

# Smartphone

A **smartphone**, or **smart phone**, is a mobile phone built on a mobile operating system, with more advanced computing capability and connectivity than a feature phone.<sup>[1][2]</sup> The first smartphones combined the functions of a personal digital assistant (PDA) with a mobile phone. Later models added the functionality of portable media players, low-end compact digital cameras, pocket video cameras, and GPS navigation units to form one multi-use device. Many modern smartphones also include high-resolution touchscreens and web browsers that display standard web pages as well as mobile-optimized sites. High-speed data access is provided by Wi-Fi and mobile broadband. In recent years, the rapid development of mobile app markets and of mobile commerce have been drivers of smartphone adoption.

The mobile operating systems (OS) used by modern smartphones include Google's Android, Apple's iOS, Nokia's Symbian, BlackBerry Ltd's BlackBerry OS, Samsung's Bada, Microsoft's Windows Phone, Hewlett-Packard's webOS, and embedded Linux distributions such as Maemo and MeeGo. Such operating systems can be installed on many different phone models, and typically each device can receive multiple OS software updates over its lifetime. A few other upcoming operating systems are Mozilla's Firefox OS, Canonical Ltd.'s Ubuntu Phone, and Tizen.

Worldwide sales of smartphones exceeded those of feature phones in early 2013.<sup>[1]</sup> As of July 18, 2013, 90 percent of global handset sales are attributed to the purchase of iPhone and Android smartphones.<sup>[2]</sup>

## History

### Origin of the term

Devices that combined telephony and computing were conceptualized as early as 1973, and were offered for sale beginning in 1994. The term "smartphone", however, did not appear until 1997, when Ericsson described its GS 88 "Penelope" concept as a *Smart Phone*.<sup>[3][4][5]</sup>

The distinction between smartphones and feature phones can be vague, and there is no official definition for what constitutes the difference between them. One of the most significant differences is that the advanced application programming interfaces (APIs) on smartphones for running third-party applications<sup>[1]</sup> can allow those applications to have better integration with the phone's OS and hardware than is typical with feature phones. In comparison, feature phones more commonly run on proprietary firmware, with third-party software support through platforms such as Java ME or BREW.<sup>[1]</sup> An additional complication is that the capabilities found in newer feature phones exceed those of older phones that had once been promoted as smartphones.

Some manufacturers and providers use the term "superphone" for their high end phones with unusually large screens and other expensive features.<sup>[4][5]</sup>

With the advent of devices with larger screens, the term "phablet", a portmanteau of the words *phone* and *tablet*,<sup>[1]</sup> had come into common usage by 2008.<sup>[1]</sup>



IBM Simon and charging base  
(int. August 16, 1994)

## Early years

The first cellular phone to incorporate PDA features was an IBM prototype developed in 1992 and demonstrated that year at the COMDEX computer industry trade show. A refined version of the product was marketed to consumers on 16 August 1994 by BellSouth under the name Simon Personal Communicator. The Simon was the first device that can be properly referred to as a "smartphone", even though that term was not yet coined.<sup>[1]</sup> In addition to its ability to make and receive cellular phone calls, Simon was also able to send and receive facsimiles, e-mails and pages through its touch screen display. Simon included many applications including an address book, calendar, appointment scheduler, calculator, world time clock, games, electronic note pad, handwritten annotations and standard and predictive touchscreen keyboards.

In 1996, Nokia released the Nokia 9000, part of the Nokia Communicator line, which became their best-selling phone of that time. It was a palmtop computer-style phone combined with a PDA from HP. In early prototypes, the two devices were fixed together via a hinge in what became known as a clamshell design. When opened, the display of 640×200 pixels was on the inside top surface and with a physical QWERTY keyboard on the bottom. Email and text-based web browsing was provided via the GEOS V3.0 operating system.

In the late 1990s though, the vast majority of mobile phones had only basic phone features so many people also carried a separate dedicated PDA device, running early versions of operating systems such as Palm OS, BlackBerry OS or Windows CE/Pocket PC.<sup>[2]</sup> These operating systems would later evolve into mobile operating systems and power some of the high-end smartphones.

In early 2001, Palm, Inc. introduced the Kyocera 6035, the first smartphone in the United States. This device combined a PDA with a mobile phone and operated on the Verizon Wireless network. It also supported limited web browsing.<sup>[6]</sup> The device was not adopted widely outside North America.<sup>[7]</sup>

In 2004, HP released the iPaq h6315, a device that combined their previous PDA, the HP 2215 with cellular capability.<sup>[8]</sup>

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## Operating systems

### Symbian

Symbian is a mobile operating system designed for smartphones originally developed by Psion as EPOC32 and later passed to and managed by Symbian Ltd. but currently maintained by Accenture.<sup>[1]</sup> It was the world's most widely used smartphone operating system until Q4 2010. It has become obsolete since 2011 when Nokia, the last remaining OEM and by far Symbian's most popular OEM, dropped the platform in favor of Windows Phone.

The first Symbian phone, the touchscreen Ericsson R380 Smartphone, was released in 2000,<sup>[9][10]</sup> and was the first device marketed as a "smartphone".<sup>[11]</sup> It combined a PDA with a mobile phone.<sup>[12]</sup> Later in 2000, the Nokia 9210 communicator was released.

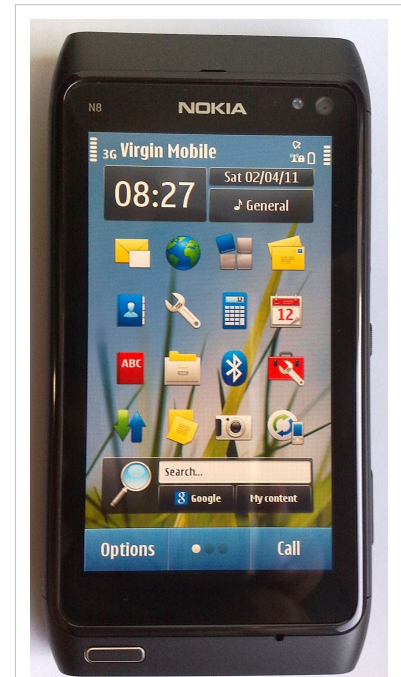
The 7650 from 2002 was the first ever camera phone to hit the European market – it was also Nokia's first with a color screen display and the first to run on Nokia's Series 60 (later known as S60) platform, which would become a major smartphone platform in the coming years. In 2007, Nokia launched the Nokia N95, which integrated various multimedia features: GPS, a 5-megapixel camera with autofocus and LED flash, 3G and Wi-Fi connectivity and TV-out. In the next few years these features would become standard on high-end smartphones.

In 2010, Nokia released the Nokia N8 smartphone with a stylus-free capacitive touchscreen, the first device to use the new Symbian^3 OS.<sup>[13]</sup> Its 12-megapixel camera able to record HD video in 720p.<sup>[14]</sup> It also featured a front-facing VGA camera for videoconferencing.

Some estimates indicate that the number of mobile devices shipped with the Symbian OS up to the end of Q2 2010 is 385 million.<sup>[15]</sup> Symbian was the number one smartphone platform by market share from 1996 until 2011 when it dropped to second place behind Google's Android OS.

In February 2011, Nokia announced that it would replace Symbian with Windows Phone as the operating system on all of its future smartphones.<sup>[1]</sup> This transition was completed in October 2011, when Nokia announced its first line of Windows Phone 7.5 smartphones, Nokia Lumia 710 and Nokia Lumia 800.<sup>[16]</sup> Nokia committed to support its Symbian based smartphones until 2016, by releasing further OS improvements like Belle, and new devices, like the Nokia 808 PureView. On January 24, 2013, Nokia officially confirmed that 808 Pureview would be the last Symbian smartphone.

Unlike other smartphone platforms in the early years, Symbian was the first to popularize mobile phone multimedia such as music, video and gaming. The other major smartphone operating systems at the time like Windows Mobile, BlackBerry OS (in those days) and Palm OS were solely focused on business-use. Despite this Symbian S60 still remained as a popular platform for business use as a result of Nokia's Communicator series such as the E90, as well as the Navigator series. Symbian's popularity in multimedia was centred in its Nseries, with devices such as the N73, N93, N95 and N97.



The Nokia N8 - the first device to feature a 12-megapixel autofocus lens (2010)

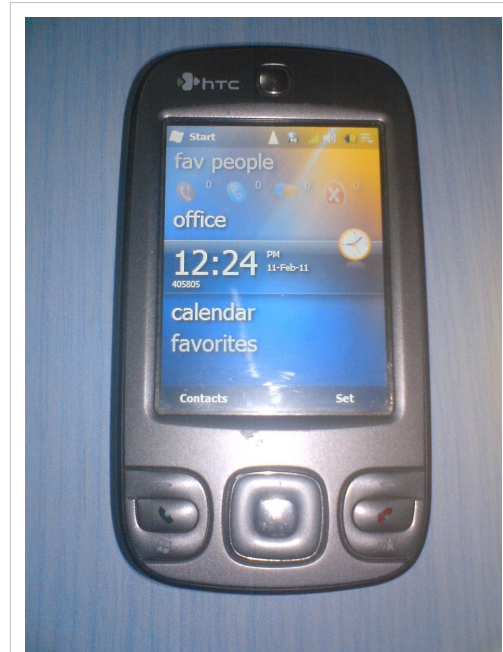
## Windows Mobile

Windows Mobile was based on the Windows CE kernel and first appeared as the Pocket PC 2000 operating system. Throughout its lifespan, the operating system was available in both touchscreen and non-touchscreen formats. It was supplied with a suite of applications developed with the Microsoft Windows API and was designed to have features and appearance somewhat similar to desktop versions of Windows. Third parties could develop software for Windows Mobile with no restrictions imposed by Microsoft. Software applications were eventually purchasable from Windows Marketplace for Mobile during the service's brief lifespan.

Most early touchscreen devices came with a stylus, which could be used to enter commands by tapping it on the screen. The primary touch input technology behind most devices were resistive touchscreens that often responded more accurately to a stylus for input, but could also be driven by a finger. Later devices used capacitive touchscreens, which were more suited to finger input. Along with touchscreens a large variety of form factors existed for the platform from the humble 'candy bar' style to sliding, folding and articulating keyboards.

A key software feature of Windows Mobile was ActiveSync; a data synchronization technology and protocol developed by Microsoft, originally released in 1996. This allowed servers running Microsoft Exchange Server, or other third party variants (such as Google Mail), to act as a personal information manager and share information such as email, calendar appointments, contacts or internet favorites.

Despite being replaced by Windows Phone, Windows Mobile is still in use to this day in the enterprise market by supermarket chains and courier companies.



HTC Gene P3400 running Windows Mobile 6.5 (2007)

## BlackBerry

In 1999, RIM released its first BlackBerry devices, making secure real-time push-email communications possible on wireless devices. Services such as BlackBerry Messenger and the integration of all communications into a single inbox allowed users to access, create, share and act upon information instantly. There are 80 million active BlackBerry service subscribers (BIS/BES) and the 200 millionth BlackBerry smartphone was shipped in September 2012 (twice the number since June 2010<sup>[17]</sup>). Popular models include the BlackBerry Bold, BlackBerry Torch (slider and all-touch) and BlackBerry Curve. Most recently, RIM has undergone a platform transition. The company has changed its name to Blackberry and is pushing out new devices on a new platform named "Blackberry 10." So far, 3 devices have been released on this platform: the full-touch "Blackberry Z10" and the Qwerty devices "Q10" and "Q5".<sup>[18]</sup>



A BlackBerry Curve 8900  
(2008)



## Android

*Android* is an open-source platform founded in October 2003 by Andy Rubin and backed by Google, along with major hardware and software developers (such as Intel, HTC, ARM, Motorola and Samsung, to name a few), that form the Open Handset Alliance.<sup>[19][20]</sup> The first phone to use Android was released in October 2008.<sup>[11]</sup> It was called the HTC Dream and was branded for distribution by T-Mobile as the G1. The software suite included on the phone consists of integration with Google's proprietary applications, such as Maps, Calendar, and Gmail, and a full HTML web browser. Android supports the execution of native applications and a preemptive multitasking capability (in the form of services). Third-party free and paid apps are available via Google Play, which launched in October 2008 as Android Market.

In January 2010, Google launched the Nexus One smartphone using its Android OS. Android has multi-touch abilities, but Google initially removed that feature from the Nexus One,<sup>[21]</sup> but it was added through a firmware update on February 2, 2010.<sup>[22]</sup> By Q4 2010, Android became the best selling smartphone platform after massive gains throughout the year.

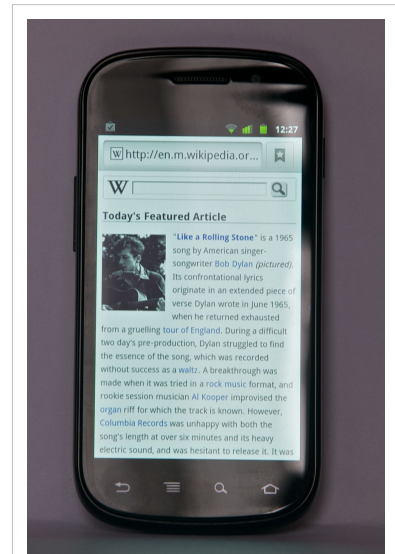
On June 24, 2011, HTC Corporation released the HTC EVO 3D, a smartphone that can produce stereoscopic 3D effects and take 3D stereoscopic photos for viewing on its screen. Samsung Galaxy S III sales hit 18 million in the third quarter of 2012.<sup>[23]</sup> On November 13, 2012 Google and LG released the Nexus 4 with Qualcomm's Snapdragon S4 Pro processor.

## iOS

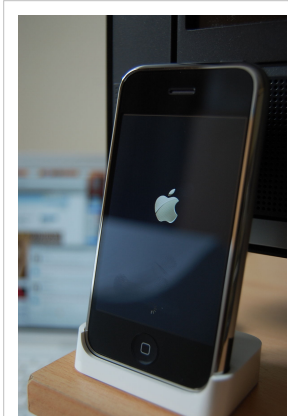
In 2007, Apple Inc. introduced the original iPhone, one of the first mobile phones to use a multi-touch interface. The iPhone was notable for its use of a large touchscreen for direct finger input as its main means of interaction, instead of a stylus, keyboard, and/or keypad as typical for smartphones at the time. It initially lacked the capability to install native applications, meaning some did not regard it as a smartphone.<sup>[24]</sup> However in June 2007 Apple announced that the iPhone would support third-party "web 2.0 applications" running in its web browser that share the look and feel of the iPhone interface.<sup>[25]</sup> A process called jailbreaking emerged quickly to provide unofficial third-party native applications to replace the built-in functions (such as a GPS unit, kitchen timer, radio, map book, calendar, notepad, and many others).<sup>[26]</sup>

In July 2008, Apple introduced its second generation iPhone with a much lower list price and 3G support. Simultaneously, they introduced the App Store, which allowed any iPhone to install third party native applications (both free and paid) over a Wi-Fi or cellular network, without requiring a PC for installation. Applications could additionally be browsed through and downloaded directly via the iTunes software client. Featuring over 500 applications at launch,<sup>[27]</sup> the App Store was very popular,<sup>[28]</sup> and achieved over one billion downloads in the first year, and 15 billion by 2011.<sup>[29][30]</sup>

In June 2010, Apple introduced iOS 4, which included APIs to allow third-party applications to multitask,<sup>[31]</sup> and the iPhone 4, with an improved display and back-facing camera, a front-facing camera for videoconferencing, and other improvements.<sup>[32]</sup> In early 2011 the iPhone 4 allowed customers to use the handset's 3G connection as a wireless Wi-Fi hotspot.<sup>[33]</sup>



A Google Nexus S running Android OS 2.3 (2010)



First generation iPhone (2007)

The iPhone 4S was announced on October 4, 2011, improving upon the iPhone 4 with a dual core A5 processor, an 8-megapixel camera capable of recording 1080p video at 30 frames per second, World phone capability allowing it to work on both GSM & CDMA networks, and the Siri automated voice assistant.<sup>[34]</sup> On October 10, Apple announced that over one million iPhone 4Ss had been pre-ordered within the first 24 hours of it being on sale, beating the 600,000 device record set by the iPhone 4.<sup>[[35]</sup> Along with the iPhone 4S Apple also released iOS 5 and iCloud, untethered device activation, backup, and synchronization,<sup>[36]</sup> along with additional features.<sup>[37]</sup>

In September 2012 Apple released iPhone 5 running iOS 6. In the last generation iOS number of new features was introduced, including panoramic photography, Passbook, Apple Maps and others.

## Windows Phone

On February 15, 2010, Microsoft unveiled its next-generation mobile OS, Windows Phone 7. Microsoft's mobile OS includes a completely over-hauled UI inspired by Microsoft's "Metro Design Language". It includes full integration of Microsoft services such as Microsoft SkyDrive and Office, Xbox Music, Xbox Video, Xbox Live games and Bing, but also integrates with many other non-Microsoft services such as Facebook, Twitter and Google accounts. The new software platform has received some positive reception from the technology press and has been praised for its uniqueness.<sup>[38][39][40]</sup>



Nokia Lumia 620 running Windows Phone 8 (2013)

On October 29, 2012, Microsoft released **Windows Phone 8**, the next generation of the operating system. Windows Phone 8 replaces its previously Windows CE-based architecture with one based on the Windows NT kernel with many components shared with Windows 8, allowing developers to easily port applications between the two platforms.

## Palm OS

In late 2001, Handspring launched their own Springboard GSM phone module with lim. In early 2002, Handspring released the Palm OS Treo smartphone, utilizing both a touch screen and a full keyboard that combined wireless web browsing, email, calendar, and contact organizer with mobile third-party applications that could be downloaded or synced with a computer.<sup>[41]</sup> Handspring was soon acquired by Palm, which released the Treo 600 and continued, though the series eventually took on Windows Mobile. The last Palm OS smartphone was the Palm Centro.

## Bada

The Bada operating system for smartphones was announced by Samsung on 10 November 2009.<sup>[42][43]</sup> The first Bada-based phone was the Samsung Wave S8500, released on June 1, 2010,<sup>[44][45]</sup> which sold one million handsets in its first 4 weeks on the market.<sup>[46]</sup>

Samsung shipped 3.5 million phones running Bada in Q1 of 2011.<sup>[47]</sup> This rose to 4.5 million phones in Q2 of 2011.<sup>[48]</sup>

In 2013, Bada has merged with a similar platform called Tizen. The future of its development is unknown.



A Palm Treo 650, running Palm OS 5.4 (2004)

## Open-source development

The open-source culture has penetrated the smartphone market in several ways. There have been attempts to create open source hardware and software for smartphones.

In February 2010, Nokia made Symbian open source. Thus, most commercial smartphones were based on open-source operating systems. These include those based on Linux, such as Google's Android, Nokia's Maemo, Hewlett-Packard's webOS, and those based on BSD, such as the Darwin-based Apple iOS. Maemo was later merged with Intel's project Moblin to form MeeGo.<sup>[49][50]</sup>

On the 2nd of January, Canonical, best known for its Ubuntu desktop and Smart TV operating systems, announced a mobile version of its operating system, built for both smartphones and tablets. Its design is based on the desktop equivalent and features such as gesture-based navigation.

## Features and applications

### Display

Screens on smartphones vary largely in both display size and display resolution. The most common screen sizes range from 3 inches to over 5 inches (measured diagonally). Some 6- to 8-inch screen devices exist that run on mobile OSes and have the ability to make phone calls, such as Huawei Ascend Mate (6.1 in), Sony Xperia Z Ultra (6.4 in), Huawei MediaPad 7 Vogue (7 in), Asus Fonepad (7 in) and Samsung Galaxy Note 8.0 (8 in). Ergonomics arguments have been made that increasing screen sizes start to negatively impact usability.<sup>[citation needed]</sup>

Common resolutions for smartphone screens vary from 240×320 (QVGA) pixels to 1080×1920 (Full HD), with flagship Android phones commonly sporting full HD, 1080p displays and the iPhone 5 at 640×1136. By late-2012 and early 2013, the trend was for full HD 1080p smartphone screens for the highest-end handsets.

With the passing of the years, Pixel density of smartphone screen is getting higher. Apple branded high-density display as Retina. High-density display is worthwhile for small complex characters (especially East Asian text) and sharp edges (especially Line arts and Aliased fonts).

Android <sup>[51]</sup>	iPhone	Windows Phone <sup>[52]</sup>	note
ldpi (120dpi, Android 1.6 or later)		Windows Phone 7 96dpi	
		Windows Phone 7 131dpi	
mdpi (160dpi)	iPhone 1/3/3GS (163dpi)		
tvdpi (213dpi, Android 3.2 or later)		Windows Phone 7 192dpi Lumia 820/900 (217dpi)	
hdpi (240dpi, Android 1.6 or later) Nexus One (254dpi)/Nexus S (235dpi)		Windows Phone 7 262dpi Lumia 710/Lumia 800 (252dpi)	
xhdpi (320dpi, Android 2.2 or later) Galaxy Nexus (316dpi)/Nexus 4 (320dpi)	iPhone 4/4S/5 (326dpi)	Lumia 920 (332dpi)	
xxhdpi (480dpi, Android 4.1 or later)			5-inch Full-HD (440ppi) 4.7-inch Full-HD (468ppi)

## Radio and television

Some smartphones support FM radio, but noise-sensitive AM radio is usually not supported. In some regions, such as Japan and Korea, most smartphones support mobile digital broadcasts (1seg or T-DMB), while some smartphones support regular digital broadcasts.<sup>[citation needed]</sup>

## Popular applications

According to a ComScore report released on May 12, 2011, nearly one in five smartphone users are tapping into check-in services like Foursquare and Gowalla. A total of 16.7 million mobile phone subscribers used location-based services on their phones in March 2011.<sup>[53]</sup>

Research published by Forrester Research in mid-2013 revealed that in a survey of 13,000 iPhone users and 15,000 Android users in the U.S., weather apps were the most popular across both platforms, followed by social networking, navigation/mapping, and gaming apps. The results of the Forrester survey also showed that app usage is higher on iOS when compared to Android.<sup>[54]</sup>

Some smartphones are equipped with a television-viewing function<sup>[55]</sup> and a second screen app allows the user to engage in media multitasking.<sup>[56]</sup>

Some applications allow the user to protect their privacy, such as preventing unwanted calls from telemarketers and "do not disturb" services. The demand for these apps has increased as a result of the *National Do Not Call Registry*.<sup>[57]</sup>

## Application stores

Store	2009 (millions U.S.)	2010 (millions U.S.) <sup>□</sup>
<b>Apple App Store</b>	\$769	\$1782
<b>Blackberry App World</b>	\$36	\$165
<b>Nokia Ovi Store</b>	\$13	\$105
<b>Google Play</b>	\$11	\$102
<b>Total</b>	\$828	\$2155

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 focused on a single platform. Before this, smartphone application distribution was largely dependent on third-party sources providing applications for multiple platforms, such as GetJar, Handango, Handmark, PocketGear, and others.

The iPhone's platform is officially restricted to installing apps through the App Store, through "B2B" deployment, and on an "Ad Hoc" basis on up to 100 iPhones.<sup>[58]</sup> Through jailbreaking it can install apps from other sources. Other platforms may allow application distribution through additional sources outside of their manufacturer-provided app stores, such as third-party app stores and downloads from individual websites.

Following the success of Apple's App Store other smartphone manufacturers quickly launched application stores of their own. Google launched the Android Market in October 2008. MiKandi launched the first adult app market for smartphones in 2009. RIM launched its app store, BlackBerry App World, in April 2009. Nokia launched its Ovi Store in May 2009. Palm launched its Palm App Catalog for webOS in June 2009. Microsoft launched an application store for Windows Mobile called Windows Marketplace for Mobile in October 2009, and then a separate Windows Phone Marketplace for Windows Phone in October 2010. Samsung launched Samsung Apps for its Bada based phones in June 2010. Amazon launched its Amazon Appstore for the Google Android operating system in March 2011.

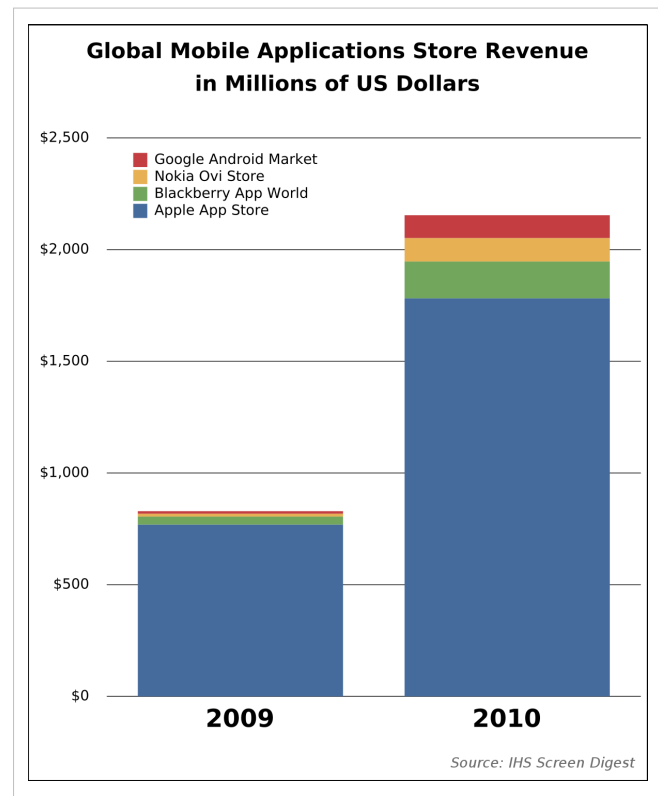
The relatively high revenue of U.S. \$5782 million in 2012 for Apple's App Store compared to competitor's stores<sup>[58]</sup> Wikipedia:Verifiability can be attributed to a combination of factors. In large part this can be attributed to having the largest number of apps available and the highest download volume of any mobile app store in 2010, but besides that only 28% of the apps in Apple's App Store were free apps, compared to over 57% in the Android Market. Similarly, Nokia's Ovi Store and the BlackBerry App World both had only 26% of their apps available for free, and both generated higher revenues than the Android Market despite having much lower download volumes.<sup>[59]</sup>

## Market share

### Smartphone usage

For several years, the demand for smartphones has outpaced other products on the mobile phone market.<sup>[60]</sup> According to a 2012 survey, around half of U.S. mobile consumers own smartphones. They could account for around 70% of all U.S. mobile devices by 2013;<sup>[61]</sup> in the 25 to 34 age group, smartphone ownership is so far reported at 62%.<sup>[62]</sup> For the third quarter of 2011, the NPD Group reported that in the U.S., the proportion of handset sales that were made up of smartphones reached 59% for consumers aged 18 and over.<sup>[63]</sup>

The European mobile device market, as measured by active subscribers of the top 50 networks, is 860 million.<sup>[62]</sup> According to an Olswang report in early 2011, the rate of smartphone adoption is accelerating: as of March 2011, 22% of UK consumers used a smartphone, with this percentage rising to 31% amongst 24- to 35-year-olds.<sup>[63]</sup>



In China, smartphones represented more than half (51%) of all handset shipments in the second quarter of 2012.<sup>[64]</sup>

In terms of worldwide profit share, smartphones far exceed the share of non-smartphones. According to a November 2011 research note from Canaccord Genuity, Apple Inc. holds 52% of the mobile industry's operating profits, while only holding 4.2% of the global handset market. Similarly, HTC and RIM only make smartphones and their worldwide profit shares are at 9% and 7%, respectively. Samsung, second to Apple at 29%, makes both smartphones and basic feature phones, but does not report separate profit results for the two kinds of devices.<sup>[65]</sup>

Until the end of November 2011, 27% of all photographs were taken with camera-equipped smartphones, a significant increase from 17% in 2010. For many people, smartphones have replaced Point-and-shoot cameras.<sup>[66]</sup> A study conducted in September 2012 concluded that 4 out of 5 smartphone owners (85.9 million U.S. users) use the device to shop.<sup>[67]</sup>

In the third quarter of 2012, one billion smartphones were in use worldwide.<sup>[68]</sup> Global smartphone sales surpassed the sales figures for older-style phones in early 2013,<sup>[69]</sup> while the three largest smartphone markets after the first quarter of 2013 are India, China, and the U.S.<sup>[69][70]</sup>



## By manufacturer

Smartphone Customer Satisfaction by J.D. Power and Associates	
Manufacturer	Score
Apple 2010	810
Apple 2011	838
HTC 2010	727
HTC 2011	801
Industry Average 2010	753
Industry Average 2011	788
Samsung 2010	724
Samsung 2011	777
Motorola 2010	N/A
Motorola 2011	775
RIM 2010	741
RIM 2011	762
LG 2010	N/A
LG 2011	760
HP/Palm 2010	712
HP/Palm 2011	733
Nokia 2010	720
Nokia 2011	721
Rankings are based on a possible top score of 1000	

Starting with the launch of their Communicator model in 1996, until 2011 Nokia was dominant in the smartphone market, though the company has more recently been joined by other competitors in the market. Based on a report by Strategy Analytics, Samsung overtook Nokia in smartphone shipments with an estimated 27.8 million units shipped in Q3 2011<sup>[71]</sup> (Samsung does not publicly disclose the numbers of their smartphone shipments and sales).

For the first time in Q2 2011, Apple surpassed Nokia worldwide by revenue and profit, with Apple's profit share of the total worldwide smartphone market increasing to 66.3% while Nokia reported a loss.<sup>[72]</sup>

Between Q2 2010 and Q2 2011 Nokia's worldwide Symbian smartphone sales dropped significantly from 38.1% to 15.2%, while Samsung smartphone sales increased significantly worldwide from 5% to 17.5%.<sup>[1]</sup> As of Q1 2011, Nokia had already announced plans to switch to Windows Phone. Samsung smartphones use a diverse portfolio of operating systems, including their own Bada operating system along with Android and Windows Mobile.<sup>[73]</sup>

Market share among smartphone manufacturers does not equate to OS market share since some systems are available only to one manufacturer, while others are licensed across multiple manufacturers. Apple's iPhone, Nokia's Symbian, and RIM's BlackBerry smartphones are currently only available from single manufacturers. Google's Android OS and Microsoft's mobile systems are platforms that are licensed and used by a variety of manufacturers. As a result, manufacturers of smartphones using licensed systems split the total market share of the corresponding OS between them, while the total share for a single-manufacturer OS is held by that manufacturer alone. Nokia's Symbian OS was previously available from several manufacturers under a licensed model, then later predominantly only from Nokia itself.<sup>[citation needed]</sup>

In the second quarter of 2013, after 15 years on the market, Samsung sold 71.5 million smartphones, or 31.7% market share, while 31.9 million iPhones were sold, or 14.2% of the market share.<sup>[74]</sup> In August 2013, Credit Suisse reported that Samsung and Apple held a combined market share of more than 90%.<sup>□</sup>

Currently the vast majority of smartphones are manufactured in China, Taiwan and Mexico, for companies based in the U.S. (Apple, HP, Motorola), South Korea (LG, Samsung), Japan (Sony), Canada (RIM), Finland (Nokia) and Taiwan (HTC).<sup>[citation needed]</sup>

### By operating system

2010 saw the rapid rise of the Google Android operating system from 4% of new deployments in 2009 to 33% at the beginning of 2011 making it share the top position with the since long dominating Symbian OS. The smaller rivals include Blackberry OS, iOS, Samsung's recently introduced Bada, HP's heir of Palm webOS and the Microsoft Windows Phone OS, which is now supported by Nokia. In the UK, which currently has one of the highest penetrations of smartphones in the World, Android achieved 50% market share in October 2011.<sup>□</sup> As of the end of Q1 2013, Android was the top operating system worldwide smartphone market, with a 75% market share, followed by iOS with 17.3%, and Windows Phone with 3.2%.<sup>[75][76]</sup> Forecasts show that by 2017 Windows Phone will be approaching second place, with 12.7% market share, while Android and iOS will remain in their previous positions, with 67.1% and 14.1% respectively.<sup>[77]</sup>

### Historical sales figures (in millions of units)

Year	Android (Google)	Blackberry (RIM)	iOS (Apple)	Linux (other than Android)	Palm/WebOS (Palm/HP)	Symbian (Nokia)	Asha Full Touch (Nokia)	Windows Mobile/Phone (Microsoft)	Bada (Samsung)	Other
2007 <sup>[78]</sup>		11.77	3.3	11.76	1.76	77.68		14.7		
2008 <sup>[78]</sup>		23.15	11.42	11.26	2.51	72.93		16.5		
2009 <sup>[79]</sup>	6.8	34.35	24.89	8.13	1.19	80.88		15.03		
2010 <sup>[80]</sup>	67.22	47.45	46.6			111.58		12.38		
2011 <sup>[81]</sup>	219.52	51.54	89.26			93.41		8.77		14.24
2012-Q1 <sup>[82]</sup>	81.07	9.94	33.12			12.47		2.71	3.84	1.24
2012-Q2 <sup>[83]</sup>	104.8	7.4	26.0	3.5		6.8		5.4		0.1
2012-Q3 <sup>[84]</sup>	122.5	9.0	23.6			4.4	6.5 <sup>[85]</sup>	4.1	5.1	0.7
2012-Q4 <sup>[86]</sup>	144.7	7.3	43.5			2.6	9.3 <sup>[87]</sup>	6.2	2.7	0.7
2013-Q1 <sup>[88]</sup>	162.1	6.3	37.4			—	--	7.0	--	--
2013-Q2 <sup>[89]</sup>	177.9	6.2	31.9			.631	--	7.4	.838	.471

### Enterprise share by operating system

In a worldwide study of 2,300 workers at 1,100 businesses by iPass it was reported that Apple's iPhones have displaced RIM's BlackBerry devices in enterprise adoption in 2011.<sup>[90]</sup> The share for iPhones increased to 45% from 31.1% in 2010, while the Blackberry share dropped to 32.2% from 34.5% in the previous year. Android phones also increased in share, from 11.3% to 21.3% in 2010, exceeding Symbian for the first time, which dropped to 7.4% from 12.4%. Windows Mobile and all other smartphone OSes also dropped in 2011 compared to 2010.<sup>[91]</sup>

### Customer loyalty by operating system

According to a survey of more than 6,000 smartphone users through 2010 by mobile analytics firm Zokem, the top five loyalty scores for smartphone platforms are the iPhone at 73%, followed by Google's Android at 40%, Samsung's Bada at 33%, RIM's BlackBerry at 30%, and Symbian S60 at 23%. Windows Mobile and Palm follow at 10% each. Customer loyalty gauges the likelihood that the user of a smartphone platform whose contract has expired or who has broken or lost their phone will repurchase another one on the same platform.<sup>[92][93]</sup>

### Malicious software attacks

As smartphone adoption increases, these devices become more appealing to attackers who try to infect them with malicious software (malware).<sup>[94]</sup> Smartphone security literature suggests that smartphone malware can be written even by average developers.<sup>[95]</sup>

Smartphone malware is more easily distributed through application stores that have minimal or no security mechanisms, such as app kill switch (aka remote app removal), review process for their content, etc.<sup>[95]</sup> Often malware is hidden in pirated versions of legitimate apps, which are then distributed through 3rd party app stores.<sup>[96][97]</sup> Malware risk also comes from what's 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. Additionally, the ability to acquire software directly from links on the web results in a distribution vector called "malvertizing," where users are directed to click on links, such as on ads that look legitimate, which then open in the device's web browser and download and install malware automatically.<sup>[98]</sup>

Typical smartphone malware leverages platform vulnerabilities that allow it to gain root access on the device in the background. Using this access the malware installs additional software to target communications, location, or other personal identifying information. A common form of malware on mobile phones is the SMS trojan, which sends premium SMS messages, possibly while unknowingly running in the background of a legitimate application. These premium SMS messages run up charges on the owner's phone bill that cannot be recovered.

In August 2010, Kaspersky Lab reported detection of the first malicious program for smartphones running on Google's Android operating system, named Trojan-SMS.AndroidOS.FakePlayer.a, an SMS trojan that had already infected a number of devices using that OS.<sup>[99]</sup> Over the spring of 2011 Android malware increased 76%, according to McAfee.<sup>[100]</sup> A report from Juniper Global Threat Center notes that malware on the Android platform increased 400% from 2009 to the summer of 2010, and then saw a 472% increase between July and November 2011.<sup>[95]</sup> The Juniper report indicates that 55% of Android malware acts as spyware, and 44% are SMS trojans.

While potential security flaws remain in iOS,<sup>[98]</sup> as of at least August 2011 there were no known malware or spyware apps in Apple's App Store, according to security firm Lookout. There are however commercial spyware applications available, outside the App Store, for jailbroken iOS devices.<sup>[101]</sup> In June 2011 Symantec's 23-page report "A Window Into Mobile Device Security" characterized (non-jailbroken) devices running iOS as having "full protection" against malware attacks.<sup>[99]</sup>

Symbian and older versions of Windows Mobile have had to contend with a degree of malware in the past, but as legacy systems it is believed that the people who previously targeted them have shifted their focus to Android.<sup>[95]</sup> There were also a few Palm OS viruses.

The only mobile platform other than Apple's iOS without reports of malware so far is HP's (formerly Palm's) webOS, but this may be explained by its relatively low adoption rate.<sup>[102]</sup>

The best way to reduce a device's vulnerability to malware attacks is to install the most recent operating system version, including security patches. This can be complicated by long delays<sup>[100]</sup> in software updates for many devices that have had their software modified with custom "skins," services, or promotional on-deck apps by their manufacturer or mobile carrier.<sup>[103]</sup> In some cases a device may no longer be receiving updates from its manufacturer or carrier, leaving it vulnerable to exploits that have been patched in an OS version that's more recent than the device's

last supported one.

## **Environmental impact**

### **Mining for resources**

To the surprise of many users, the amount of pollution which results from the production of a smart phone until its disposal is substantial. The environmental impact of these devices can be observed by looking at its product life cycle. Obtaining the resources required to create such devices involves the mining of minerals such as coltan which has shown to cause damaging effects on the wildlife in the surrounding area and the population in developing countries.<sup>[101]</sup> Coltan and tantaline are minerals that are used extensively in electronics to create capacitors. Mining for coltan is related to many ethical issues surrounding the basic human rights of workers in African countries such as Rwanda.<sup>[102]</sup> Many incidents in these countries include men, women, and children working at gunpoint to mine for these minerals. The conditions in which they are working in are not safe either as the workers do not have the proper safety equipment to mine this mineral.<sup>[102]</sup> Mining for other raw materials such as oils, copper, plastics, and solvents have the potential to contaminate both the soil and groundwater.<sup>[101]</sup> Recent studies have also shown that toxic chemicals such as lead, bromine, chlorine, mercury, or cadmium are present in different models and brands of smart phones.<sup>[103]</sup>

### **Disposal**

Another major issue associated with cell phones is the process by which they are disposed of after the end of their lifespan. Companies have been responsible for improperly recycling their old/used smart phones causing damage to the environment.<sup>[104]</sup> Cell phones can contain dangerous chemicals such as antimony, cadmium, copper, lead, arsenic, nickel and zinc.<sup>[101]</sup> These chemicals have the potential to run off into surrounding water bodies or seep into soil causing harmful effects to wildlife and even the human population. Chemicals running off into surrounding water bodies could make their way into drinkable water systems and contaminate this supply.<sup>[105]</sup>

### **Recycling initiatives**

New programs and control measures are the focus of the future as countries strive to produce initiatives where consumers can properly dispose of their smartphone. An example of such an initiative is called "Recycle My Cell" which has been established in Canada since 2008 which assists Canadian residents in disposing of their cell phones properly.<sup>[106]</sup> Programs such as these test the devices to see if they can be reused in Canada or anywhere else in the world. Cell phones that can't be salvaged will be recycled in accordance with the Basel Convention on the trans-boundary movement of hazardous waste and their disposal.<sup>[107]</sup>

## **Social factors and impact**

A study conducted by the University of Vienna found that social factors played a major role in the usage of mobile phones. Especially the subjective belief of how users are seen by significant others, or how they would like to be seen by significant others seem to play a major role.<sup>[108]</sup> A University of Southern California study found that the unprotected adolescent sexual activity was more common amongst owners of smartphones.<sup>[109]</sup> There are numerous smartphone applications that have positive social and environmental effects.<sup>[110]</sup> For example, smartphones have proven to be useful tools for encouraging energy conservation by assisting crowd source building energy audits.<sup>[111]</sup>

## Patent licensing and litigation

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. As of August 8, 2013, the U.S. International Trade Commission (USITC) is scheduled to announce its decision regarding an Apple-initiated case, whereby Samsung is accused of infringing four Apple patents related to user interfaces and headphone input functionality.<sup>[1]</sup>

A second separate case is before the U.S. Court of Appeals for the Federal Circuit and is an appeal from Apple in regard to a lower court decision that rejected a U.S. import ban to address Samsung's infringement upon Apple patents. As part of the original decision, a jury awarded Apple more than US\$1 billion in damages before the presiding judge reduced the award by about US\$450 million. As of August 8, 2013, Apple is seeking the enactment of an import ban, as well as the awarded damages.<sup>[2]</sup>

## Thefts

According to the Federal Communications Commission, one out of three robberies involve the theft of a cellular phone. An online petition urging that smartphone makers install kill switches in their devices to make them unusable in case of theft is part of a joint effort by New York Attorney General Eric Schneiderman and San Francisco District Attorney George Gascon called *Secure our Smartphones*.<sup>[112]</sup>

On Monday, June 10, 2013, Apple announced it would install a kill switch on its next iPhone operating system, due to debut in October 2013.<sup>[113]</sup>

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