose by 7.8% to 289.4 million units. Samsung, with a 20.8% market share, overtook Apple to become the leading smartphone manufacturer. Apple's smartphone shipments dropped 10%. Xiaomi secured the third spot with a 14.1% market share.[297] Further information: Mobile operating system § By operating system See also: Mobile phone § Use, and Technological convergence Some technologic devices whose markets have declined by the popularity of smartphones: (from top-left) portable media players (inc. "MP3 players"); compact digital cameras; in-car satellite navigation systems; personal digital assistants (inc. electronic organizers) The rise in popularity of touchscreen smartphones and mobile apps distributed via app stores along with rapidly advancing network, mobile processor, and storage technologies led to a convergence where separate mobile phones, organizers, and portable media players were replaced by a smartphone as the single device most people carried.[298][299][300][301][1][302] Advances in digital camera sensors and on-device image processing software more gradually led to smartphones replacing simpler cameras for photographs and video recording.[92] The built-in GPS capabilities and mapping apps on smartphones largely replaced stand-alone satellite navigation devices, and paper maps became less common.[90] Mobile gaming on smartphones greatly grew in popularity,[303] allowing many people to use them in place of handheld game consoles, and some companies tried creating game console/phone hybrids based on phone hardware and software.[304][305] People frequently have chosen not to get fixed-line telephone service in favor of smartphones.[306][307] Music streaming apps and services have grown rapidly in popularity, serving the same use as listening to music stations on a terrestrial or satellite radio. Streaming video services are easily accessed via smartphone apps and can be used in place of watching television. People have often stopped wearing wristwatches in favor of checking the time on their smartphones, and many use the clock features on their phones in place of alarm clocks.[308] Mobile phones can also be used as a digital note taking, text editing and memorandum device whose computerization facilitates searching of entries. Additionally, in many lesser technologically developed regions smartphones are people's first and only means of Internet access due to their portability,[309][failed verification] with personal computers being relatively uncommon outside of business use. The cameras on smartphones can be used to photograph documents and send them via email or messaging in place of using fax (facsimile) machines. Payment apps and services on smartphones allow people to make less use of wallets, purses, credit and debit cards, and cash. Mobile banking apps can allow people to deposit checks simply by photographing them, eliminating the need to take the physical check to an ATM or teller. Guide book apps can take the place of paper travel and restaurant/business guides, museum brochures, and dedicated audio guide equipment. Main articles: Mobile banking and Mobile payment See also: Branchless banking and Contactless payment Mobile payment system. In many countries, mobile phones are used to provide mobile banking services, which may include the ability to transfer cash payments by secure SMS text message. Kenya's M-PESA mobile banking service, for example, allows customers of the mobile phone operator Safaricom to hold cash balances which are recorded on their SIM cards. Cash can be deposited or withdrawn from M-PESA accounts at Safaricom retail outlets located throughout the country and can be transferred electronically from person to person and used to pay bills to companies. Branchless banking has been successful in South Africa and the Philippines. A pilot project in Bali was launched in 2011 by the International Finance Corporation and an Indonesian bank, Bank Mandiri.[310] Another application of mobile banking technology is Zidisha, a US-based nonprofit micro-lending platform that allows residents of developing countries to raise small business loans from Web users worldwide. Zidisha uses mobile banking for loan disbursements and repayments, transferring funds from lenders in the United States to borrowers in rural Africa who have mobile phones and can use the Internet.[311] Mobile payments were first trialled in Finland in 1998 when two Coca-Cola vending machines in Espoo were enabled to work with SMS payments. Eventually, the idea spread and in 1999, the Philippines launched the country's first commercial mobile payments systems with mobile operators Globe and Smart. Some mobile phones can make mobile payments via direct mobile billing schemes, or through contactless payments if the phone and the point of sale support near-field communication (NFC).[312] Enabling contactless payments through NFC-equipped mobile phones requires the co-operation of manufacturers, network operators, and retail merchants.[313][314] Some apps allows for sending and receiving facsimile (fax), over a smartphone, including facsimile data (composed of raster bi-level graphics) generated directly and digitally from document and image file formats. See also: List of films shot on mobile phones Films are increasingly made using smartphones and tablets, leading to the rise of dedicated film festivals for such films, including the SmartFone Flick Fest in Sydney, Australia;[315][316] Dublin Smartphone Film Festival; the International Mobil Film Festival based in San Diego; the Spanish festival Cinephone – Festival Internacional de Cine con Smartphone; the African Smartphone International Film Festival;[317] Toronto Smartphone Film Festival; New York Mobile Film Festival; and others.[318] Cobalt and lithium are needed in order to manufacture smartphones' rechargeable batteries. Workers in cobalt and lithium mining, including children, suffer injuries, amputations, and death as the result of the hazardous working conditions and mine tunnel collapses in the Democratic Republic of the Congo during artisanal mining of cobalt and lithium.[319] In 2019 a lawsuit was filed against Apple and other tech companies for the use of child labor in mining cobalt;[320][321] in 2024 the court ruled that the companies were not liable.[322] Apple announced it would convert to using recycled cobalt by 2025.[323] Main article: Problematic smartphone use In 2012, University of Southern California study found that unprotected adolescent sexual activity was more common among owners of smartphones.[324] A study conducted by the Rensselaer Polytechnic Institute's (RPI) Lighting Research Center (LRC) concluded that smartphones, or any backlit devices, can seriously affect sleep cycles.[325] Some persons might become psychologically attached to smartphones, resulting in anxiety when separated from the devices.[326] A "smombie" (a combination of "smartphone" and "zombie") is a walking person using a smartphone and not paying attention as they walk, possibly risking an accident in the process, an increasing social phenomenon.[327] The issue of slow-moving smartphone users led to the temporary creation of a "mobile lane" for walking in Chongqing, China.[328] The issue of distracted smartphone users led the city of Augsburg, Germany, to embed pedestrian traffic lights in the pavement.[329] Main articles: Mobile phones and driving safety and Texting while driving A New York City driver holding two phones A user consulting a mapping app on a phone Mobile phone use while driving—including calling, text messaging, playing media, web browsing, gaming, using mapping apps or operating other phone features—is common but controversial, since it is widely considered dangerous due to what is known as distracted driving. Being distracted while operating a motor vehicle has been shown to increase the risk of accidents. In September 2010, the US National Highway Traffic Safety Administration (NHTSA) reported that 995 people were killed by drivers distracted by phones. In March 2011 a US insurance company, State Farm Insurance, announced the results of a study which showed 19% of drivers surveyed accessed the Internet on a smartphone while driving.[330] Many jurisdictions prohibit the use of mobile phones while driving. In Egypt, Israel, Japan, Portugal and Singapore, both handheld and hands-free calling on a mobile phone (which uses a speakerphone) is banned. In other countries, including the UK and France, and in many US states, calling is only banned on handheld phones, while hands-free calling is permitted. A 2011 study reported that over 90% of college students surveyed text (initiate, reply or read) while driving.[331] The scientific literature on the danger of driving while sending a text message from a mobile phone, or texting while driving, is limited. A simulation study at the University of Utah found a sixfold increase in distraction-related accidents when texting.[332] Due to the complexity of smartphones that began to grow more after, this has introduced additional difficulties for law enforcement officials when attempting to distinguish one usage from another in drivers using their devices. This is more apparent in countries which ban both handheld and hands-free usage, rather than those which ban handheld use only, as officials cannot easily tell which function of the phone is being used simply by looking at the driver. This can lead to drivers being stopped for using their device illegally for a call when, in fact, they were using the device legally, for example, when using the phone's incorporated controls for car stereo, GPS or satnav. A sign along Bellaire Boulevard in Southside Place, Texas (Greater Houston) states that using mobile phones while driving is prohibited from 7:30 am to 9:00 am and from 2:00 pm to 4:15 pm. A 2010 study reviewed the incidence of phone use while cycling and its effects on behavior and safety.[333] In 2013 a national survey in the US reported the number of drivers who reported using their phones to access the Internet while driving had risen to nearly one of four.[334] A study conducted by the University of Vienna examined approaches for reducing inappropriate and problematic use of mobile phones, such as using phones while driving.[335] Accidents involving a driver being distracted by being in a call on a phone have begun to be prosecuted as negligence similar to speeding. In the United Kingdom, from 27 February 2007, motorists who are caught using a handheld phone while driving will have three penalty points added to their license in addition to the fine of £60.[336] This increase was introduced to try to stem the increase in drivers ignoring the law.[337] Japan prohibits all use of phones while driving, including use of hands-free devices. New Zealand has banned handheld phone use since 1 November 2009. Many states in the United States have banned text messaging on phones while driving. Illinois became the 17th American state to enforce this law.[338] As of July 2010[update], 30 states had banned texting while driving, with Kentucky becoming the most recent addition on July 15.[339] Public Health Law Research maintains a list of distracted driving laws in the United States. This database of laws provides a comprehensive view of the provisions of laws that restrict the use of mobile devices while driving for all 50 states and the District of Columbia between 1992, when first law was passed through December 1, 2010. The dataset contains information on 22 dichotomous, continuous or categorical variables including, for example, activities regulated (e.g., texting versus talking, hands-free versus handheld calls, web browsing, gaming), targeted populations, and exemptions.[340] Main article: Smartphone wars A "patent war" between Samsung and Apple started when the latter claimed that the original Galaxy S Android phone copied the interface—and possibly the hardware—of Apple's iOS for the iPhone 3GS. There was also smartphone patents licensing and litigation involving Sony Mobile, Google, Apple Inc., Samsung, Microsoft, Nokia, Motorola, HTC, Huawei and ZTE, among others. The conflict is part of the wider "patent wars" between multinational technology and software corporations. To secure and increase market share, companies granted a patent can sue to prevent competitors from using the methods the patent covers. Since the 2010s the number of lawsuits, counter-suits, and trade complaints based on patents and designs in the market for smartphones, and devices based on smartphone OSes such as Android and iOS, has increased significantly. Initial suits, countersuits, rulings, license agreements, and other major events began in 2009 as the smartphone market stated to grow more rapidly by 2012. Main article: Mobile app With the rise in number of mobile medical apps in the market place, government regulatory agencies raised concerns on the safety of the use of such applications. These concerns were transformed into regulation initiatives worldwide with the aim of safeguarding users from untrusted medical advice.[341] According to the findings of these medical experts in recent years, excessive smartphone use in society may lead to headaches, sleep disorders and insufficient sleep, while severe smartphone addiction may lead to physical health problems, such as hunchback, muscle relaxation and uneven nutrition.[342] Main article: Digital media use and mental health There is a debate about beneficial and detrimental impacts of smartphones or smartphone-uses on cognition and mental health. Main articles: Mobile security, Malware, Mobile virus, and Media Transfer Protocol Smartphone malware is easily distributed through an insecure app store.[343][344] Often, malware is hidden in pirated versions of legitimate apps, which are then distributed through third-party app stores.[345][346] Malware risk also comes from what is known as an "update attack", where a legitimate application is later changed to include a malware component, which users then install when they are notified that the app has been updated.[347] As well, one out of three robberies in 2012 in the United States involved the theft of a mobile phone. An online petition has urged smartphone makers to install kill switches in their devices.[348] In 2014, Apple's "Find my iPhone" and Google's "Android Device Manager" can locate, disable, and wipe the data from phones that have been lost or stolen. With BlackBerry Protect in OS version 10.3.2, devices can be rendered unrecoverable to even BlackBerry's own Operating System recovery tools if incorrectly authenticated or dissociated from their account.[349] Leaked documents from 2013 to 2016 codenamed Vault 7 detail the capabilities of the United States Central Intelligence Agency (CIA) to perform electronic surveillance and cyber warfare, including the ability to compromise the operating systems of most smartphones (including iOS and Android).[350][351] In 2021, journalists and researchers reported the discovery of spyware, called Pegasus, developed and distributed by a private company which can and has been used to infect iOS and Android smartphones often—partly via use of 0-day exploits—without the need for any user-interaction or significant clues to the user and then be used to exfiltrate data, track user locations, capture film through its camera, and activate the microphone at any time.[352] Analysis of data traffic by popular smartphones running variants of Android found substantial by-default data collection and sharing with no opt-out by this pre-installed software.[353][354] Guidelines for mobile device security were issued by NIST[355] and many other organizations. For conducting a private, in-person meeting, at least one site recommends that the user switch the smartphone off and disconnect the battery.[356] Main article: Electronic media and sleep Using smartphones late at night can disturb sleep, due to the blue light and brightly lit screen, which affects melatonin levels and sleep cycles. In an effort to alleviate these issues, "Night Mode" functionality to change the color temperature of a screen to a warmer hue based on the time of day to reduce the amount of blue light generated became available through several apps for Android and the f.lux software for jailbroken iPhones.[357] iOS 9.3 integrated a similar, system-level feature known as "Night Shift." Several Android device manufacturers bypassed Google's initial reluctance to make Night Mode a standard feature in Android and included software for it on their hardware under varying names, before Android Oreo added it to the OS for compatible devices.[358] It has also been theorized that for some users, addiction to use of their phones, especially before they go to bed, can result in "ego depletion." Many people also use their phones as alarm clocks, which can also lead to loss of sleep.[359][360][361][362][363] As the 2010s decade commenced, the sale figures of dedicated compact cameras decreased sharply since mobile phone cameras were increasingly perceived as serving as a sufficient surrogate camera.[364] Increases in computing power in mobile phones enabled fast image processing and high-resolution filming, with 1080p Full HD being achieved in 2011 and the barrier to 2160p 4K being breached in 2013. However, due to design and space limitations, smartphones lack several features found even on low-budget compact cameras, including a hot-swappable memory card and battery for nearly uninterrupted operation, physical buttons and knobs for focusing and capturing and zooming, a bolt thread tripod mount, a capacitor-charged xenon flash that exceeds the brightness of smartphones' LED flashlights, and an ergonomic grip for steadier holding during handheld shooting, which enables longer exposure times. Since dedicated cameras can be more spacious, they can house larger image sensors and feature optical zooming. Since the late 2010s, smartphone manufacturers have bypassed the lack of optical zoom to a limited extent by incorporating additional rear cameras with fixed magnification levels.[365][366] Further information: Lithium-ion battery § Lifespan, and Planned obsolescence § Batteries E-waste in Agbogbloshie In mobile phones released since the second half of the 2010s, operational life span commonly is limited by built-in batteries which are not designed to be interchangeable. The life expectancy of batteries depends on usage intensity of the powered device, where activity (longer usage) and tasks demanding more energy expire the battery earlier. Lithium-ion and lithium-polymer batteries, those commonly powering portable electronics, additionally wear down more from fuller charge and deeper discharge cycles, and when unused for an extended amount of time while depleted, where self-discharging may lead to a harmful depth of discharge.[367][368][369] Manufacturers have prevented some smartphones from operating after repairs, by associating components' unique serial numbers to the device so it will refuse to operate or disable some functionality in case of a mismatch that would occur after a replacement. Locking of the serial number was first documented in 2015 on the iPhone 6, which would become inoperable from a detected replacement of the "home" button. Later, some functionality was restricted on Apple and Samsung smartphones when a battery replacement not authorized by the vendor was detected.[370][371] Telephones portalInternet portalModern history portal Comparison of smartphones Lists of mobile computers List of mobile app distribution platforms Media Transfer Protocol Mobile Internet device Portable media player Second screen Smartphone kill switch Smartphone zombie

^ For example, Samsung starting with the Galaxy S6 ^ Presuming common file system support, which is usually given. Some software-specific data left over from a previous device might not be relevant on the new device. ^ I.e. while the device is not in stand-by mode or charging while the main operating system is powered off. ^ a b Islam, Zak (December 30, 2012). "Smartphones Heavily Decrease Sales of iPod, MP3 Players". Tom's Hardware. Retrieved May 3, 2013. ^ "Smartphone sales worldwide 2007-2022". Statista. Retrieved January 24, 2024. ^ "Topic: Smartphones". ^ Meyers, Justin (May 5, 2011). "From Backpack Transceiver to Smartphone: A Visual History of the Mobile Phone". Gadget Hacks. Retrieved June 28, 2022. ^ Sager, Ira (June 29, 2012). "Before IPhone and Android Came Simon, the First Smartphone". Bloomberg.com. Bloomberg News. Retrieved August 18, 2019. ^ Sager, Ira (June 29, 2012). "Before iPhone and Android Came Simon, the First Smartphones". Bloomberg Businessweek. Bloomberg L.P. Archived from the original on July 1, 2012. Retrieved June 30, 2012. Simon was the first smartphone. Twenty years ago, it envisioned our app-happy mobile lives, squeezing the features of a cell phone, pager, fax machine, and computer into an 18-ounce black brick. ^ Schneidawind, John (November 23, 1992). "Poindexter putting finger on PC bugs; Big Blue unveiling". USA Today. p. 2B. ^ Connelly, Charlotte (August 15, 2014). "World's first 'smartphone' celebrates 20 years". BBC News. Retrieved August 16, 2014. ^ History of first touchscreen smartphone Archived May 1, 2016, at the Wayback Machine Spinfold.com ^ Jin, Dal Yong (2017). Smartland Korea: Mobile Communication, Culture, and Society. University of Michigan Press. pp. 34–35. ISBN 9780472053377. ^ Nochkin, Alexandr (July 10, 2013). "IBM Simon. The first smartphone in the World. What's inside". IBM blog (in Russian). Habrahabr.ru. Retrieved June 5, 2017. ^ "First Smartphone Turns 20: Fun Facts About Simon". Time. August 18, 2014. Retrieved August 18, 2019. ^ Mostefaoui, Ghita K.; Tariq, Faisal (2018). Mobile Apps Engineering: Design, Development, Security, and Testing. CRC Press. p. 16. ISBN 9781351681438. ^ Savage, Pamela (January 1995). "Designing a GUI for Business Telephone users". Interactions. 2. Association for Computing Machinery: 32–41. doi:10.1145/208143.208157. ISSN 1072-5520. S2CID 19863684. Retrieved September 13, 2014. ...It is at this point that early usability test participants met impasse. The switch connected to our "smart phone" is expecting the typical "dumb end-point"... AT&T's PhoneWriter was demonstrated at the 1993 Comdex Computer Show... ^ Andersen, Kim Normann; Francesconi, Enrico; Grönlund, Ake; Engers, Tom M. van (August 19, 2011). Electronic Government and the Information Systems Perspective: Second International Conference, EGOVIS 2011, Toulouse, France, August 29 -- September 2, 2011, Proceedings. Springer Science & Business Media. ISBN 978-3-642-22960-2. ^ "Qualcomm's pdQ Smartphone" (Press release). Qualcomm. ^ "Ericsson R380 / R380s | Device Specs". PhoneDB. January 25, 2008. Retrieved September 29, 2019. ^ "PDA Review: Ericsson R380 Smartphone". Geek.com. Archived from the original on July 12, 2011. Retrieved April 27, 2011. ^ Brown, Bruce (April 24, 2001). "Ericsson R380 World Review & Rating". PC Magazine. ^ "Ericsson Introduces The New R380e". Mobile Magazine. Archived from the original on March 25, 2012. Retrieved April 27, 2011. ^ "Kyocera QCP 6035 | Device Specs". PhoneDB. February 29, 2008. Retrieved September 29, 2019. ^ "Kyocera QCP 6035 Smartphone Review". Palm Infocenter. March 16, 2001. Retrieved September 7, 2011. ^ Segan, Sascha (March 23, 2010). "Kyocera Launches First Smartphone In Years | News & Opinion". PCmag.com. Retrieved September 7, 2011. ^ "Nokia 9210 Communicator Device Specs". PhoneDB. October 16, 2007. Retrieved September 28, 2019. ^ "Handspring Treo Communicator 180". mobiletechreview.com. Archived from the original on June 17, 2016. Retrieved February 1, 2016. ^ Rose, Frank (September 2001). "Pocket Monster: How DoCoMo's wireless Internet service went from fad to phenom - and turned Japan into the first post-PC nation". Wired. Vol. 9, no. 9. Retrieved January 24, 2014. ^ Huff, Sid L.; Barnes, Stuart J (November 1, 2003). Rising Sun: iMode and the Wireless Internet, Vol. 46, No. 1. Communications of the ACM. pp. 79–84. ^ Anwar, Sayid Tariq. "NTT DoCoMo and M-Commerce: A Case Study in Market Expansion and Global Strategy" (PDF). The American Graduate School of International Management. Retrieved February 16, 2014. ^ Tabuchi, Hiroko (July 20, 2009). "Why Japan's Smartphones Haven't Gone Global". The New York Times. Retrieved October 6, 2018. ^ Budmar, Patrick (July 11, 2012). "Why Japanese smartphones never went global". PC World AU. Archived from the original on June 12, 2018. Retrieved October 6, 2018. ^ Stewart, Devin (April 29, 2010). "Slowing Japan's Galapagos Syndrome". Huffington Post. Retrieved June 24, 2010. 'Galapagos syndrome', a phrase originally coined to describe Japanese cell phones that were so advanced they had little in common with devices used in the rest of the world, could potentially spread to other parts of society. Indeed signs suggest it is happening already. ^ "Info Addicts Are All Thumbs: Crackberry Is the 2006 Word of the Year". PR Newswire. November 1, 2006. Retrieved January 24, 2014. ^ "The Nokia E Series Range of Smartphones". Brighthub.com. September 27, 2010. Retrieved September 6, 2017. ^ Schroeder, Stan (February 23, 2010). "Smartphones in 2009: Symbian Dominates, iPhone, RIM and Android Rising Fast". Mashable. Retrieved September 3, 2013. ^ a b Whitwam, Ryan (October 7, 2011). "How Steve Jobs killed the stylus and made smartphones usable". ExtremeTech. Retrieved April 4, 2018. ^ a b c d Elgan, Mike (July 2, 2011). "How iPhone Changed the World". Cult of Mac. Retrieved October 17, 2019. ^ "LG, Prada to Start Selling Mobile Phone at Start of Next Year" (Press release). December 11, 2006. Archived from the original on January 8, 2007. ^ Temple, Stephen. "Vintage Mobiles: LG Prada - First mobile with a capacitive touchscreen (May 2007)". History of GMS: Birth of the mobile revolution. ^ "LG KE850 Prada review: Sophistication made simple". May 27, 2007. p. 4. Retrieved June 23, 2021. ^ Jobs, Steve (January 19, 2007). Macworld San Francisco 2007 Keynote Address. San Francisco: Apple, Inc. Archived from the original on December 22, 2010. ^ Cohen, Peter (March 13, 2007). "Macworld Expo Keynote Live Update". Macworld. Archived from the original on July 24, 2010. Retrieved July 21, 2010. ^ "Apple Reinvents the Phone with iPhone" (Press release). Apple Inc. January 9, 2007. Retrieved October 16, 2019. ^ Louis, Tristan (January 9, 2007). "The iPhone is here". TNL.net. Retrieved October 16, 2019. ^ Mossberg, Walter S.; Boehret, Katherine (June 26, 2007). "The iPhone Is a Breakthrough Handheld Computer". The Mossberg Solution. Archived from the original on June 14, 2021. Retrieved October 17, 2019. The iPhone is the first smart phone we've tested with a real, computer-grade Web browser, a version of Apple's Safari. It displays entire Web pages, in their real layouts, and allows you to zoom in quickly by either tapping or pinching with your finger. ^ Levy, Steven (June 25, 2007). "First Look: Test Driving the iPhone". Newsweek. Retrieved October 16, 2019. Web-browsing is where the iPhone leaves competitors in the dust. It does the best job yet of compressing the World Wide Web on a palm-size device. The screen can nicely display an entire Web page, and by dragging, tapping, pinching and stretching your fingers you can zero in on the part of the page you want to read. Web pages you wouldn't dare go to on other phones are suddenly accessible ^ Baig, Ed (June 26, 2007). "iPhone Review". USA Today. Retrieved October 16, 2019. This is the closest thing to the real-deal Internet that I've seen on a pocket-size device ... IPhone runs Apple's Safari browser. You can view full Web pages, then double-tap the screen to zoom in. Or pinch to make text larger. Sliding your finger moves the page around. Rotating iPhone lets you view a page widescreen. ^ Shea, Dave (January 9, 2007). "iMobile". mezzoblue.com. Archived from the original on October 17, 2019. Retrieved October 16, 2019. It doesn't run a stripped-down mobile browser that delivers a sub-par experience, it runs Safari - a customized version with special UI tweaks, but that's still WebKit under the hood. It will render your site the same way your desktop does. ^ Duncan, Geoff (October 17, 2007). "Apple confirms iPhone SDK coming next year". Digital Trends. Retrieved June 11, 2017. ^ "Steve Jobs confirms native iPhone SDK by February". AppleInsider. October 17, 2007. Retrieved June 11, 2017. ^ Dalrymple, Jim (March 6, 2008). "Apple unveils iPhone SDK". Macworld. International Data Group. Retrieved June 11, 2017. ^ Block, Ryan (March 6, 2008). "Live from Apple's iPhone SDK press conference". Engadget. AOL. Retrieved June 11, 2017. ^ "The Day Google Had to 'Start Over' on Android". The Atlantic. December 18, 2013. Retrieved December 20, 2013. ^ Elgin, Ben (August 17, 2005). "Google Buys Android for Its Mobile Arsenal". Bloomberg Businessweek. Bloomberg. Archived from the original on February 5, 2011. Retrieved February 20, 2012. ^ Block, Ryan (August 28, 2007). "Google is working on a mobile OS, and it's due out shortly". Engadget. Retrieved February 17, 2012. ^ Cha, Bonnie (January 23, 2009). "All T-Mobile retail stores to carry G1". CNET. Retrieved December 28, 2021. ^ "Bendgate: Is the iPhone 6 Plus bending too easily or is it a st". www.pocket-lint.com. September 24, 2014. Retrieved January 26, 2022. ^ Oreskovic, Alexei (January 23, 2017). "Here's Samsung's infographic that explains why the Note 7 phones exploded". Business Insider. Retrieved January 26, 2022. ^ "How to access the hardware menu button on Samsung Galaxy S5?". Samsung Galaxy S5 Guide. May 7, 2014. ^ Stokes, Jon (January 8, 2009). "Palm strikes back with new OS, pre handset at CES". Ars Technica. Retrieved February 25, 2020. ^ Stokes, Jon (January 12, 2009). ""Synergy" means no need to "save" or "sync" on Palm's pre". Ars Technica. Retrieved February 25, 2020. ^ Iwatani, Yukari (August 19, 2011). "Pioneering Firm Bows to 'Post-PC World'". The Wall Street Journal. Retrieved November 30, 2011. ^ "HP sells Palm WebOS assets to LG". BBC News. February 26, 2013. Retrieved March 2, 2020. ^ Cha, Bonnie. "BlackBerry Torch 9800 review: BlackBerry Torch 9800". CNET. Retrieved February 25, 2020. ^ "Can Blackerry Torch compete with iPhone?". Orange County Register. September 21, 2010. Retrieved February 25, 2020. ^ "RIM launches BlackBerry Torch 9810, Torch 9860 and Bold 9900, we go hands-on!". Engadget. August 3, 2011. Retrieved February 25, 2020. ^ Topolsky, Joshua (January 30, 2013). "BlackBerry Z10 review: a new life, or life support?". The Verge. Retrieved February 25, 2020. ^ "Windows Phone 7: An In-depth Look at the Features and Interface". PCWorld. February 15, 2010. Retrieved February 25, 2020. ^ "Nokia and Microsoft form partnership". BBC News. February 11, 2011. Retrieved December 16, 2018. ^ Weintraub, Seth (February 8, 2011). "Nokia's Elop drops bomb: the platform is on fire". CNN. Archived from the original on June 27, 2013. Retrieved June 14, 2013. ^ ben-Aaron, Diana (February 11, 2011). "Nokia Falls Most Since July 2009 After Microsoft Deal". Bloomberg. Retrieved February 26, 2020. ^ a b Bright, Peter (October 9, 2017). "Windows Phone is now officially dead: A sad tale of what might have been". Ars Technica. Retrieved February 26, 2020. ^ Tung, Liam. "Lumia 520 extends lead as most popular Windows Phone, as Nokia takes 90 percent of the market". ZDNet. Retrieved February 26, 2020. ^ Miller, Matthew. "IDC: Windows Phone sees largest year-over-year increase, Android still dominates". ZDNet. Retrieved February 26, 2020. ^ Vincent, James (February 16, 2017). "99.6 percent of new smartphones run Android or iOS". The Verge. Retrieved February 25, 2020. ^ Savov, Vlad (August 20, 2015). "96.8 percent of new smartphones sold are either iPhone or Android devices". The Verge. Retrieved March 2, 2020. ^ "BlackBerry bails on building its own phones". CNET. Retrieved June 21, 2017. ^ "TCL signs an exclusive deal to build BlackBerry-branded phones". TechCrunch. December 15, 2016. Retrieved December 15, 2016. ^ "BlackBerry bets on Android's apps to buoy new Priv". The Globe & Mail. Retrieved September 26, 2015. ^ a b Warren, Tom (July 8, 2015). "Microsoft writes off $7.6 billion from Nokia deal, announces 7,800 job cuts". The Verge. Retrieved February 26, 2020. ^ Rivera, Jaime (October 18, 2013). "Nokia owns 90% of the Windows Phone market share". PocketNow. Archived from the original on November 16, 2017. Retrieved February 26, 2020. ^ Warren, Tom (October 23, 2015). "Windows Phone has a new app problem". The Verge. Retrieved February 26, 2020. ^ Warren, Tom (May 25, 2016). "Microsoft lays off hundreds as it guts its phone business". The Verge. Retrieved February 26, 2020. ^ Savov, Vlad (October 10, 2017). "Windows Phone was a glorious failure". The Verge. Retrieved February 26, 2020. ^ Warren, Tom (February 24, 2014). "This is Nokia X: Android and Windows Phone collide". The Verge. Retrieved March 2, 2020. ^ a b c Yegulalp, Serdar (May 11, 2012). "Camera phones: A look back and forward". Computerworld. Archived from the original on October 9, 2019. Retrieved September 15, 2019. ^ "First mobile videophone introduced". CNN. May 18, 1999. Archived from the original on March 17, 2002. Retrieved September 15, 2019. ^ Wan, Hoi (February 28, 2012). "Evolution of the Camera phone: From Sharp J-SH04 to Nokia 808 Pureview". Hoista.net. Archived from the original on July 31, 2013. Retrieved June 21, 2013. ^ "From J-Phone to Lumia 1020: A complete history of the camera phone". Digital Trends. August 11, 2013. Retrieved September 15, 2019. ^ "Taking pictures with your phone". BBC News. BBC. September 18, 2001. Retrieved September 15, 2019. ^ a b O'Brien, Kevin J. (November 15, 2010). "Smartphone Sales Taking Toll on G.P.S. Devices". The New York Times. ^ "Nokia 6111 review: Venus and maybe Mars too". GSMArena.com. ^ a b Ogg, Erica (December 22, 2011). "Smartphones killing point-and-shoots, now take almost 1/3 of photos". Gigaom. Archived from the original on July 14, 2019. Retrieved October 22, 2019. ^ Siegler, MG (April 17, 2011). "iPhone 4 About To Be Flickr's Top Camera. Point & Shoots? Pretty Much The Opposite". TechCrunch. Retrieved November 4, 2019. ^ Cooke, Alex (October 30, 2017). "Nikon Closes China Camera Factory, Cites Smartphones as Cause". Fstoppers. Retrieved August 23, 2019. ^ "Smile, and Say 'Android'". The New York Times. December 20, 2012. Retrieved August 22, 2013. ^ Stirr, Thomas (April 2, 2016). "Digital Camera Sales Continued To Decline In 2015". Archived from the original on October 31, 2016. Retrieved October 31, 2016. ^ "Worldwide unit sales of digital cameras from 2011 to 2016 (in millions)". Retrieved March 28, 2017. ^ "Sony Ericsson Satio – A Phone with Ultimate multimedia experience". Newtechnology.co.in. Archived from the original on July 14, 2012. Retrieved June 21, 2013. ^ "Samsung Pixon12 M8910 Price in India - 12 megapixel camera-phone". Newtechnology.co.in. Archived from the original on April 24, 2012. Retrieved June 21, 2013. ^ "Nokia N86 8MP review: Lens wide open". GSMArena.com. June 24, 2009. p. 7. ^ Chan, John (June 15, 2010). "Hands-on with the 14-megapixel Altek Leo". CNET. CBS Interactive. Archived from the original on April 3, 2012. ^ Cozma, Nicole. "Use your voice to take pictures with the Samsung Galaxy S III". CNET. Retrieved May 29, 2021. ^ "Nokia 808 PureView review: Photo Finnish". GSMArena.com. June 22, 2012. p. 7. ^ Dobie, Alex (April 19, 2016). "HTC 10 review: Iconic, impressive, imperfect". Android Central. Retrieved May 16, 2023. ^ a b "Samsung I9300 Galaxy S III review: S to the third". GSMArena.com. May 20, 2012. p. 9. ^ "Samsung Galaxy S4 review: Supernova". GSMArena.com. March 28, 2013. p. 9. ^ Costello, sam (January 22, 2020). "Snap Photos and Record Video on an iPhone at the Same Time". Lifewire. ^ "Sony Xperia Z1 review: A smartphone with a camera-sized sensor". DPReview. November 1, 2013. ^ Carson, Biz (September 12, 2017). "Tim Cook Isn't Wrong: Why The iPhone X Could Change How We Use Phones Forever". Forbes. ^ "How to control focus and depth of field on your iPhone camera". Macworld. January 5, 2014. ^ "Samsung Galaxy K Zoom vs Galaxy S4 Zoom: What's the difference?". www.pocket-lint.com. April 29, 2014. Retrieved April 20, 2021. ^ "Panasonic Lumix DMC-CM1 camera review". DPReview. May 27, 2015. p. 10. Retrieved April 20, 2021. ^ Brawley, William (April 27, 2015). "Panasonic CM1 Review". Imaging Resource. Retrieved April 20, 2021. ^ "UltraPixel Camera Image Quality Review". Trusted Reviews. November 18, 2016. p. 7. ^ Savvides, Lexy (April 10, 2014). "HTC One M8: the camera review". CNET. ^ Cade, DL (October 24, 2016). "Apple Just Released Their Fake Bokeh Portrait Mode to Everyone". PetaPixel. Retrieved November 5, 2019. ^ Boxall, Andy (June 4, 2018). "Huawei P20 Pro review". ^ "Nokia 9 PureView - Full phone specifications". GSMarena.com. Retrieved May 20, 2019. ^ La, Lynn. "The dual-display LG V10 offers ultimate camera and video control (review)". CNET. ^ "HTC One X review: eXtra special". GSMArena.com. April 12, 2012. ^ "MediaTek shows off 480fps super slow-motion 1080p video recording on the MT6795". Neowin. February 17, 2015. ^ "Sony Xperia S review: NXT of kin". GSMArena.com. p. 6. ^ "HTC One X review: eXtra special". GSMArena.com. Retrieved April 2, 2021. ^ "Apple iPhone XS review". GSMArena.com. p. 7. ^ Smith, Mat (December 29, 2011). "1 million Galaxy Notes shipped worldwide, US fans throw money at their screens". Engadget. ^ "Samsung: 10M Galaxy Notes sold in nine months". CNET. Retrieved January 18, 2013. ^ History Of The Huawei Mate Flagships 2 May 2019. ^ "Samsung's Galaxy Round is the first phone with a curved display". The Verge. Vox Media. October 8, 2013. Retrieved March 21, 2017. ^ "LG G Flex appears on the FCC with AT&T-friendly LTE". Engadget. November 15, 2013. Retrieved March 9, 2014. ^ "LG G Flex announced with vertically curved 6-inch 720p screen, 'self-repairing' back cover". Engadget. Verizon Media. October 28, 2013. Retrieved March 9, 2014. ^ Dent, Steve (February 18, 2014). "Do you really need a 4K smartphone screen?". ^ "Sony's 4K smartphone shows most content in 1080p". Engadget. September 15, 2015. Retrieved March 21, 2017. ^ "LG G6 With 5.7-Inch FullVision Display, Google Assistant Launched at MWC 2017". Gadgets360. NDTV. February 26, 2017. Retrieved February 26, 2017. ^ "The LG G6 is sleek, solid, and surprisingly sensible". The Verge. Vox Media. February 26, 2017. Retrieved February 26, 2017. ^ "This is the Samsung Galaxy S8, coming April 21st". The Verge. Retrieved October 4, 2018. ^ Mathur, Vishal (April 29, 2018). "Why do Android phones want a notch?". Livemint. Retrieved October 4, 2018. ^ "Google thankfully bans Android phones with three notches or other exotic configurations". PCWorld. Retrieved October 4, 2018. ^ Petrov, Daniel. "What was the first phone with a notch? Answer may surprise you". Phone Arena. Retrieved October 4, 2018. ^ Axon, Samuel (November 25, 2017). "How app developers and designers feel about the iPhone X—and the notch". Ars Technica. Condé Nast. Retrieved December 4, 2017. ^ Williams, Andrew (November 14, 2018). "Cut it out: how the smartphone notch became 'a thing'". TechRadar. Retrieved February 25, 2020. ^ "Is the hole-punch camera here to stay? We look at the pros and cons of the front camera design". Pocket-lint. February 11, 2020. Retrieved February 25, 2020. ^ Low, Aloysius (August 20, 2019). "Oppo Find X review: Sexier and more innovative than the Galaxy S9". CNET. Retrieved February 26, 2020. ^ Seifert, Dan (June 19, 2018). "Oppo's Find X ditches the notch for pop-up cameras". The Verge. Retrieved February 25, 2020. ^ Byford, Sam (June 26, 2019). "Oppo unveils the world's first under-screen selfie camera". The Verge. Retrieved February 25, 2020. ^ Peters, Jay (August 19, 2020). "Here's your best look yet at ZTE's first smartphone with an under-display camera". The Verge. Retrieved September 1, 2020. ^ Jansen, Mark (July 19, 2020). "What does a 90Hz or 120Hz refresh rate mean for your smartphone screen?". Digital Trends. Retrieved July 23, 2020. ^ Savov, Vlad (June 7, 2018). "Android gaming phones have a lot of growing up to do". The Verge. Retrieved May 26, 2021. ^ "Samsung I9300 Galaxy S III review: S to the third". GSMArena.com. May 20, 2012. p. 8. Retrieved May 29, 2021. ^ "N7000UBLS4 – Galaxy Note Android 4.1.2 Jelly Bean TEST firmware From Tel Cel Mexico". SamMobile. February 17, 2013. ^ Reisinger, Don (December 7, 2012). "Samsung's Galaxy S3 to get Premium Suite upgrade". CNET. ^ "Samsung Galaxy Note 3 User Guide". Tom's Guide. September 7, 2013. ^ King, Ian (December 15, 2013). "Bendable smartphones aren't coming anytime soon". The Sydney Morning Herald. Retrieved February 5, 2019. ^ Warren, Tom (November 8, 2018). "The foldable phones are coming". The Verge. Retrieved February 5, 2019. ^ Statt, Nick (November 5, 2018). "We tried the world's first folding phone, and it actually works". The Verge. Retrieved February 5, 2019. ^ Warren, Tom (November 7, 2018). "This is Samsung's foldable smartphone". The Verge. Retrieved February 5, 2019. ^ Dunn, Jeff (February 20, 2019). "Samsung's foldable phone is finally official—meet the Galaxy Fold". Ars Technica. Retrieved February 23, 2019. ^ Warren, Tom (September 5, 2019). "How Samsung fixed the Galaxy Fold". The Verge. Retrieved February 25, 2020. ^ Gartenberg, Chaim (November 13, 2019). "Motorola resurrects the Razr as a foldable Android smartphone". The Verge. Retrieved February 25, 2020. ^ Dolcourt, Jessica. "Samsung Galaxy Z Flip's foldable glass screen: Already more impressive than the Razr". CNET. Retrieved May 26, 2021. ^ "Fingerprint Scanner On Phones: History & Evolution, But Do We Really Need That?". Web cusp. April 17, 2016. Archived from the original on July 26, 2020. Retrieved March 15, 2018. ^ Newton, Casey (September 10, 2013). "Apple's new iPhone will read your fingerprint". The Verge. Retrieved September 11, 2013. ^ "Touch ID: Inside the fingerprint scanner on Apple's iPhone 5s". NDTV Gadgets 360. September 11, 2013. Retrieved January 25, 2021. ^ Monbiot, George (September 23, 2013). "Why is Apple so shifty about how it makes the iPhone?". The Guardian. Retrieved September 24, 2013. ^ Schröder, Horst (April 4, 2016). "So gut ist das erste Fairphone aus Deutschland". www.gruenderszene.de. Retrieved September 5, 2018. ^ Etherington, Darrell (October 10, 2013). "Quasar IV Encrypted Ninja Smartphone Goes Into Production, Despite Indiegogo Failure". TechCrunch. Verizon Media. Retrieved October 10, 2013. ^ Byford, Sam (October 29, 2013). "Motorola reveals ambitious plan to build modular smartphones". The Verge. Vox Media. Retrieved October 29, 2013. ^ Musil, Steven (October 29, 2013). "Motorola unveils Project Ara for custom smartphones". CNET. CBS Interactive. Retrieved October 29, 2013. ^ Pierce, David. "Project Ara Lives: Google's Modular Phone Is Ready for You Now". Wired. Retrieved May 20, 2016. ^ "Google confirms the end of its modular Project Ara smartphone". The Verge. Vox Media. September 2, 2016. Retrieved September 2, 2016. ^ "LG G5 hands-on—LG may have made the most innovative phone of MWC". Ars Technica. February 21, 2016. Retrieved February 21, 2016. ^ "Motorola's new Moto Z ditches the headphone jack, adds hot-swapping magnetic modular accessories". CNET. CBS Interactive. Retrieved June 9, 2016. ^ "Inside Microsoft's Plan to Unlock the Full Power of Your Phone". Time. November 20, 2015. Retrieved March 21, 2017. ^ Miller, Ross (October 6, 2015). "Microsoft's new Display Dock transforms your Windows 10 mobile into a PC". The Verge. Vox Media. Retrieved October 6, 2015. ^ "This map shows the percentage of people around the world who own smartphones". Business Insider. ^ "Number of smartphone users worldwide 2014-2020 | Statista". Statista. Retrieved May 23, 2017. ^ "In 4G era, app, video streaming experience key for brand loyalty: Report". www.thehindubusinessline.com. August 26, 2016. Retrieved January 20, 2023. ^ "7 exciting smartphone trends to watch in 2016: VR, super-fast LTE, and more". PC World. February 5, 2016. Retrieved March 21, 2017. ^ "Galaxy Note 7 power saving mode lowers resolution to save battery". SlashGear. August 3, 2016. Retrieved October 31, 2021. ^ "Samsung's adaptive refresh rate tech could be coming to a phone near you". Android Authority. August 11, 2020. Retrieved October 31, 2021. ^ "I tried the first phone with an in-display fingerprint sensor". The Verge. Retrieved October 4, 2018. ^ Seifert, Dan (February 20, 2019). "Samsung officially announces the Galaxy S10 and S10 Plus, starting at $899". The Verge. Retrieved February 20, 2019. ^ "Seven New Smartphone Features For 2019 - TelcoWorld Corp. Melbourne Mobile Phone Repairs". ^ "Samsung is hiding its ads that made fun of Apple's removal of headphone jack". Android Authority. August 8, 2019. Retrieved October 17, 2022. ^ Smith, Dave (June 6, 2019). "Apple's iPhone X introduced the 'notch' trend 2 years ago. Now, smartphone makers are trying to kill it once and for all". Business Insider. Retrieved October 17, 2022. ^ Rosenberg, Adam (December 26, 2020). "Xiaomi ditches chargers for the Mi 11 after mocking Apple's similar move". Mashable. Retrieved October 17, 2022. ^ "Xiaomi Removes Charger From Box After Mocking Apple For It". NDTV.com. December 28, 2020. Retrieved October 17, 2022. ^ Robbins, Ebenezer (September 11, 2022). "After Apple, Xiaomi and Samsung: The next mobile manufacturer falls apart". Tech Gaming Report. Retrieved October 17, 2022. ^ c. f. camera software of Samsung since the Galaxy S10, of Huawei since the P20, of LG since the G8, since the OnePlus 6, of Xiaomi since Redmi Note 5, and of UleFone smartphones released since at least 2017 (as of 2022). ^ Alspach, Kyle (October 17, 2019). "10 Mobile Trends To Watch Out For In 2020". CRN. Retrieved February 10, 2021. ^ Tranate, Jess (December 28, 2020). "Samsung, Xiaomi Remove Charger From Smartphones After Mocking Apple". HNGN - Headlines & Global News. Retrieved September 27, 2021. ^ "The $149 Smartphone That Could Bring The Linux Mobile Ecosystem to Life". Vice. Retrieved January 30, 2022. ^ Vaughan-Nichols, Steven. "PinePhone KDE Linux phone is getting ready for pre-orders". ZDNet. Retrieved January 30, 2022. ^ Amadeo, Ron (September 26, 2019). "Purism's Librem 5 phone starts shipping—a fully open GNU/Linux phone". Ars Technica. Retrieved January 30, 2022. ^ Nestor, Marius (February 16, 2020). "Maui Project Wants to Bring Convergent Apps to Linux Desktops and Android". 9to5Linux. Retrieved January 30, 2022. ^ Jose, Manuel. "Purism: A Linux OS is talking Convergence again". ^ Larabel, Michael. "Purism's PureOS Proclaims Convergence Success For Mobile & Desktop Support - Phoronix". Phoronix. ^ Crume, Jacob (December 30, 2021). "Maui Shell is Here, Ushering in a New Era of Desktop Linux". It's FOSS – News. Retrieved January 16, 2022. ^ Hamner, David (September 29, 2020). "Desktop and Phone Convergence". Purism. Retrieved January 30, 2022. ^ "Qualcomm's Snapdragon Satellite will let Android phones text off the grid". Engadget. January 5, 2023. Retrieved January 15, 2023. ^ "The problems with Elon Musk's satellite phone plan". Quartz. August 26, 2022. Retrieved January 15, 2023. ^ a b c d Kim, Woonyun (2015). "CMOS power amplifier design for cellular applications: an EDGE/GSM dual-mode quad-band PA in 0.18 µm CMOS". In Wang, Hua; Sengupta, Kaushik (eds.). RF and mm-Wave Power Generation in Silicon. Academic Press. pp. 89–90. ISBN 978-0-12-409522-9. ^ "Remarks by Director Iancu at the 2019 International Intellectual Property Conference". United States Patent and Trademark Office. June 10, 2019. Retrieved July 20, 2019. ^ Kent, Joel (May 2010). "Touchscreen technology basics & a new development". 2010 CMOS Emerging Technologies Conference Presentation Slides. Vol. 6. CMOS Emerging Technologies. ISBN 9781927500057. ^ Ganapati, Priya (March 5, 2010). "Finger Fail: Why Most Touchscreens Miss the Point". Wired. Archived from the original on May 11, 2014. Retrieved November 9, 2019. ^ Baliga, B. Jayant (2005). Silicon RF Power MOSFETS. World Scientific. ISBN 9789812561213. ^ Asif, Saad (2018). 5G Mobile Communications: Concepts and Technologies. CRC Press. pp. 128–134. ISBN 9780429881343. ^ "LDMOS Products and Solutions". NXP Semiconductors. Retrieved December 4, 2019. ^ "Camera and thermal imaging Review". Trusted Reviews. November 11, 2016. Retrieved April 19, 2021. ^ Chopra, Purvi (November 19, 2018). "Ulefone Armor 3T Review: A Digital Walkie-Talkie Smartphone". Veditto. Retrieved April 19, 2021. ^ "CPU Frequency". CPU World Glossary. CPU World. March 25, 2008. Retrieved January 1, 2010. ^ Athow, Desire (March 9, 2021). "Best rugged smartphones of 2021: waterproof, shockproof and IP68 mobiles". TechRadar. Retrieved June 18, 2021. ^ Corbin Davenport (November 13, 2019). "The menu navigation button has finally been retired in Android 10". Retrieved June 20, 2021. ^ Krasnoff, Barbara (July 27, 2020). "How to take screenshots on your iPhone". The Verge. Retrieved June 21, 2021. ^ "How to Take Screenshot on LG G3 (3 Methods)". DroidViews. August 14, 2014. Retrieved June 21, 2021. ^ "4 Ways To Take a Screenshot on the Samsung Galaxy Note 20 and Note 20 Ultra - NaldoTech". August 20, 2020. Retrieved June 21, 2021. ^ "Don't call it a phablet: the 5.5" Samsung Galaxy S7 Edge is narrower than many 5.2" devices". PhoneArena. March 21, 2016. Retrieved April 3, 2017. ^ "We're gonna need Pythagoras' help to compare screen sizes in 2017". The Verge. March 30, 2017. Retrieved April 3, 2017. ^ "The Samsung Galaxy S8 will change the way we think about display sizes". The Verge. Vox Media. March 30, 2017. Archived from the original on July 25, 2018. Retrieved April 3, 2017. ^ Ward, J. R.; Phillips, M. J. (April 1, 1987). "Digitizer Technology: Performance Characteristics and the Effects on the User Interface". IEEE Computer Graphics and Applications. 7 (4): 31–44. doi:10.1109/MCG.1987.276869. ISSN 0272-1716. S2CID 16707568. ^ "How does Air view work?". Samsung Galaxy site. ^ "Floating touch™ – Developer World". September 17, 2012. Archived from the original on September 17, 2012. ^ "How to Change Unlock Effect on Galaxy S4 Lock Screen". Android Widget Center. May 13, 2013. ^ "S Pen on the Note 4 is better than ever: Feature Focus". Android Authority. October 2, 2014. Archived from the original on January 19, 2022. Retrieved April 9, 2021. ^ Whitney, Lance (July 8, 2019). "How to Use and Control 3D Touch on Your iPhone". PCMag UK. Retrieved April 2, 2021. ^ Zibreg, Christian (October 28, 2015). "Apple rejects Gravity, a 3D Touch-based iPhone 6s digital scale app". iDownloadBlog.com. Retrieved April 2, 2021. ^ "HTC Bravo: TMO UK Nexus One Plus Optical Trackpad – Phandroid". phandroid.com. January 21, 2010. Retrieved July 20, 2021. ^ "How to Use Heart Rate Sensor on Note 4 as a Shutter Button". Android Widget Center. December 25, 2014. Archived from the original on June 15, 2021. Retrieved April 2, 2021. ^ "Hidden innovation in the Galaxy S4". SamMobile. April 10, 2013. ^ S, Ray (September 6, 2014). "Playing with the Note 4's UV and SpO2 sensors". Phone Arena. Retrieved April 2, 2021. ^ Ezekiel, Odunayo (November 18, 2019). "eMMC or UFS: Understanding new generation of mobile phone storage". Dignited. ^ Ware, Russell (November 13, 2019). "Understanding Smartphone Storage – How much storage does your phone need?". Lifewire. ^ "Samsung Starts Producing First 512-Gigabyte Universal Flash Storage for Next-Generation Mobile Devices". www.businesswire.com. December 5, 2017. ^ Gottsegen, Gordon (December 5, 2017). "Samsung is bringing a huge 512GB memory chip to its phones". CNET. ^ "US will only receive 32GB Galaxy S7 and Galaxy S7 edge". Android Authority. February 21, 2016. ^ "MicroSD vs. cloud storage: Which do you prefer?". phonedog.com. May 31, 2013. ^ "Understanding Life Expectancy of Flash Storage". www.ni.com. July 23, 2020. ^ "How to back up your Android phone". Android Authority. December 9, 2022. Retrieved February 13, 2023. ^ Popa, Bogdan (December 31, 2019). "Xiaomi Ships Android 11 Update, Completely Bricks Devices". softpedia. ^ "Kaufberatung: Smartphones mit Dual-SIM und Micro-SD". TechStage (in German). January 29, 2019. Retrieved June 13, 2021. ^ "How to increase internal memory on the Galaxy Note 4". NextPit. July 5, 2015. ^ Thorn, Thomas (August 9, 2013). "Samsung Galaxy S4 Mini review". TechRadar. ^ Hidalgo, Jason. "Replace the SIM & Memory Card in a Samsung Galaxy S7 or S7 Edge". Lifewire. ^ "Samsung Galaxy Ace S5830 review: Ace in the hole". GSMArena.com. February 23, 2011. p. 1. ^ "What Happened To Mass Storage & File Management? [Updated] - Mobility Arena - Mobile Phone, Smartphone, Cell Phone Reviews". mobilityarena.com. November 18, 2011. ^ Hecht, Jeff (September 30, 2014). "Why Mobile Voice Quality Still Stinks—and How to Fix It". IEEE. ^ Malykhina, Elena. "Why Is Cell Phone Call Quality So Terrible?". Scientific American. ^ Henry, Alan (May 22, 2014). "What's the Best Mobile VoIP App?". Lifehacker. Gawker Media. ^ Hoyle, Andrew (March 25, 2014). "HTC One M8 BoomSound speakers are loud and proud". CNET. ^ "Was ditching the headphone jack a good idea?". SoundGuys. August 9, 2019. ^ "Causes and Fixes of Unexpected Phone Shutoffs - RTCL ... rtcl.eecs.umich.edu › assets › 2020" (PDF). June 15, 2020. ^ Jasieniak, Jacek (July 31, 2017). "Explainer: how to extend your phone's battery life". The Conversation. ^ Yee, Ho Kar; Ramakrishnan, Sivakumar; Mohamad, Ahmad Azmin (2014). "Modelling of Charge/Discharge Cycle of Lithium Ion Battery System" (PDF). Journal of Quality Measurement and Analysis. 10 (1): 39–47. ^ "Planned obsolescence: the outrage of our electronic waste mountain". the Guardian. April 15, 2020. ^ Rao, Sumukh (April 9, 2020). "Qualcomm Quick Charge vs OnePlus Warp Charge vs Oppo VOOC vs USB-PD

- TechPP". techpp.com. Retrieved December 9, 2021. ^ Ho, Joshua (2014). "The Samsung Galaxy Note 4 Review". www.anandtech.com. ^ T, Nick (June 30, 2016). "How it works: Dash Charge fast charging on the OnePlus 3". Phone Arena. ^ Byford, Sam (October 10, 2018). "Oppo has the fastest fast charging we've ever seen". The Verge. ^ "PSA: The Galaxy S8 and S8+ doesn't actually Fast Charge while you're using it – Phandroid". phandroid.com. May 11, 2017. ^ "6 phones with the best battery life". Retrieved October 31, 2017. ^ "J.D. Power and Associates Reports: Smartphone Battery Life has Become a Significant Drain on Customer Satisfaction and Loyalty" (Press release). Retrieved September 11, 2014. ^ Kendrick, James (August 4, 2014). "The secret behind poor smartphone battery life". ZDNet. Retrieved November 2, 2017. ^ "Peak Battery: Why Smartphone Battery Life Still Stinks, and Will for Years". Time. April 1, 2013. ^ "Refurbished version of ill-fated Galaxy Note 7 will soon be available overseas". May 5, 2017. ^ "The Most Impactful New iPhone Feature May Be the Most Boring". WIRED. Retrieved September 22, 2017. ^ Frumusanu, Andrei (June 23, 2015). "Analysing AMOLED Power Efficiency Improvements". www.anandtech.com. Retrieved September 14, 2023. ^ "How to Shoot Photos in DNG/RAW on Samsung Galaxy S7". Android Beat | Android News, Hacks, Apps, Tips & Reviews Blog. April 24, 2016. Archived from the original on August 19, 2021. Retrieved August 19, 2021. ^ Nikam, Sohil (May 8, 2015). "Samsung Dropping RAW Image Support Into Galaxy S6 And S6 Edge Via Android 5.1.1 Update - TechShout". www.techshout.com. Retrieved August 19, 2021. ^ "Top 16 Best Camera Phones For Photography 2019". April 4, 2019. Archived from the original on May 12, 2019. ^ Ho, Joshua (May 5, 2014). "A Discussion on Material Choices in Mobile". www.anandtech.com. Retrieved April 11, 2021. ^ "Bring back plastic phones". Android Authority. July 5, 2019. ^ "Benefits And Applications Of Polycarbonates". Tuflite. June 17, 2020. Archived from the original on April 11, 2021. Retrieved April 11, 2021. ^ "Build materials: metal vs glass vs plastic". Android Authority. July 19, 2018. ^ "Gartner Says Worldwide Sales of Smartphones Returned to Growth in First Quarter of 2018". Gartner, Inc. Gartner. May 29, 2018. Archived from the original on June 13, 2018. Retrieved August 25, 2018. ^ Thom Holwerda, OSNews, November 12, 2013, The second operating system hiding in every mobile phone Archived November 13, 2013, at the Wayback Machine ^ "What The Heck Is An "App"?". Business Insider. ^ W3C Interview: Vision Mobile on the App Developer Economy with Matos Kapetanakis and Dimitris Michalakos Archived June 29, 2016, at the Wayback Machine. February 18, 2014. Retrieved February 24, 2015. ^ Ogg, Erica (December 22, 2011). "Smartphones killing point-and-shoots, now take almost 1/3 of photos". GIGAOM. Archived from the original on July 23, 2013. Retrieved June 27, 2013. ^ Rao, Leena (September 19, 2012). "comScore: 4 Out Of 5 Smartphone Owners Use Device To Shop; Amazon Is The Most Popular Mobile Retailer". TechCrunch. AOL Inc. Retrieved June 27, 2013. ^ "Smartphones now outsell 'dumb' phones". 3 News NZ. April 29, 2013. Archived from the original on August 1, 2013. Retrieved April 29, 2013. ^ Swearingen, Jake (December 4, 2018). "We're No Longer in Smartphone Plateau. We're in the Smartphone Decline". New York Magazine. ^ "Worldwide Smartphone Shipments Top One Billion Units for the First Time, According to IDC". IDC. January 2014. Archived from the original on January 31, 2014. Retrieved January 27, 2014. ^ Daniel van Boom (April 27, 2016). "It's not just Apple: Global smartphone market shrinks for the first time ever". ^ Leprince-Ringuet, Daphne (November 26, 2019). "As smartphone sales decline again, Apple may have a few lessons to learn from Samsung and Huawei". ZDNet. ^ Axon, Samuel (December 11, 2019). "Fewer than 10% of Americans are buying $1,000 smartphones, report says". Ars Technica. ^ Eadicicco, Lisa (December 12, 2019). "Evidence is mounting that people are fed up with the sky-high cost of smartphones, and it's sparking a massive change in the industry". Business Insider. ^ "Counterpoint: Global smartphone market is alive thanks to China and India". GSMArena.com. ^ Weissberger, Alan (November 8, 2019). "Counterpoint Research: Smartphone Market Decline Ends, What Might Help it Grow?". IEEE Communications Society Technology Blog. ^ McCaskill, Steve (September 26, 2019). "Smartphone market set for 'biggest ever decline'". TechRadar. ^ Fingas, Jon (January 28, 2014). "Smartphone sales may have topped 1 billion in 2013, depending on who you ask". Engadget. ^ Millward, Steven (May 13, 2014). "Xiaomi breaks into global top 10 for smartphone shipments, kicks out HTC". Tech In Asia. Retrieved September 9, 2014. ^ Brett Molina and Marco della Cava, USA TODAY (March 3, 2015). "Apple beats Samsung in Q4 smartphone sales". USA TODAY. ^ "Gartner Says Five of Top 10 Worldwide Mobile Phone Vendors Increased Sales in Second Quarter of 2016" (Press release). Gartner. August 19, 2016. Retrieved May 28, 2022. ^ Hersey, Frank (July 4, 2017). "6 of the world's top 10 smartphone brands are Chinese". technode. Retrieved July 7, 2017. ^ Dunn, Jeff (February 28, 2017). "Samsung introduced 10 times as many phones as Apple last year, but its mobile division made half as much revenue". Business Insider. ^ Argam Artashyan (December 12, 2019). "Huawei And Honor Account For Half Of Chinese Smartphone Market". GizChina. ^ "Samsung dominates early market for 5G smartphones | TechRadar". www.techradar.com. December 11, 2019. ^ "Apple loses top phonemaker spot to Samsung as iPhone shipments drop, IDC says". gulfnews.com. April 15, 2024. Retrieved April 15, 2024. ^ Reisinger, Don (August 15, 2013). "Smartphones Sales Finally Overtake Feature Phones: 10 Reasons Why". eWeek. ^ Rob van der Meulen & Janessa Rivera (August 14, 2013). "Gartner Says Smartphone Sales Grew 46.5 Percent in Second Quarter of 2013 and Exceeded Feature Phone Sales for First Time". Archived from the original on August 16, 2013. ^ Farivar, Cyrus (August 14, 2013). "Smartphones Outsell Feature Phones, for the First Time". ^ Andrew Smith, Faithe Wempen (2011). CompTIA Strata Study Guide. John Wiley & Sons. p. 140. ISBN 978-0-470-97742-2. Retrieved July 5, 2012. ^ Yu, Emily. "PMP needs to merge with cellphone, says Smartwork exec". EE Times Asia. Archived from the original on 23 April 2008. Retrieved 3 October 2007. ^ Wijman, Tom (April 30, 2018). "Mobile Revenues Account for More Than 50% of the Global Games Market as It Reaches $137.9 Billion in 2018". newzoo.com. Newzoo. Retrieved July 12, 2018. ^ "Xperia Play | PlayStation certified Android mobile". Sony Ericsson. Archived from the original on August 8, 2011. Retrieved February 14, 2011. ^ Lowe, Scott (July 30, 2013). "Android handheld of the future. Not today". IGN. Retrieved July 31, 2013. ^ "Milestone for cellphones vs. landline phones". CBS News. May 4, 2017. Archived from the original on June 16, 2017. Retrieved May 30, 2017. ^ "The Daily — Residential Telephone Service Survey, 2013". Statistics Canada. June 23, 2014. Archived from the original on October 23, 2014. ^ "Why Are Alarm Clocks Still a Thing?". Motherboard.vice.com. Motherboard. April 10, 2015. Retrieved August 16, 2018. ^ "ICT Facts and Figures 2005, 2010, 2016". Telecommunication Development Bureau, International Telecommunication Union (ITU). Retrieved May 24, 2015. ^ "Branchless banking to start in Bali". The Jakarta Post. April 13, 2012. Retrieved June 4, 2012. ^ ""Zidisha Set to "Expand" in Peer-to-Peer Microfinance", Microfinance Focus, Feb 2010". Microfinancefocus.com. February 7, 2010. Archived from the original on September 21, 2012. Retrieved June 4, 2012. ^ Feig, Nancy (June 25, 2007). "Mobile Payments: Look to Korea". banktech.com. Archived from the original on March 26, 2010. Retrieved January 29, 2011. ^ Ready, Sarah (November 10, 2009). "NFC mobile phone set to explode". connectedplanetonline.com. Archived from the original on January 24, 2010. Retrieved January 29, 2011. ^ Tofel, Kevin C. (August 20, 2010). "VISA Testing NFC Memory Cards for Wireless Payments". gigaom.com. Archived from the original on June 21, 2012. Retrieved January 21, 2011. ^ "SF3". FilmFreeway. October 7, 2023. Retrieved November 3, 2024. ^ Kornits, Dov (October 26, 2024). "The rise and rise of smartphone films – Australia leads the way". FilmInk. Retrieved November 3, 2024. ^ Fletcher, James (July 5, 2022). "Darcy Yuille: One Punch Man". FilmInk. Retrieved November 3, 2024. ^ Kornits, Dov (October 13, 2024). "Short Film of the Week: Idiot-Proof". FilmInk. Retrieved November 3, 2024. ^ Gross, Terry (February 1, 2023). "How 'modern-day slavery' in the Congo powers the rechargeable battery economy". NPR. Retrieved November 10, 2024. ^ "U.S. cobalt lawsuit puts spotlight on 'sustainable' tech". Sustainability Times. December 17, 2019. Retrieved September 16, 2020. ^ "Apple, Google Fight Blame For Child Labor In Cobalt Mines - Law360". www.law360.com. Retrieved September 16, 2020. ^ "Buying cobalt doesn't make US firms liable for abuses in DR Congo". March 6, 2024. ^ "Apple to use only recycled cobalt in batteries by 2025". Reuters. 2023. Retrieved November 9, 2024. ^ "SMARTPHONES make TEENS have SEX with STRANGERS". theregister.co.uk. Retrieved January 18, 2016. ^ Colaner, Seth (August 27, 2012). "Your Tablet and Smartphone Could Be Ruining Your Sleep". Retrieved January 22, 2014. ^ Cheever, N. A.; Rosen, L. D.; Carrier, L. M.; Chavez, A. (2014). "Out of sight is not out of mind: The impact of restricting wireless mobile device use on anxiety levels among low, moderate and high users". Computers in Human Behavior. 37: 290–297. doi:10.1016/j.chb.2014.05.002. S2CID 9196376. ^ Hookham, Mark; Togoh, Isabel; Yeates, Alex (February 21, 2016). "Walkers hit by curse of the smombie". The Sunday Times. UK. Archived from the original on February 22, 2016. Retrieved February 23, 2016. ^ Hatton, Celia (September 15, 2014). "Chongqing's 'mobile lane'". BBC News. UK: BBC. Retrieved February 23, 2016. ^ Rick Noack (April 25, 2016) This city embedded traffic lights in the sidewalks so that smartphone users don't have to look up The Washington Post. Retrieved 5 May 2016. ^ "Quit Googling yourself and drive: About 20% of drivers using Web behind the wheel, study says". Los Angeles Times. March 4, 2011. ^ Atchley, Paul; Atwood, Stephanie; Boulton, Aaron (January 2011). "The Choice to Text and Drive in Younger Drivers: Behaviour May Shape Attitude". Accident Analysis and Prevention. 43 (1): 134–142. doi:10.1016/j.aap.2010.08.003. PMID 21094307. ^ "Text messaging not illegal but data clear on its peril". Democrat and Chronicle. Archived from the original on February 2, 2016. Retrieved February 7, 2021. ^ de Waard, Dick; Schepers, Paul; Ormel, Wieke; Brookhuis, Karel (January 2010). "Mobile phone use while cycling: Incidence and effects on behaviour and safety". Ergonomics. 53 (1): 30–42. doi:10.1080/00140130903381180. hdl:11370/1ad6e9a1-37c9-44fb-8978-65dbdce42456. PMID 20069479. S2CID 205403680. ^ Copeland, Larry. "Drivers still Web surfing while driving, survey finds". USA TODAY. ^ Burger, Christoph; Riemer, Valentin; Grafeneder, Jürgen; Woisetschläger, Bianca; Vidovic, Dragana; Hergovich, Andreas (2010). "Reaching the Mobile Respondent: Determinants of High-Level Mobile Phone Use Among a High-Coverage Group" (PDF). Social Science Computer Review. 28: 336–349. doi:10.1177/0894439309353099. S2CID 61640965. ^ "BBC NEWS - UK - UK Politics - Drivers face new phone penalties". news.bbc.co.uk. January 22, 2007. ^ "BBC NEWS - UK - Magazine - Careless talk". news.bbc.co.uk. February 22, 2007. ^ "Illinois to ban texting while driving - CNN.com". CNN. August 6, 2009. Retrieved May 12, 2010. ^ Steitzer, Stephanie (July 14, 2010). "Texting while driving ban, other new Kentucky laws take effect today". The Courier-Journal. Archived from the original on January 19, 2013. Retrieved July 15, 2010. ^ "Distracted Driving Laws". Public Health Law Research. July 15, 2011. Retrieved June 27, 2014. ^ Yetisen, A. K.; Martinez-Hurtado, J. L.; et al. (2014). "The regulation of mobile medical applications". Lab on a Chip. 14 (5): 833–840. doi:10.1039/C3LC51235E. PMID 24425070. S2CID 16910239. ^ Shankar, S Barani; Rani, S Leslie; Brundha, M P (July 2020). "Comparison study of factors associated with smartphone addiction among college students". Drug Invention Today. 14 (7): 1165–1168. ISSN 0975-7619 – via Academic Search Complete. ^ Mobile Malware Development Continues To Rise, Android Leads The Way. ^ Alexios, Mylonas; Bill, Tsoumas; Stelios, Dritsas; Dimitris, Gritzalis (2011). 8th International Conference on Trust, Privacy & Security in Digital Business (TRUSTBUS-2011). Springer Berlin / Heidelberg. pp. 49–61. ^ "The Mother Of All Android Malware Has Arrived". Android Police. March 6, 2011. ^ Perez, Sarah (February 12, 2009). "Android Vulnerability So Dangerous, Owners Warned Not to Use Phone's Web Browser". Readwriteweb.com. Archived from the original on August 10, 2011. Retrieved August 8, 2011. ^ "Lookout, Retrevo warn of growing Android malware epidemic, note Apple's iOS is far safer". Appleinsider.com. August 3, 2011. Retrieved January 5, 2012. ^ "Plea urges anti-theft phone tech". The San Francisco Examiner. June 7, 2013. Archived from the original on October 16, 2014. Retrieved June 11, 2013. ^ "Getting started with Anti-Theft Protection in BlackBerry 10 OS version 10. - Inside BlackBerry Help Blog". blackberry.com. Retrieved January 18, 2016. ^ "Vault 7: Wikileaks reveals details of CIA's hacks of Android, iPhone Windows, Linux, MacOS, and even Samsung TVs". Computing. March 7, 2017. ^ Greenberg, Andy (March 7, 2017). "How the CIA Can Hack Your Phone, PC, and TV (Says WikiLeaks)". WIRED. ^ "What is Pegasus spyware and how does it hack phones?". The Guardian. July 18, 2021. Retrieved August 13, 2021. ^ "Study reveals scale of data-sharing from Android mobile phones". Trinity College Dublin. Retrieved November 16, 2021. ^ Liu, Haoyu; Patras, Paul; Leith, Douglas J. (October 6, 2021). "Android Mobile OS Snooping By Samsung, Xiaomi, Huawei and Realme Handsets" (PDF). Retrieved November 16, 2021. ^ Souppaya, Murugiah P.; Scarfone, Karen A. (June 21, 2013). Guidelines for Managing the Security of Mobile Devices in the Enterprise (Technical report). Special Publication (NIST SP). National Institute of Standards and Technology. doi:10.6028/NIST.SP.800-124r1. 800-124 Rev 1. ^ "Use Your Smartphone As Securely As Possible". Security in-a-box. ^ Hoffman, Chris (October 23, 2014). "Reduce Eye Strain and Get Better Sleep by Using f.lux on Your Computer". How-To Geek. Retrieved January 15, 2016. ^ Blichert, Frederick (July 17, 2019). "How to enable Night Mode on Android to reduce eye strain". Retrieved November 8, 2019. ^ "Stop your gadgets from keeping you awake at night". CNET. Retrieved June 1, 2016. ^ Kalsbeek, Andries (2012). The Neurobiology of Circadian Timing Elsevier. pp. 382. ^ Dillner, Luisa (June 9, 2013). "Should I keep my smartphone and tablet out of my bedroom?". The Guardian. Retrieved June 17, 2014. ^ "Are smartphones disrupting your sleep?". ScienceDaily. Retrieved June 17, 2014. ^ Sharma, Mahesh. "Switching off your smartphone at night makes you more productive". Sydney Morning Herald. Retrieved June 17, 2014. ^ "As iPhone Turns 15, Smartphones Continue to Hurt Camera Sales". VOA. July 6, 2022. Retrieved March 5, 2023. ^ "Mobile Photography vs. the DSLR | B&H eXplora". www.bhphotovideo.com. Retrieved March 5, 2023. ^ Jones, Brad (August 16, 2017). "DSLRs vs. Smartphone Cameras, Compared: The Pros and Cons". MUO. Retrieved March 5, 2023. ^ Wang, J.; Liu, P.; Hicks-Garner, J.; Sherman, E.; Soukiazian, S.; Verbrugge, M.; Tataria, H.; Musser, J.; Finamore, P. (2011). "Cycle-life model for graphite-LiFePO4 cells". Journal of Power Sources. 196 (8): 3942–3948. Bibcode:2011JPS...196.3942W. doi:10.1016/j.jpowsour.2010.11.134. ^ Saxena, S.; Hendricks, C.; Pecht, M. (2016). "Cycle life testing and modeling of graphite/LiCoO2 cells under different state of charge ranges". Journal of Power Sources. 327: 394–400. Bibcode:2016JPS...327..394S. doi:10.1016/j.jpowsour.2016.07.057. ^ "Questions and answers related to lithium - ion rechargeable b attery care" (PDF). PLARAD Torque & Tension Systems. Archived from the original (PDF) on November 11, 2020. Retrieved January 4, 2021. ^ Shahid, Furqan (January 18, 2021). "Samsung Secretly Restricts 3rd Party Hardware Repairs". Wccftech. Retrieved January 30, 2023. ^ "Apple apologises, releases fix for iPhones bricked by Error 53". Macworld. July 26, 2018. Retrieved January 30, 2023. Media related to Smartphone at Wikimedia Commons Retrieved from " 2 This is a list of 3D-enabled mobile phones, which typically use autostereoscopic displays. Some devices may use other kinds of display technology, like holographic displays or multiscopic displays. Some devices employ eye tracking in aiming the 3D effect to the viewer's eye. Model Release Availability Display 3D Camera 3D output via HDMI or USB C Sharp mova SH251iS[1] 2002-11-16 Japan Parallax barrier No No Sharp mova SH505i[2] 2003-06-20 Japan Parallax barrier No No Samsung SCH-B710[3] 2007-07-11 South Korea Parallax barrier Yes No Hitachi Wooo Ketai H001[4] 2009-02-06 Japan Cell-matrix parallax barrier No No Samsung AMOLED 3D SCH-W960[5] 2010-05-03 South Korea Parallax barrier No No Motorola MING MT810[6] 2010-08-30 China Parallax barrier No No Sharp LYNX SH-03C[7] 2010-12-03 Japan Striped parallax barrier No No Sharp Galapagos 003SH[8] 2010-12-17 Japan Striped parallax barrier No No Sharp Galapagos 005SH[8] 2011-02-25 Japan Striped parallax barrier No No HTC EVO 3D[9] 2011-06-24 USA Parallax barrier Yes Yes LG Optimus 3D P920 aka LG Thrill 4G[10] 2011-07-07 Global Parallax barrier Yes Yes Sharp Aquos 006 SH[11] 2011-05-18 Japan Striped parallax barrier Yes Yes Sharp Aquos SH-12C[12] or SH-80F[13] 2011-05-20 Japan & France Striped parallax barrier Yes Yes Sharp Aquos SH-01D[14] 2011-12-02 Japan Striped parallax barrier No Yes Sharp Aquos 102SH 2011-12-16 Japan Striped parallax barrier No Yes LG Optimus 3D Cube SU870[10] 2012-02-14 South Korea Parallax barrier Yes Yes ZOPO ZP200 Shining 2012-03-00 China Parallax barrier No No Sharp Aquos SH-06D[15] 2012-03-23 Japan Striped parallax barrier No Yes LG Optimus 3D MAX[10] 2012-04-23 Global Parallax barrier Yes Yes Sharp Aquos 102SHII 2012-07-12 Japan Striped parallax barrier No Yes ZOPO ZP200+ Royal Shining 2012-10-00 China Parallax barrier No No Micromax A115 Canvas 3D 2012-04-00 China Parallax barrier No No ZOPO ZP600 Libero 3D[16] 2012-12-00 China Parallax barrier No No Konka S1 Mirage 2013-05-04 China [17] Parallax barrier No No ZOPO INFINITY ZP600+[18][19] 2014-06 India Parallax barrier No No 3D69[20][21][22][23] 2014-01-22 China Parallax barrier No No Fire Phone[24] 2014-07-25 United States Four front-facing cameras to create a 3D perspective No No Macxen S1[25] 2014-09-00 China Parallax barrier No No GALAZ Noah 3D or GALAZ GAL-N1159 or GALAZ N1 or Noah N1 (4G LTE version) 2014-09-26 China [26][27][28][29][30][31] 2560 x 1600 pixel resolution laid upon a LTPS panel made by Japan Display (JDI) with 2560 semicircular prisms, each one being 70 microns in diameter. Proprietary 3D API technology & Eye-tracking No Yes Takee 1[32][33][34][35] 2015-01-06 China SeeReal Technologies Holographic display based on eye tracking[36][37] No No Snail W 3D[38][39][40][41] 2015-01-07 China SuperD Lenticular lens & eye tracking No No mPhone 9Plus[42] 2015-02-00 India Parallax Barrier No No InFocus M550-3D[43][44][45][46][47][48][49][50][40] 2015-07-00 China SuperD LC lens & eye-tracking No Yes VKWorld Discovery S1[51] 2015-08-00 China Parallax barrier No No PPTV King 7S[52][53] 2015-09-00 China Lenticular screen 2560x1440, column interlaced mode No No Changhong X1 / X1-K 2015-09-16 China [54][55][56][57] KDX Lenticular screen, column interlaced mode & eye-tracking No Yes VKWorld Discovery S2 or TeknoAVR S2-3D 2015-11-00 China [58][59] Parallax barrier No No ZTE N940Sc or ZTE V5 Pro 2015-12-01 China [60] Parallax barrier No No Focalmax Maxphone T1 2016-01-28 China [61] Parallax barrier & eye-tracking No No D Color 7.0 V01 or DColor7V01 or DColor7.0V01 (3G calls version) 2016-00-00 China [62][63][64][65] K3DX Lenticular screen, column interlaced mode & eye-tracking No No Ding Ding C200 and Ding Ding Guide S1 2016-01-05 China and Malaysia [66][67][68][69][70][71] Parallax barrier No No MBI R6 2016-05-31 China [72] Parallax barrier No No V5 K3DX-V5G 2016-06-16 China [73][74][75] K3DX Lenticular screen, column interlaced mode & eye-tracking No No Cleyyo[76] 2016-07-00 Mauritius Parallax Barrier No Yes Alienline Alpha 5 and Alpha 5 Pro 2016-08-00 Australia [77] Lenticular screen No No SuperD D1[78][79][80][81][82][83][84][85][86] 2016-09-00 China SuperD columnar grating liquid crystal screen, which uses the lenticular grating technology & eye-tracking & anti moiré No No ZTE axon 7 max (C2017)(some models) 2016-10-00 China [87][88][89][90] KDX Parallax barrier, column interlaced mode Yes No DOOGEE Y6 Max 3D 2016-10-00 China [91][92][93] Lenticular screen, column interlaced mode No No (Brand: IDEA Model: ID-S9) 2017-01-00 China Lenticular screen, column interlaced mode No No ZTE Blade V8 2017-02-00 China [94] No 3D screen Yes No Ivvi K5 2017-04-19 China [95][96][97][82][84][85][86] SuperD columnar grating liquid crystal screen, which uses the lenticular grating technology & eye-tracking No No MBI R7 2017-05-00 China [98][99][100][101] Lenticular screen & eye-tracking ? No No Energy Phone Pro 3 2017-06-00 Spain [102] No 3D screen Yes No IQH 3D 2017-06-00 Jamaica & USA[103] Lenticular Film Yes No DMZ DAMUZHI Thumb V3 / V3D 2017-07-17 China [104] [105] [106] Lenticular screen & eye-tracking No No Unno P8 2017-09-00 China [107] KDX Lenticular screen No No ARK BENEFIT M551 (SuperD D1)[108] 2017-09-26 China SuperD LC lens & eye-tracking No No Blackview P2 Lite 3D or Blackview DE3DLite-BL 2017-12-00 China [109] K3DX Lenticular screen No No Jiashun Digitech (Shanghai) S5 2018-00-00 China [110] Lenticular screen No No Sooloo ASIL 2018-00-00 China Lenticular screen No No UNIWA W6036i 2018-00-00 China [111] Lenticular screen No No Elephone P8 3D / CNOEMS M126 2018-01-00 China [112][113][114][115] KDX Lenticular screen, column interlaced mode, eye-tracking is disabled No No Konka Phantom T1 / 801 2018-02-07 China [116] [117] [118][119] KDX Lenticular screen. Mirage 3D Game version supports Naked Eye 3D. The Standard version does not support Naked Eye 3D. No No SANSO H1/H1Pro [120][121] 2018-02-12 Global H/W based Parallax barrier with FHD+ OLED Display Yes Yes Yocophone A9 2018-04-10 CHINA [122][123][124][125][126] Yes No Kaliho M3 or AIYA3D 2018-04-13 China [127] Lenticular screen No No Koobee F2 (3D limited edition) 2018-04-26 China [128][129][130][131] [132] [133] KDX Lenticular screen No No Koobee F2 Plus (with notch) 2018-07 China [134][135] [136] [137] KDX Lenticular screen No No Tianjin BlueCool LK7 2018-07-12 China [138][139][140][141][142] KDX Lenticular screen No No VEECON ROKiT IO 3D 2018-10-25 India [143][144][145][146][147] Lenticular screen Yes No VEECON ROKiT IO Pro 3D 2018-10-25 India [143][144][145][146][147] Lenticular screen Yes No Red Hydrogen One 2018-11-00 USA [148][149][150] Holographic 4-View (H4V display). Diffractive Lightfield Backlighting (DLB) by Leia Yes Yes Elephone A4 Pro with naked-eye 3D (optional) / CNOEMS E3007 2018-11-08 Malaysia [151][152][153] Yes No Elephone A5 with naked-eye 3D (optional) 2018-11-08 Malaysia [151][154] Yes No DINGDING X20 2019-03-00 CHINA [155][156] Yes No Yocophone A11 2019-03-00 CHINA [157][158] Yes No ROKiT IO 3D[159] 2019-03-20 USA [160] Yes No ROKiT IO PRO 3D[161] 2019-03-20 USA [160][162] Yes No Elephone P11 3D 2019-04-00 China [151] No No Alienline Jupiter 8 Tablet 2020-01-23 Hungary [163][164][165][166] Yes No Alienline Jupiter 10 Tablet 2020-01-24 Hungary [163][164][167][168] Yes No Alienline Alpha 6 Smartphone 2020-06-09 Hungary [163][164][169][170] Yes No Lume Pad 2020-10-16 USA [171][172][173][174][175][176][177][178] 2nd generation Holographic 4-View (H4V display). Diffractive Lightfield Backlighting (DLB) by Leia Yes Yes ProMa King 2022-01-07 Spain/China [179][180] New lenticular screen designed for larger displays. Tablet that can also work as PC 3D monitor and mobile phone (4G Sim card slot allows to make calls/send SMS & use internet without Wi-Fi needed) No Yes ZTE nubia Pad 3D LitByLeia aka Lume Pad 2 2023-02-28 Global [181][182][183][184][185][186][187][188][189][190] Advanced 3D lightfield is enabled by a proprietary DLB layer that's integrated beneath the LCD display, enabling 3D viewing. AI face tracking and 8 views vision. Diffractive Lightfield Backlighting (DLB) by Leia Yes Yes Opic's 3D smartphone 2023-05-01 USA [191] Provides "3D livestream" to VR headsets Yes Yes Xreal Beam Pro 2024-06-22 Global [192] No 3D, output to AR/VR headsets (Xreal air 2 pro) This device only functions as an internet phone and has no phone network capability. Yes Yes Video Player Release Publisher Compatibility 3DVideoPlayer (Mik-el) [33] 2019 Mik-el, GitHub EStar Takee 1 List of mobile phone games with 3D display support Nintendo 3DS List of NFC-enabled mobile devices Projector phone LEIA Inc ^ "NTT DoCoMo: Press Releases - Latest i-shot Model Offers World's First 3D Mobile Phone Screen". 2007-01-02. Archived from the original on 2007-01-02. Retrieved 2022-09-26. ^ "NTT DoCoMo: Press Releases - NTT DoCoMo to Market 1-Megapixel Handset". 2006-05-22. Archived from the original on 2006-05-22. Retrieved 2022-09-26. ^ "PHOTOS: Samsung SCH-B710 3D Mobile - Pocket-lint". 2009-10-23. Archived from the original on 2009-10-23. Retrieved 2022-09-26. ^ Hitachi Wooo H001 CellPhone features stereoscopic screen for 3D movies Archived 2011-10-01 at the Wayback Machine ^ "Samsung SCH-W960 is 3D Phone for South Korea - Sammy Hub". 5 March 2010. Archived from the original on 8 April 2011. Retrieved 11 June 2011. ^ Cell Motorola | The White Version Of MT810 Cell Phone Equipped With Double 3D Touch Screen Of MOTO Was Exposed Archived 2011-08-20 at the Wayback Machine ^ "Sharp Glasses-Less 3D Smartphone". Archived from the original on 2016-11-15. Retrieved 2011-06-11. ^ a b "Sharp Galapagos 003SH and 005SH bring glasses-free 3D to Japanese Android lovers". 4 November 2010. Archived from the original on 2018-08-02. Retrieved 2017-09-03. ^ "HTC's dual-core Evo 3D unveiled [hands-on] | Electronista". 2011-03-25. Archived from the original on 2011-03-25. Retrieved 2022-09-25. ^ a b c Nisar, Abdul (13 February 2011). "LG Optimus 3D Launch - 2011 MWC - Optimus 3D Specs - Review Price Features - LG Smartphones". News.oneindia.in. Archived from the original on 9 October 2012. Retrieved 11 June 2011. ^ "ソフトバンクの本格3Dスマートフォン「AQUOS PHONE 006SH」ムービーレビュー". 18 May 2011. Archived from the original on 27 September 2019. Retrieved 27 September 2019. ^ "Sharp Aquos SH-12C Phone: 3D Dual Cameras & Gingerbread - PhonesReviews UK- Mobiles, Apps, Networks, Software, Tablet etc". 12 May 2011. Archived from the original on 3 February 2020. Retrieved 11 June 2011. ^ "Sharp unveils Aquos SH80F 3D Phone for Europe". Archived from the original on 2018-08-02. Retrieved 2014-09-25. ^ "Sharp's splashproof Aquos SH-01D arrives at the FCC's door, won't shut up about its 12.1 MP camera". 11 November 2011. Archived from the original on 2020-02-03. Retrieved 2017-09-03. ^ "Aquos SH-06D - Sharp - The Verge". Theverge.com. Archived from the original on 2020-02-03. Retrieved 2017-09-03. ^ "裸眼3D 卓普 Libero 3D详细评测(6) - MTK手机网". Mtksj.com. Archived from the original on 16 January 2019. Retrieved 2 April 2019. ^ "Konka S1 Mirage: 3D Display, 3 GB RAM, and Built-in Projector - Smartphone Zero". Smartphonezero.com. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ Kimovil.com. "Zopo ZP600+ Infinity: Price, specs and best deals". Kimovil.com. Retrieved 2022-09-30. ^ "Zopo ZP600+ Infinity specs, review, release date". PhonesData. Retrieved 2022-09-30. ^ "3D69 is a smartphone with a strange name, 2.0GHz octa-core processor and 3D display!". Gizchina.com. 23 December 2013. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ "2G主频八核3D是主菜 3D69手机发布 - MTK手机网". Mtksj.com. Archived from the original on 3 January 2019. Retrieved 2 April 2019. ^ "3D69手机公众版开放预订 裸眼3D+八核高配 - MTK手机网". Mtksj.com. Archived from the original on 15 September 2014. Retrieved 2 April 2019. ^ "裸眼3D/八核 3D69手机破冰上市 - MTK手机网". Mtksj.com. Archived from the original on 3 April 2015. Retrieved 2 April 2019. ^ Molen, Brad (18 June 2014). "Live from Amazon's phone announcement in Seattle!". Engadget.com. Archived from the original on 2020-02-03. Retrieved 2014-06-18. ^ "Android Forum for Mobile Phones, Tablets, Watches & Android App Development - XDA Forums". Forum.xda-developers.com. Archived from the original on 2020-02-19. Retrieved 2018-04-13. ^ "Galaz Noah released: China's first 3D naked eye tablet!". 26 September 2014. Archived from the original on 3 February 2020. Retrieved 16 September 2019. ^ "Behold the 8.4-Inch Galaz Noah Tablet That Can Show 3D Content, No Glasses Involved". 29 September 2014. Archived from the original on 3 February 2020. Retrieved 16 September 2019. ^ "Noah裸眼3D平板电脑 还原真实世界_平板电脑新闻-中关村在线". Archived from the original on 2022-09-26. Retrieved 2019-09-16. ^ "Galaz анонсировала планшет Noah 3D с автостереоскопическим дисплеем". Archived from the original on 2020-02-03. Retrieved 2019-09-16. ^ Archived at Ghostarchive and the Wayback Machine: "GALAZ GAL-N1159 Glasses-Free 3D Tablet PC - Gearbest.com". YouTube. ^ "FCC ID 2ADK8-TRJ1412 GALAZ N1 Tablet PC by Galapad Technology Limited". Archived from the original on 2020-02-03. Retrieved 2019-09-17. ^ Takee 1 Holographic 3D Smartphone Test. Jason Official. 3 August 2014. Archived from the original on 22 February 2020. Retrieved 4 August 2021 – via YouTube. ^ a b "3DVideoPlayer (Mik-el)". GitHub. 4 February 2022. Archived from the original on 3 November 2020. Retrieved 6 May 2019. ^ "Takee 1 (Full Review) 3D Holographic Phone (Cheaper 2015 version with Play Store)". 16 September 2015. Archived from the original on 2019-10-12. Retrieved 2019-10-12. ^ "Takee 1 - Обсуждение - 4PDA". Archived from the original on 2016-07-09. Retrieved 2019-10-12. ^ "Holographic 3D Display Technology". SeeReal Technologies. Archived from the original on 1 February 2020. Retrieved 2 April 2019. ^ SeeReal Technologies featured on Worldwide Business with kathy ireland®. Worldwide Business with kathy ireland®. 22 October 2018. Archived from the original on 29 July 2021. Retrieved 4 August 2021 – via YouTube. ^ Exclusive look at the W3D @ E3 2015. Solbash. 20 June 2015. Archived from the original on 13 March 2019. Retrieved 4 August 2021 – via YouTube. ^ "Snail V 3D hands-on review at CES 2015". Recombu.com. 7 January 2015. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ a b "SuperD: 3D Revolution in the Making — Shenzhen 100 Innovative Companies". Globalization Shenzhen 100. 12 December 2016. Archived from the original on 2019-09-25. Retrieved 2019-09-25. ^ "Review Snail MUCH W3D Phablet console Gaming 3D eye". Open Your Eyes. Archived from the original on 2019-09-25. Retrieved 2019-09-25. ^ "Archived copy". Archived from the original on 2016-10-21. Retrieved 2016-08-22.{{cite web}}: CS1 maint: archived copy as title (link) ^ InFocus M550 3D Hands on Review. Nothing Wired. 29 July 2015. Archived from the original on 25 March 2020. Retrieved 4 August 2021 – via YouTube. ^ Infocus M550 3D hands on review, initial impressions. Inspire2Rise. 30 July 2015. Archived from the original on 28 April 2020. Retrieved 4 August 2021 – via YouTube. ^ InFocus M550 3D. 富可視. 17 November 2015. Archived from the original on 25 March 2020. Retrieved 4 August 2021 – via YouTube. ^ InFocus M550 立體攝影功能介紹. 電腦王阿達. 10 July 2015. Archived from the original on 25 March 2020. Retrieved 4 August 2021 – via YouTube. ^ "InFocus M550 3D - Specifications". Archived from the original on 2019-09-25. Retrieved 2019-09-25. ^ Infocus M550 3D 4G. Alex. 23 September 2017. Archived from the original on 25 March 2020. Retrieved 4 August 2021 – via YouTube. ^ Infocus m550 (3D) en test. Une bonne affaire! ;). HemoDrroidE. 7 April 2017. Archived from the original on 25 April 2020. Retrieved 4 August 2021 – via YouTube. ^ infocus m550 3d test. 郭秉璁. 13 July 2015. Archived from the original on 28 March 2020. Retrieved 4 August 2021 – via YouTube. ^ "VKWorld Discovery S1 is the first smartphone with a glasses-free 3D display in HD". Phonearena.com. 7 August 2015. Archived from the original on 2020-02-03. Retrieved 2015-09-17. ^ Andi (7 September 2015). "PPTV launch first phone with 2K, 3D display and HIFI Audio". Archived from the original on 3 February 2020. Retrieved 15 September 2015. ^ "[Help] TWRP on PPTV King 7s". 10 December 2016. Archived from the original on 2019-10-12. Retrieved 2019-10-12. ^ "Changhong Italia". Facebook.com. Archived from the original on 7 April 2019. Retrieved 2 April 2019. ^ "手机详细功能". Shouji.tenaa.com.cn. Archived from the original on 22 February 2020. Retrieved 2 April 2019. ^ "首款裸眼3D手机，长虹X1发布". Archived from the original on 2019-08-28. Retrieved 2019-08-28. ^ "Alps Changhong X1-K - Geekbench Browser". Archived from the original on 2019-08-28. Retrieved 2019-08-28. ^ Vkworld discovery s2 unboxing demenstration. Vkworld Phone. 21 January 2016. Archived from the original on 22 February 2020. Retrieved 4 August 2021 – via YouTube. ^ "Glass Free Naked Eye 3D Smartphone - Holographic Display". Teknoavr.com. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ "Google Translate". Translate.google.com. Archived from the original on 22 February 2020. Retrieved 2 April 2019. ^ Focalmax Maxphone T1 with Naked Eye 3D Display,Qualcomm Snapdragon 820 MSM8996. Charbax. 28 January 2016. Archived from the original on 12 January 2021. Retrieved 4 August 2021 – via YouTube. ^ "淘宝网 - 淘！我喜欢". Archived from the original on 2022-09-26. Retrieved 2019-09-16. ^ "淘宝网 - 淘！我喜欢". Archived from the original on 2022-09-26. Retrieved 2019-09-16. ^ "淘宝网 - 淘！我喜欢". Archived from the original on 2022-09-26. Retrieved 2019-09-16. ^ Ding Ding C200 smartphone with 3D glasses free. Notebook Italia. 1 May 2016. Archived from the original on 22 February 2020. Retrieved 4 August 2021 – via YouTube. ^ "Ding Ding Guide S1 | Ding Ding Mobile". www.dingdingmobile.com.my. Archived from the original on 2016-11-05. ^ Dingding Guide S1 ADS. Pico Gadget. 1 August 2016. Archived from the original on 4 August 2021. Retrieved 4 August 2021 – via YouTube. ^ DingDing S1. Kevin Dolling. 20 June 2016. Archived from the original on 4 August 2021. Retrieved 4 August 2021 – via YouTube. ^ Ding Ding Guide S1 Unboxing + Benchmark - Malaysia's First 3D Smartphone?. Tekgila. 10 August 2016. Archived from the original on 4 August 2021. Retrieved 4 August 2021 – via YouTube. ^ DING DING Guide S1 VS Heat 8 - Camera Comparison!. Tekgila. 11 October 2016. Archived from the original on 4 August 2021. Retrieved 4 August 2021 – via YouTube. ^ MBI R6 手机影片介绍 Version II. MCC Live. 31 May 2016. Archived from the original on 22 February 2020. Retrieved 4 August 2021 – via YouTube. ^ "许可证相关信息". Tenaa.com.cn. Archived from the original on 2 April 2019. Retrieved 2 April 2019. ^ "3d smartphone". V.youku.com. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ "V5 K3DX-V5G - Обсуждение - 4PDA". Archived from the original on 2022-09-26. Retrieved 2019-10-12. ^ "Business-Class Web Hosting by (mt) Media Temple". Cleyyo.com. 1980-01-01. Archived from the original on 2018-08-02. Retrieved 2018-08-01. ^ "Products". Alienline.com. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ "China-based Global Leader In Visual Technology SuperD Launches World's First Full Display Mode Smartphone, The SuperD D1". En.prnasia.com. Archived from the original on 2017-03-15. Retrieved 2016-09-13. ^ SuperD D1 3D/VR. SuperD. 16 September 2016. Archived from the original on 25 April 2020. Retrieved 4 August 2021 – via YouTube. ^ "SuperD D1 – TronXYZ Technology". Archived from the original on 2019-05-04. Retrieved 2019-05-04. ^ SuperD D1 - Português. Nuno Joel. 3 June 2018. Archived from the original on 25 March 2020. Retrieved 4 August 2021 – via YouTube. ^ a b The Future of 3D Display Technology. Tronxyz Technology. 7 November 2018. Archived from the original on 13 April 2020. Retrieved 4 August 2021 – via YouTube. ^ "Review: SuperD D1. So much for so little". 8 October 2018. Archived from the original on 6 August 2020. Retrieved 4 May 2019. ^ a b "Autostereoscopic display apparatus and method". Archived from the original on 2019-09-27. Retrieved 2019-09-26. ^ a b "US Patent for Autostereoscopic display system and method Patent (Patent # 9,523,858 issued December 20, 2016) - Justia Patents Search". Archived from the original on September 26, 2019. Retrieved September 26, 2019. ^ a b "US Patent for Simulated 3D image display method and display device Patent (Patent # 9,961,334 issued May 1, 2018) - Justia Patents Search". Archived from the original on September 26, 2019. Retrieved September 26, 2019. ^ KDX. "KDX Announces Agreement with Philips to Partner on Glasses-Free 3D Display Technology for the Chinese Market". Prnewswire.com (Press release). Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ "ZTE Axon 7 Max - Specifications". Archived from the original on 2019-08-14. Retrieved 2019-05-03. ^ "Introducing ZTE Axon 7 Max with 3D screen and depth map camera". 4 January 2017. Archived from the original on 6 August 2020. Retrieved 3 May 2019. ^ "Review: ZTE Axon 7 Max, an incredible device". 27 October 2017. Archived from the original on 2 November 2019. Retrieved 3 May 2019. ^ Doogee Y6 Max 3D and Y6 Max. Notebook Italia. 19 October 2016. Archived from the original on 22 February 2020. Retrieved 4 August 2021 – via YouTube. ^ Doogee Y6 Max 3D Review English. ChinaMobileMag. 3 March 2017. Archived from the original on 13 February 2020. Retrieved 4 August 2021 – via YouTube. ^ "Review: Doogee Y6 Max 3D". 14 April 2017. Archived from the original on 29 August 2018. Retrieved 5 May 2019. ^ Zte Blade V8 un smartphone a moins de 300 €. Daddy Dtech. 24 March 2017. Archived from the original on 22 February 2020. Retrieved 4 August 2021 – via YouTube. ^ "Ivvi K5 Launched: 3D Display, Curved Glass Body, 4GB RAM But No Snapdragon 835 Chip!". Gizmochina.com. 18 April 2017. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ "视频去哪了呢？_哔哩哔哩_bilibili". ^ "这2种技术让ivvi K5拥有IMAX般的3D效果-手机专区". Archived from the original on 2019-08-28. Retrieved 2019-08-28. ^ "MBI International R7 - Phone Specifications". Archived from the original on 2019-11-13. Retrieved 2019-11-13. ^ "Archived copy". Archived from the original on 2019-11-13. Retrieved 2019-11-13.{{cite web}}: CS1 maint: archived copy as title (link) ^ 智能手机 R7 ~ 还你极致生活. MCC Live. 7 April 2017. Archived from the original on 25 March 2020. Retrieved 4 August 2021 – via YouTube. ^ "一款安全到不怕丢的手机，MBI R7安全手机首发". www.sohu.com. Archived from the original on 2019-11-13. ^ Energy Phone Pro 3, primeras impresiones #MWC17. Topes de Gama. 3 March 2017. Archived from the original on 22 February 2020. Retrieved 4 August 2021 – via YouTube. ^ "iqh3d". Iqh3d.com. Archived from the original on 2020-02-03. Retrieved 2018-10-04. ^ "又一款千元裸眼3D手机！大拇指V3现身电商平台 - MTK手机网". Mtksj.com. Archived from the original on 18 July 2017. Retrieved 2 April 2019. ^ "大拇指V3/V3D曝光！纤薄设计+裸眼3D - MTK手机网". Mtksj.com. Archived from the original on 13 August 2017. Retrieved 2 April 2019. ^ "【快资讯】你的专属资讯平台". Sh.qihoo.com. Archived from the original on 22 February 2020. Retrieved 2 April 2019. ^ "Octa-core smartphone adopts naked-eye 3D". Global Sources. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ "ARK BENEFIT M551 SUPERD (2017) Price in USA, New York City, Washington, Boston". 101prices.com. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ Blackview P2 Lite 3D - Lo Smartphone con Display 3D. Best Discount. 27 December 2017. Archived from the original on 22 February 2020. Retrieved 4 August 2021 – via YouTube. ^ "Jiashun Digitech (Shanghai) Co., Ltd". Js3d.cc. Archived from the original on 2 April 2019. Retrieved 2 April 2019. ^ "6" Octa Core Naked Eye 3D Smartphone". Cwelltech.com. Archived from the original on 13 August 2019. Retrieved 2 April 2019. ^ García, Javier (2 May 2018). "Elephone P8 3D Review". Tridimensional.info. Archived from the original on 2 April 2019. Retrieved 2 April 2019. ^ "M126 Naked Eye 3D Display Smartphone". Oemakers.com. Archived from the original on 2 April 2019. Retrieved 2 April 2019. ^ "PhereoRoll3D". GitHub. 31 March 2022. Archived from the original on 5 January 2021. Retrieved 4 May 2019. ^ "[GUIDE] Rooting the Elephone P8 3D with TWRP". 8 March 2018. Archived from the original on 2019-10-12. Retrieved 2019-10-12. ^ "KDX Film Co., Ltd". Facebook.com. Archived from the original on 22 February 2020. Retrieved 2 April 2019. ^ "6G+64G！康佳幻影3D游戏手机众筹首发！ - MTK手机网". Mtksj.com. Archived from the original on 24 July 2019. Retrieved 2 April 2019. ^ "6+64G/3D/P23!康佳幻影T1/801仅1499元！ - MTK手机网". Mtksj.com. Archived from the original on 20 August 2019. Retrieved 2 April 2019. ^ "6G运存/3D流光后壳：康佳T1正式上市！ - MTK手机网". Mtksj.com. Archived from the original on 2 July 2019. Retrieved 2 April 2019. ^ SANSO™ | Sanso Technologies® [@SansoGlobal] (12 February 2018). "Don't Let Your #Gamin Passion Faded. Get your #SANSOH13D Smartphone and enjoy the #realtime #3D gaming experience with the #Fast processor of #8Cores in it to make it a #smartMachine. Enjoy Real #3D #Graphics in your Palm (Tweet). Archived from the original on 22 February 2020. Retrieved 4 August 2021 – via Twitter. ^ "- Legacy is Forever". www.sanso-h.com. Archived from the original on 25 June 2019. Retrieved 2 April 2019. ^ "Yocophone A9 3D, el 3D sin gafas en tu teléfono inteligente". 13 April 2018. Archived from the original on 10 November 2019. Retrieved 10 November 2019. ^ Vídeo exterior Yocophone A9. Oscar Dominguez. 11 April 2018. Archived from the original on 10 November 2019. Retrieved 4 August 2021 – via YouTube. ^ Archived 2022-09-26 at the Wayback Machine [user-generated source] ^ "Yocophone A9 specifications | Yocosta Global". Archived from the original on 2019-11-10. Retrieved 2019-11-10. ^ Valakia LAB - Jakso 3 - Unboxing Yocophone 3D. Valakia Interactive. 10 April 2018. Archived from the original on 28 April 2020. Retrieved 4 August 2021 – via YouTube. ^ "M3 Introduction-Shenzhen kaliho Technology Development co,ltd". Kaliho.com. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ "四摄/裸眼3D！酷比F2系列发布！ - MTK手机网". Mtksj.com. Archived from the original on 3 January 2019. Retrieved 2 April 2019. ^ "酷比携手康得新打造F2 3D手机 消费电子迎来"3D智能显示创新潮" - 康得新复合材料集团股份有限公司". Kangdexin.com. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ "Koobee F2 - Specifications". DeviceSpecifications. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ 捕鱼达人 (6 June 2018). "酷比F2 3D版体验评测：9600万成像畅玩裸眼3D". YouTube. Archived from the original on 22 February 2020. Retrieved 2 April 2019. ^ koobee F2 1080P FHD 日間錄影(柯基-咕咕表演)【SOGI手機王】. SOGI 手機王. 20 August 2018. Archived from the original on 22 February 2020. Retrieved 4 August 2021 – via YouTube. ^ koobee F2 1080P FHD 夜間錄影(西門町街頭藝人表演)【SOGI手機王】. SOGI 手機王. 20 August 2018. Archived from the original on 22 February 2020. Retrieved 4 August 2021 – via YouTube. ^ "Koobee F2 Plus - Specifications". DeviceSpecifications. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ koobee F2 Plus與K10 超高畫素成像與2CA【SOGI手機王】. SOGI 手機王. 4 October 2018. Archived from the original on 22 February 2020. Retrieved 4 August 2021 – via YouTube. ^ koobee F2 Plus 1080P FHD 日間錄影(柯基-咕咕表演)【SOGI手機王】. SOGI 手機王. 5 September 2018. Archived from the original on 22 February 2020. Retrieved 4 August 2021 – via YouTube. ^ koobee F2 Plus 1080P FHD 夜間錄影(西門町街頭藝人表演)【SOGI手機王】. SOGI 手機王. 9 September 2018. Archived from the original on 22 February 2020. Retrieved 4 August 2021 – via YouTube. ^ "蓝酷科技". Bluecool.cn. Archived from the original on 14 August 2018. Retrieved 2 April 2019. ^ "产品中心". Bbluecool.cn. Archived from the original on 14 August 2018. Retrieved 2 April 2019. ^ "产品规格". Bluecool.cn. Archived from the original on 3 January 2019. Retrieved 2 April 2019. ^ "蓝酷蓝信LK7裸眼3D手机将上市！ - MTK手机网". Mtksj.com. Archived from the original on 21 August 2018. Retrieved 2 April 2019. ^ "【蓝信 LK7手机】报价_参数_图片_蓝信 LK7手机报价_手机信息网". shouji.tenaa.com.cn. Archived from the original on 22 February 2020. Retrieved 2 April 2019. ^ a b Veecon Rok 3D Phones Hands on review of specifications, features, camera test, price in India. Nothing Wired. 25 October 2018. Archived from the original on 23 March 2021. Retrieved 4 August 2021 – via YouTube. ^ a b "VEECON ROKiT - affordable handsets, with unique features and services available for all". Veeconrokit.com. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ a b "VEECON ROKiT - affordable handsets, with unique features and services available for all". Veeconrokit.com. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ a b "VEECON ROKiT - affordable handsets, with unique features and services available for all". Veeconrokit.com. Archived from the original on 3 February 2020. Retrieved 2 April 2019. ^ a b Dolcourt, Jessica. "Rokit Android phones have 3D screens and 'free' health care, for under $300". Cnet.com. Archived from the original on 12 January 2020. Retrieved 2 April 2019. ^ "Hydrogen One". Archived from the original on 2019-04-08. Retrieved 2019-04-08. ^ "Holopix". Archived from the original on 2020-06-16. Retrieved 2019-04-08. ^ "Leia Loft". www.leialoft.com. Archived from the original on 2018-06-16. ^ a b c "Elephone Malaysia Official | Keep Expecting and be Surprised". Archived from the original on 2019-04-19. Retrieved 2019-04-19. ^ Elephone A4 and Elephone A4 Pro refresh with dual-camera. Notebook Italia. 21 November 2018. Archived from the original on 25 March 2020. Retrieved 4 August 2021 – via YouTube. ^ "OEM MAKERS E3007 Specifications. Wholesale Notched display Smartphone full screen Side Fingerprint Glasses-free 3D cell phone MT6763 Octa-core Naked Eye 3D mobile phone Quick-Charge 4GB RAM 64GB ROM price quote. OEM ODM Mobile Phone from Chinese Manufacturer Maker Company Factory Supplier". Archived from the original on 2019-05-03. Retrieved 2019-05-03. ^ Elephone A5 with triple camera and optional naked-eye 3D and Elephone A5 Lite. Notebook Italia. 8 November 2018. Archived from the original on 28 March 2020. Retrieved 4 August 2021 – via YouTube. ^ "Android9-0-5-67inch-mobilephone-4g". Archived from the original on 2019-11-10. Retrieved 2019-11-10. ^ "DingDing | The Perfect Supplier for your Smarthphone". www.dingdingmobile.com. Archived from the original on 2018-08-15. ^ Archived 2022-09-26 at the Wayback Machine [user-generated source] ^ "Yocophone A11 specifications | Yocosta Global". Archived from the original on 2019-11-10. Retrieved 2019-11-10. ^ "ROKiT iO 3D | ROKiT 3D Phone | ROKiT Phones". rokitphones.com. Archived from the original on 2020-10-31. Retrieved 2020-09-22. ^ a b "ROKiT - YouTube". YouTube. Archived from the original on 2020-03-18. Retrieved 2019-05-04. ^ "ROKiT 3D Phone | ROKiT iO Pro 3D | ROKiT Phones". rokitphones.com. Retrieved 2020-09-22. ^ Rokit IO Pro 3D | Unboxing and Tour. Recombu. 22 March 2019. Archived from the original on 1 January 2020. Retrieved 4 August 2021 – via YouTube. ^ a b c "Welcome to the brand new world of 3D visual technology". Archived from the original on 2018-08-23. Retrieved 2018-12-19. ^ a b c "Archived copy". Archived from the original on 2022-03-28. Retrieved 2021-04-07.{{cite web}}: CS1 maint: archived copy as title (link) ^ "Archived copy". Archived from the original on 2021-04-10. Retrieved 2021-04-07.{{cite web}}: CS1 maint: archived copy as title (link) ^ Alienline Jupiter 8 3D Tablet. Alienline 3D. 24 January 2020. Archived from the original on 9 April 2022. Retrieved 4 August 2021 – via YouTube. ^ "Archived copy". Archived from the original on 2021-04-10. Retrieved 2021-04-07.{{cite web}}: CS1 maint: archived copy as title (link) ^ Alienline Jupiter 10 3D Tablet. Alienline 3D. 24 January 2020. Archived from the original on 9 April 2022. Retrieved 4 August 2021 – via YouTube. ^ "Archived copy". Archived from the original on 2021-04-10. Retrieved 2021-04-07.{{cite web}}: CS1 maint: archived copy as title (link) ^ Alienline Alpha 6 3D Smartphone. Alienline 3D. 9 June 2020. Archived from the original on 9 April 2022. Retrieved 4 August 2021 – via YouTube. ^ "Lume Pad | Creators Edition - the World's First 3D Lightfield Tablet". Archived from the original on 2021-03-07. Retrieved 2021-03-14. ^ "Leia Inc. And Infuse Medical announce partnership". Leia Inc. 10 February 2021. Archived from the original on 2021-03-04. Retrieved 2021-03-14. ^ "Lume Pad 3D Lightfield Tablet | Leia Inc". Archived from the original on 2021-03-04. Retrieved 2021-03-14. ^ "Lume Pad: Finally the first 3D tablet that actually can be watched comfortably". 16 October 2020. Archived from the original on 18 April 2021. Retrieved 14 March 2021. ^ "Real high quality 3D Lenticular prints with last Leia update". 24 December 2020. Archived from the original on 18 April 2021. Retrieved 14 March 2021. ^ "The CES of 3D: Lots of 3D products awarded at CES 2021, including Lume Pad". 13 January 2021. Archived from the original on 18 April 2021. Retrieved 14 March 2021. ^ "Innovation Award Honorees - CES 2022". Archived from the original on 2021-03-07. Retrieved 2021-03-14. ^ "Lume Pad now can watch and manipulate the +500000 3D models from Sketchfab". 21 January 2021. Archived from the original on 25 February 2021. Retrieved 14 March 2021. ^ "Introducing ProMa King Tablet". 16 October 2021. Archived from the original on 29 November 2021. Retrieved 11 July 2022. ^ "Advances in Lenticular Digital Displays - the ProMa King Tablet". YouTube. 12 November 2021. Archived from the original on 2022-07-11. Retrieved 2022-07-11. ^ "Nubia pad 3d - ZTE". ^ "Glasses Free 3D Technology – Believing is Seeing". 28 February 2023. ^ "Nubia Introduces a New Generation 3D Pad, the 3D Cinema at Home". 21 February 2023. ^ "Lume Pad 2 / Nubia Pad 3D announced". 28 February 2023. ^ "ZTE Nubia's first 3D•AI tablet: Offers eyewear-free immersive 3D experiences & content creation" (Press release). ^ "ZTE announces nubia Pad 3D with glasses-free 3D viewing". ^ "ZTE wants to resurrect 3D with its latest tablet". ^ "ZTE revive el 3D con una tablet espectacular: Así es la nubia Pad 3D". 28 February 2023. ^ "I just tried the first glasses-free 3D tablet — this is pretty impressive". 28 February 2023. ^ "AIS and ZTE Co-announce World's First Eyewear-free 3D Tablet Using AI Technology". March 2023. ^ "Opic's 3D smartphone enables 3D livestream to VR headsets". May 2023. ^ "Xreal Beam Pro enables 3D livestream to VR headsets and to take 3D Photo's/Video's". June 2024. 3D Video Collections For 3D DEVICES Divided by categories (version available for all Desktops, Smartphones, Tablets and above SmartTV 3D) Mobiles by categories Archived 2014-10-06 at the Wayback Machine Global 3D-Enabled Smartphones Industry Archived 2015-11-25 at the Wayback Machine Apple iPhone SE (2020) Archived 2021-02-28 at the Wayback Machine Retrieved from " 3Mobile telecommunications phase This section needs additional citations for verification. Please help improve this article by adding citations to reliable sources in this section. Unsourced material may be challenged and removed. (April 2022) (Learn how and when to remove this message) 3G mobile telephony was relatively slow to be adopted globally. In some instances, 3G networks do not use the same radio frequencies as 2G so mobile operators must build entirely new networks and license entirely new frequencies, especially so to achieve high data transmission rates. Other delays were due to the expenses of upgrading transmission hardware, especially for UMTS, whose deployment required the replacement of most broadcast towers. Due to these issues and difficulties with deployment, many carriers delayed acquisition of these updated capabilities. In December 2007, 190 3G networks were operating in 40 countries and 154 HSDPA networks were operating in 71 countries, according to the Global Mobile Suppliers Association (GSA). In Asia, Europe, Canada and the US, telecommunication companies use W-CDMA technology with the support of around 100 terminal designs to operate 3G mobile networks. Roll-out of 3G networks was delayed in some countries by the enormous costs of additional spectrum licensing fees. (See Telecoms crash.) The license fees in some European countries were particularly high, bolstered by government auctions of a limited number of licenses and sealed bid auctions, and initial excitement over 3G's potential. The 3G standard is perhaps well known because of a massive expansion of the mobile communications market post-2G and advances of the consumer mobile phone. An especially notable development during this time is the smartphone (for example, the iPhone, and the Android family), combining the abilities of a PDA with a mobile phone, leading to widespread demand for mobile internet connectivity. 3G has also introduced the term "mobile broadband" because its speed and capability make it a viable alternative for internet browsing, and USB Modems connecting to 3G networks are becoming increasingly common. The first African use of 3G technology was a 3G video call made in Johannesburg on the Vodacom network in November 2004. The first commercial launch was by Emtel-ltd in Mauritius in 2004. In late March 2006, a 3G service was provided by the new company Wana in Morocco. In May 2007, Safaricom launched 3G services in Kenya while later that year Vodacom Tanzania also started providing services. In February 2012 Bharti Airtel Launched a 3.75G Network in selected cities in Kenya with a countrywide rollout planned for later in the year. In Egypt, Mobinil launched the service in 2008 and in Somaliland, Telesom started first 3G services on 3 July 2011, to both prepaid and postpaid subscription customers. Telecommunication networks in Nigeria like Globacom, Etisalat, Airtel and MTN provide 3G services to their numerous customers. Asia is also using 3G services very well. A lot of companies like Dialog Axiata PLC Sri Lanka (First to serve 3G Service in South Asia in 2006), BSNL, WorldCall, PTCL, Mobilink, Zong, Ufone, Telenor PK, Maxis, Vodafone, Airtel, Idea Cellular, Aircel, Tata DoCoMo and Reliance have released their 3G services. Sri Lanka's All Mobile Networks(Dialog, Mobitel, Etisalat, Hutch, Airtel,) And CDMA Network Providers (Lankabell, Dialog, Suntel, SLT) Launched 3G Services. Dialog, Mobitel launched 4G LTE Services In Sri Lanka. Not Only (Dialog CDMA, Lankabell CDMA Have 4G LTE Services. Sri Lanka Telecom Have 4G LTE, FTTX Services.. On March 19, 2012, Etisalat Afghanistan, the fastest growing telecommunications company in the country and part of Etisalat Group, announced the launch of 3G services in Afghanistan.[1] between 2013 and 2014 all telecommunications company (Afghan Wireless, Etisalat, Roshan, MTN and Salaam Network) provided 3G, 3.5G and 3.75G services and they are planning for 4G services in 2016–2017. Nepal was one of the first countries in southern Asia to launch 3G services. Nepal's first 3G company was NTC Archived 2015-01-18 at the Wayback Machine (Nepal Telecom Corporation) and the second was Ncell. Ncell also covered Mount Everest with 3G. NTC provides high speed video calling with other 3G services, as well as post-paid and pre-paid 3G SIM cards. Main article: Pakistani Telecom Spectrum Auction 3G and 4G was simultaneously launched in Pakistan on April 23, 2014, through a SMRA Auction. Three out of five Companies got a 3G licence i.e. Ufone, Mobilink and Telenor while China Mobile's Zong got 3G as well as a 4G licence. Whereas the fifth company, Warid Pakistan did not participate in the auction procedure. However, they launched 4G LTE services on their existing 2G 1800 MHz spectrum due to Technology neutral terms and became world's first Telecom Company to transform directly from 2G to 4G. With that Pakistan joined the 3G and 4G world. In the non-mobile sector, Pakistan's biggest telecommunication company PTCL launched its 3G network, EVO, in mid-2008 and has since then established itself in this sector. It provides 3G services in 105 cities across Pakistan. Omantel's WorldCall also provides 3G services in 50 cities Pakistan-wide. They provide mobile broadband service via dongles and modems. On 14 August 2010, Pakistan became the first country in the world to experience EVDO's RevB 3G technology that offers maximum speeds of 9.3 Mbit/s. At present the services of EVO Nitro (brand name) are available in Islamabad, Rawalpindi, Lahore and Karachi. The RevA network, with speeds if up to 3.1 Mbit/s is available in over 100 cities of the country.[2] State-run mobile operator Teletalk Bangladesh limited and other GSM operators GrameenPhone, Banglalink, Robi and Airtel already started hi-speed 3G+ and 3.5G services using UMTS with HSDPA facilities. Grameenphone has a plan to launch 4G LTE services first time in Bangladesh using TD-LTE technology. Currently Grameenphone owned 10 MHz spectrum at 3G auction by BTRC.Robi and Airtel recently merged, newly merged company has a plan to introduce 4G operation soon. Two other data operators, Qubee and Banglalion, currently offer 4G Wimax services in Bangladesh. CityCell now switched off their operation by government order. 4G LTE services have already begun in Bangladesh through all mobile operators except Teletalk, the state run mobile operator. Bangladesh has a plan to introduce super speed 5G service soon. A test run will be conducted in the country in mid July 2018. China announced in May 2008, that the telecoms sector was re-organized and three 3G networks would be allocated so that the largest mobile operator, China Mobile, would retain its GSM customer base. China Unicom would retain its GSM customer base but relinquish its CDMA2000 customer base, and launch 3G on the globally leading W-CDMA (UMTS) standard. The CDMA2000 customers of China Unicom would go to China Telecom, which would then launch 3G on the CDMA2000 1x EV-DO standard. This meant that China would have all three main cellular technology 3G standards in commercial use. Finally in January 2009, Ministry of industry and Information Technology of China awarded licenses of all three standards: TD-SCDMA to China Mobile, W-CDMA to China Unicom and CDMA2000 to China Telecom. The launch of 3G occurred on 1 October 2009, to coincide with the 60th Anniversary of the Founding of the People's Republic of China. By August 2011, China Telecom's 3G subscriber has exceeded 23 million .[3] On 11 December 2008, India entered the 3G arena with the launch of 3G enabled Mobile and Data services by Government owned Mahanagar Telephone Nigam Ltd MTNL in Delhi and later in Mumbai. MTNL becomes the first 3G Mobile service provider in India. After MTNL, another state operator Bharat Sanchar Nigam Ltd. (BSNL) launched 3G services on 22 Feb 2009 in Chennai and Kolkata and later launched 3G as Nationwide. The auction of 3G wireless spectrum was announced in April 2010 and 3G Spectrum allocated to all private operators on 1 September 2010. While 3G was embraced by several countries at the beginning of the millennium, it was introduced to India somewhat later. The first network to make mobile internet browsing hassle-free was 3G. Even though it is sluggish those days, it is still sufficient for watching films and streaming music. However, telecommunications companies like Airtel have begun to shut down 3G networks in a number of Indian regions.[4] Maximum Speed: 384 kilobits/second[5] North Korea has had a 3G network since 2008, which is called Koryolink, a joint venture between Egyptian company Orascom Telecom Holding and the state-owned Korea Post and Telecommunications Corporation (KPTC). It is North Korea's only 3G Mobile operator, and one of only two mobile companies in the country. According to Orascom quoted in BusinessWeek, the company had 125,661 subscribers in May 2010. The Egyptian company owns 75 percent of Koryolink, and is known to invest in infrastructure for mobile technology in developing nations. It covers Pyongyang, and five additional cities and eight highways and railways. Its only competitor, SunNet, uses GSM technology and suffers from poor call quality and disconnections.[6] Phone numbers on the network are prefixed with +850 (0)192.[7] 3G services were made available in the Philippines in December 2008.[8] 3G services were made available in Singapore in October 2007. Widespread adoption of 3G began in January 2009, with the upgrading of phones to iPhone 3G and Android. In Europe, mass market commercial 3G services were introduced starting in March 2003 by O2 in the UK and Italy. The European Union Council suggested that the 3G operators should cover 80% of the European national populations by the end of 2005. In Canada, Bell Mobility, SaskTel[9] and Telus launched a 3G EVDO network in 2005.[10] Rogers Wireless was the first to implement UMTS technology, with HSDPA services in eastern Canada in late 2006.[11] Realizing they would miss out on roaming revenue from the 2010 Winter Olympics, Bell and Telus formed a joint venture and rolled out a shared HSDPA network using Nokia Siemens technology. After the AWS spectrum in 2008, new entrants to the Canadian wireless markets including but not limited to Mobilicity, Wind Mobile and Vidéotron have deployed their own UMTS networks in Canada using the AWS spectrum. In Iran Rightel won the bid for the third Operator license. Rightel is the first 3G operator in Iran. Rightel has commercially launched in the last months of 2011. In Jordan, Orange is the first mobile 3G operator. Mobitel Iraq is the first mobile 3G operator in Iraq. It was launched commercially in February 2007. MTN Syria is the first mobile 3G operator in Syria. It was launched commercially in May 2010. In Lebanon Ministry of Telecoms launched a test period on September 20, 2011, where 4,000 smart-phone users were selected to enjoy 3G for one month and provide feedback. Currently, the test period is over, MTC Touch and Alfa began rolling out the new 3G services. Saudi Arabia has got 4G as well as 3G/HSPA With Zain KSA, Saudi Telecom, and Mobily KSA. In Trinidad and Tobago, Digicel was the first to implement UMTS services with the introduction of HSPA+ in May 2012.[12] bmobile launched their 3G UMTS network in November 2012 with the implementation of HSPA+.[13] Turkcell, Avea and Vodafone launched their 3G networks commercially on 30 July 2009 at the same time. Turkcell and Vodafone launched their 3G service on all provincial centres. Avea launched it on 16 provincial centres. It was after Turkey's monopoly mobile operator Turkcell accepted number portability, mobile operators attended frequency band auction and frequencies for 3G usage distributed around mobile operators. Turkcell got A band, Vodafone B and Avea C. Currently Turkcell and Vodafone have 3G networks on most of crowded cities and towns. Turkey has 3.9G networks now. In late 2005, Vodafone NZ launched their 3G network, followed by Spark NZ's XT network in 2008, and newcomer 2degrees using a combination of Vodafone's 3G towers and their own in 2009. 2degrees has since built more towers, and is now self-sufficient in the major cities (Auckland, Hamilton, Wellington, Christchurch and Dunedin) but relies on a roaming agreement with Vodafone to cover the rest of the country. This gives it essentially the same footprint as Vodafone. ^ "The first mobile operator to launch 3G services". Kabul. March 19, 2012. Archived from the original on 2014-03-18. Retrieved 2014-03-18. Etisalat Afghanistan, the fastest growing telecommunications company in the country and part of Etisalat Group, today announced the launch of 3G services in Afghanistan. Etisalat is the first mobile operator to launch 3G services in the country. ^ "Next-generation licence: Govt raises over $1.1 billion in spectrum auction". 23 April 2014. Archived from the original on 24 April 2014. Retrieved 23 April 2014. ^ China Daily. "China Telecom subscribers reach 110.94m". Archived from the original on 28 September 2012. Retrieved 13 September 2011. ^ "3G, 4G, EDGE, 5G: What you need to know about mobile networks". The Times of India. 2020-12-10. ISSN 0971-8257. Retrieved 2024-08-31. ^ "3G, 4G, EDGE, 5G: What you need to know about mobile networks". The Times of India. 2020-12-10. ISSN 0971-8257. Retrieved 2024-08-31. ^ "Cell phone demand stays strong in North Korea". Business Week. 2009-12-08. Archived from the original on 2013-10-29. Retrieved 2010-09-06. ^ Telephone numbers in North Korea ^ "Philippines opens up to 3G networks". Archived from the original on 2008-04-16. Retrieved 2012-06-24. ^ permanent dead link] ^ "TELUS launches EVDO high speed network". 15 November 2005. Archived from the original on 4 March 2012. Retrieved 24 June 2012. ^ Kapica Jack (2006-11-02). "Rogers unveils new wireless network". The Globe and Mail. Archived from the original on 2009-10-03. Retrieved 2010-03-22. ^ "Digicel T&T launches HSPA+". TeleGeography. 2012-05-22. Archived from the original on 2014-08-13. Retrieved 2014-08-13. ^ "This is not just any '4G', this is TSTT '4G'". TeleGeography. 2012-11-14. Archived from the original on 2016-12-21. Retrieved 2014-08-13. Retrieved from " 4 The following pages link to 3G adoption External tools (link count transclusion count sorted list) · See help page for transcluding these entries Showing 50 items. View (previous 50 | next 50) (20 | 50 | 100 | 250 | 500)October 1 (links | edit) SMS (links | edit) 2001 (links | edit) Instant messaging (links | edit) Wiretapping (links | edit) List of mobile network operators (links | edit) Smartphone (links | edit) SIM card (links | edit) SIM lock (links | edit) Roaming (links | edit) Channel capacity (links | edit) Ringtone (links | edit) Mobile payment (links | edit) Multimedia Messaging Service (links | edit) 3G (links | edit) 2G (links | edit) Text messaging (links | edit) Japanese mobile phone culture (links | edit) 4G (links | edit) Qt Extended (links | edit) Satellite phone (links | edit) Smart device (links | edit) Camera phone (links | edit) Car phone (links | edit) Open Mobile Alliance (links | edit) GSM services (links | edit) Mobile game (links | edit) Mobile telephony (links | edit) 1G (links | edit) Mobile radio telephone (links | edit) History of mobile phones (links | edit) Wireless device radiation and health (links | edit) M-learning (links | edit) Clamshell design (links | edit) Mobile phone tracking (links | edit) Mobile phone feature (links | edit) OpenEmbedded (links | edit) Mobile content (links | edit) Series 40 (links | edit) Maemo (links | edit) Mobile music (links | edit) Tethering (links | edit) Push email (links | edit) Mobile phones and driving safety (links | edit) Mobile marketing (links | edit) Mobile app development (links | edit) Mobile web (links | edit) Mobile banking (links | edit) Mobile commerce (links | edit) Mobile dating (links | edit) View (previous 50 | next 50) (20 | 50 | 100 | 250 | 500) Retrieved from " WhatLinksHere/3G_adoption"