Android (operating system)

From Wikipedia, the free encyclopedia
Jump to: navigation, search
This article is about the operating system. For other uses, see Android (disambiguation).

Android

Home screen displayed by Samsung Nexus S with Google running Android 2.3 "Gingerbread"

**Company / developer**  Google Inc., Open Handset Alliance

**Programmed in**  C (core), C++ (some third-party libraries), Java (UI)

**Working state**  Current

**Source model**  Free and open source software
Initial release 21 October 2008
Latest stable release 2.3.3 (Gingerbread) [1] / 9 February 2011; 29 days ago[2]
Supported platforms ARM, MIPS, Power Architecture, x86[3][citation needed]
Kernel type Monolithic (modified Linux kernel)
Default user interface Graphical
License Apache 2.0 (Linux kernel
 patches are licensed under GPL v2[4])
Official website android.com

Android is an open-sourcesoftware stack for mobile devices that includes an operating system, middleware and key applications.[5][6] Google Inc. purchased the initial developer of the software, Android Inc., in 2005.[7] Android's mobile operating system is based upon a modified version of the Linux kernel. Google and other members of the Open Handset Alliance collaborated on Android's development and release.[8][9] The Android Open Source Project (AOSP) is tasked with the maintenance and further development of Android.[10]

Canalys reported that in Q4 2010 the Android operating system was the world's best-selling smartphone platform, dethroning Nokia's Symbian from the 10-year top position.[11][12] Jumping from 23.5 percent, Android now represents 31.2 percent of the U.S smartphone market.[13] According to Gartner, Symbian is still slightly ahead on sales if some legacy non-Nokia Symbian smartphones are included in the Q4 2010 figures.[14]

Android has a large community of developers writing application programs ("apps") that extend the functionality of the devices. There are currently over 150,000 apps available for Android.[15][16] Android Market is the online app store run by Google, though apps can also be downloaded from third-party sites. Developers write primarily in the Java language, controlling the device via Google-developed Java libraries.[17]

The unveiling of the Android distribution on 5 November 2007 was announced with the founding of the Open Handset Alliance, a consortium of 80 hardware, software, and telecom companies devoted to advancing open standards for mobile devices.[18][19] Google released most of the Android code under the Apache License, a free software and open source license.[20]

The Android open-source software stack consists of Java applications running on a Java-based, object-oriented application framework on top of Java core libraries running on a Dalvik virtual machine featuring JIT compilation. Libraries written in C include the surface manager, OpenCore[21] media framework, SQLite relational database management system, OpenGL ES 2.03D graphicsAPI, WebKit layout engine, SGL graphics engine, SSL, and Bionic libc. The
Android operating system consists of 12 million lines of code including 3 million lines of XML, 2.8 million lines of C, 2.1 million lines of Java, and 1.75 million lines of C++. [23]

Contents

[hide]

- **1 History**
  - 1.1 Android Inc. founded in 2003
  - 1.2 Android Inc. acquired by Google
  - 1.3 Development accelerates
  - 1.4 Open Handset Alliance
  - 1.5 Licensing
  - 1.6 Version history
- **2 Features**
- **3 Hardware running Android**
- **4 Software development**
  - 4.1 Software development kit
  - 4.2 Android Market
  - 4.3 App Inventor for Android
  - 4.4 Android Developer Challenge
  - 4.5 Google applications
  - 4.6 Third party applications
  - 4.7 Mobile gaming
  - 4.8 Native code
  - 4.9 Community-based firmware
- **5 Security issues**
- **6 Marketing**
  - 6.1 Logos
  - 6.2 Typeface
  - 6.3 Market share
- **7 Fragmentation**
- **8 Linux compatibility**
- **9 Claimed infringement of copyrights and patents**
- **10 See also**
- **11 References**
- **12 Bibliography**
- **13 External links**

[edit] History

[edit] Android Inc. founded in 2003
Android, Inc. was founded in Palo Alto, California, United States in October, 2003 by Andy Rubin, Rich Miner, et al. to develop, in Rubin's words "...smarter mobile devices that are more aware of its owner's location and preferences." Other early key employees include Andy McFadden, who worked with Rubin at WebTV, and Chris White, who led the design and interface of WebTV, before helping to found Android.[23]

Rubin, a co-founder of Danger Inc., Miner, a co-founder of Wildfire Communications, Inc. and former vice-president of Technology and innovation at Orange, and the other early employees brought considerable wireless industry experience to the company.[23][24] Despite the obvious past accomplishments of the founders and early employees, Android Inc. operated secretive, admitting only that it was working on software for mobile phones.[23]

[edit] Android Inc. acquired by Google

Google acquired Android Inc. in August, 2005, making Android Inc. a wholly-owned subsidiary of Google Inc. Key employees of Android Inc., including Andy Rubin, Rich Miner and Chris White, stayed at the company after the acquisition.[25]

At the time of the acquisition, because little was known about the work of Android Inc., some guessed that Google was planning to enter the mobile phone market.

[edit] Development accelerates

At Google, the team led by Rubin developed a mobile device platform powered by the Linux kernel. Google marketed the platform to handset makers and carriers on the premise of providing a flexible, upgradable system. Google had lined up a series of hardware component and software partners and signaled to carriers that it was open to various degrees of cooperation on their part. [26][27][28]

Speculation about Google's intention to enter the mobile communications market continued to build through December 2006.[29] Reports from the BBC and The Wall Street Journal noted that Google wanted its search and applications on mobile phones and it was working hard to deliver that. Print and online media outlets soon reported rumors that Google was developing a Google-branded handset.[30] Some speculated that as Google was defining technical specifications, it was showing prototypes to cell phone manufacturers and network operators.

In September 2007, InformationWeek covered an EvaluateServe study reporting that Google had filed several patent applications in the area of mobile telephony.[31][32]

[edit] Open Handset Alliance

Main article: Open Handset Alliance

"Today's announcement is more ambitious than any single 'Google Phone' that the press has been speculating about over the past few weeks. Our vision is that the powerful platform we're unveiling will power thousands of different phone models."
Eric Schmidt, former Google Chairman/CEO[8]

On the November 5, 2007 the Open Handset Alliance, a consortium of several companies which include Texas Instruments, Broadcom Corporation, Google, HTC, Intel, LG, Marvell Technology Group, Motorola, Nvidia, Qualcomm, Samsung Electronics, Sprint Nextel and T-Mobile unveiled itself. The goal of the Open Handset Alliance is to develop open standards for mobile devices. On the same day, the Open Handset Alliance also unveiled their first product, Android, a mobile device platform built on the Linux kernel version 2.6. [8]

On December 9, 2008, 14 new members joined, including PacketVideo, ARM Holdings, Atheros Communications, Asustek Computer Inc, Garmin Ltd, Softbank, Sony Ericsson, Toshiba Corp, and Vodafone Group Plc. [33][34]

**edit** Licensing

With the exception of brief update periods, Android has been available under a free software / open source license since 21 October 2008. Google published the entire source code (including network and telephony stacks) [35] under an Apache License. [36] Google also keeps the reviewed issues list publicly open for anyone to see and comment. [37]

Android is a trademark of Google; even though the software is open-source, device manufacturers can't use the Android name unless Google certifies that the device complies with their Compatibility Definition Document (CDD). In September 2010, Skyhook Wireless filed a lawsuit against Google in which they alleged "This entirely subjective review, conducted solely by Google employees with ultimate authority to interpret the scope and meaning of the CDD as they see fit, effectively gives Google the ability to arbitrarily deem any software, feature or function 'non-compatible' with the CDD." [39]

**edit** Version history

Main article: Android version history

Android has seen a number of updates since its original release. These updates to the base operating system typically focuses on fixing bugs as well as adding new features. Generally each new version of the Android operating system is developed under a code name based on a dessert item.

The most recent released versions of Android are:

- **2.0/2.1 (Eclair)**, which revamped the user interface and introduced HTML5 and Exchange ActiveSync 2.5 support [40]

- **2.2 (Froyo)**, which introduced speed improvements with JIT optimization and the ChromeV8 JavaScript engine, and added Wi-Fi hotspot tethering and Adobe Flash support [41]
- **2.3 (Gingerbread)**, which refined the user interface, improved the soft keyboard and copy/paste features, and added support for Near Field Communication\(^4[2]\)

- **3.0 (Honeycomb)**, a tablet-oriented\(^4[3][4][4][5]\) release which supports larger screen devices and introduces many new user interface features, and supports multicore processors and hardware acceleration for graphics.\(^4[6]\) The Honeycomb SDK has been released and the first device featuring this version, the Motorola Xoom tablet, went on sale in February 2011.\(^4[7]\)

Upcoming versions of Android are:

- **2.3.3 (Gingerbread)**, an update to 2.3, anticipated to be released in April 2011.\(^4[8]\) Initially, Google wanted to name that version 2.4, but renumbered the version afterwards.\(^4[9]\)

- **Ice-cream sandwich**, a combination of 2.3 Gingerbread and 3.0 Honeycomb into a "cohesive whole,"\(^5[0]\) with a possible release in mid-2011\(^5[1]\)

**[edit] Features**

Current features and specifications:\(^5[2][5][3][5][4]\)

![The Android Emulator default home screen (v1.5).](image)

**Storage**  
SQLite, a lightweight relational database, is used for data storage purposes.

**Connectivity**  
CDMA, EV-DO, UMTS, Bluetooth, Wi-Fi, LTE, and WiMAX.

**Messaging**

SMS and MMS are available forms of messaging, including threaded text messaging and now Android Cloud to Device Messaging Framework (C2DM) is also a part of Android Push Messaging service.

**Web browser**

The web browser available in Android is based on the open-source WebKit layout engine, coupled with Chrome’s V8 JavaScript engine. The browser scores a 93/100 on the Acid3 Test.

**Java support**

While most Android applications are written in Java, there is no Java Virtual Machine in the platform and Java byte code is not executed. Java classes are compiled into Dalvikexecutables and run on the Dalvik virtual machine. Dalvik is a specialized virtual machine designed specifically for Android and optimized for battery-powered mobile devices with limited memory and CPU. J2ME support can be provided via third-party-applications.

**Media support**

Android supports the following audio/video/still media formats: WebM, H.263, H.264 (in 3GP or MP4container), MPEG-4 SP, AMR, AMR-WB (in 3GP container), AAC, HE-AAC (in MP4 or 3GP container), MP3, MIDI, OggVorbis, WAV, JPEG, PNG, GIF, BMP.[44]

**Streaming media support**

RTP/RTSP streaming (3GPP PSS, ISMA), HTML progressive download (HTML5 <video> tag). Adobe Flash Streaming (RTMP) and HTTP Dynamic Streaming are supported by the Flash 10.1 plugin.[45] Apple HTTP Live Streaming is supported by RealPlayer for Mobile[46] and planned to be supported by the operating system in Android 3.0 (Honeycomb).[46] Microsoft Smooth Streaming is planned to be supported through the awaited port of Silverlight plugin to Android.

**Additional hardware support**

Android can use video/still cameras, touchscreens, GPS, accelerometers, gyroscopes, magnetometers, proximity and pressure sensors, thermometers, accelerated 2D bit blits (with hardware orientation, scaling, pixel format conversion) and accelerated 3D graphics.

**Development environment**

Includes a device emulator, tools for debugging, memory and performance profiling. The integrated development environment (IDE) is Eclipse (currently 3.4 or greater) using the Android Development Tools (ADT) Plugin. The programming languages are Java and C/C++.
Market

The Android Market is a catalog of applications that can be downloaded and installed to Android devices over-the-air, without the use of a PC.

Multi-touch

Android has native support for multi-touch which was initially made available in handsets such as the HTC Hero. The feature was originally disabled at the kernel level (possibly to avoid infringing Apple's patents on touch-screen technology at the time). Google has since released an update for the Nexus One and the Motorola Droid which enables multi-touch natively.

Bluetooth

Supports A2DP, AVRCP, sending files (OPP), accessing the phone book (PBAP), voice dialing and sending contacts between phones. Keyboard, mouse and joystick (HID) support is available through manufacturer customizations and third-party applications. Full HID support is planned for Android 3.0 (Honeycomb).

Video calling

The mainstream Android version does not support video calling, but some handsets have a customized version of the operating system which supports it, either via UMTS network (like the Samsung Galaxy S) or over IP. Video calling through Google Talk is planned for Android 3.0 (Honeycomb).

Multitasking

Multitasking of applications is available.

Voice based features

Google search through Voice has been available since initial release. Voice actions for calling, texting, navigation etc. are supported on Android 2.2 onwards.

Tethering

Android supports tethering, which allows a phone to be used as a wireless/wired hotspot. Prior to Android 2.2 this was supported by third-party applications or manufacturer customizations.

[edit] Hardware running Android

Main article: List of Android devices

The Android OS can be used as an operating system for cellphones, netbooks and tablets, including the Dell Streak, Samsung Galaxy Tab, TV and other devices. The first commercially available phone to run the Android operating system was the HTC Dream, released on 22 October 2008. In early 2010 Google collaborated with HTC to launch its
flagship[66] Android device, the Nexus One. This was followed later in 2010 with the Samsung-made Nexus S.

Apple users can also get the taste of the Android OS by going around an exploit. Because of this, hackers are able to boot Android 2.2.1 Froyo on jailbroken iPhone and iPod Touch with the help of iBoot and iDroid to dual boot iOS and Froyo[67]

[edit] Software development

It has been suggested that this section be split into a new article. (Discuss)

Early Android device.

The early feedback on developing applications for the Android platform was mixed.[68] Issues cited include bugs, lack of documentation, inadequate QA infrastructure, and no public issue-tracking system. (Google announced an issue tracker on 18 January 2008.)[69] In December 2007, MergeLab mobile startup founder Adam MacBeth stated, "Functionality is not there, is poorly documented or just doesn't work... It's clearly not ready for prime time."[70] Despite this, Android-targeted applications began to appear the week after the platform was announced. The first publicly available application was the Snake game.[71][72] The Android Dev Phone is a SIM-unlocked and hardware-unlocked device that is designed for advanced developers. While developers can use regular consumer devices purchased at retail to test and use their applications, some developers may choose not to use a retail device, preferring an unlocked or no-contract device.

[edit] Software development kit

The Android software development kit (SDK) includes a comprehensive set of development tools.[73] These include a debugger, libraries, a handset emulator (based on OEMU), documentation, sample code, and tutorials. Currently supported development platforms include computers running Linux (any modern desktop Linux distribution), Mac OS X 10.4.9 or later,
Windows XP or later. The officially supported integrated development environment (IDE) is Eclipse (currently 3.4, 3.5 or 3.6) using the Android Development Tools (ADT) Plugin, though developers may use any text editor to edit Java and XML files then use command line tools (Java Development Kit and Apache Ant are required) to create, build and debug Android applications as well as control attached Android devices (e.g., triggering a reboot, installing software package(s) remotely).[74]

A preview release of the Android SDK was released on 12 November 2007. On 15 July 2008, the Android Developer Challenge Team accidentally sent an email to all entrants in the Android Developer Challenge announcing that a new release of the SDK was available in a "private" download area. The email was intended for winners of the first round of the Android Developer Challenge. The revelation that Google was supplying new SDK releases to some developers and not others (and keeping this arrangement private) led to widely reported frustration within the Android developer community at the time.[75]

On 18 August 2008 the Android 0.9 SDK beta was released. This release provided an updated and extended API, improved development tools and an updated design for the home screen. Detailed instructions for upgrading are available to those already working with an earlier release.[76] On 23 September 2008 the Android 1.0 SDK (Release 1) was released.[77] According to the release notes, it included "mainly bug fixes, although some smaller features were added." It also included several API changes from the 0.9 version. Multiple versions have been released since.[78]

Enhancements to Android's SDK go hand in hand with the overall Android platform development. The SDK also supports older versions of the Android platform in case developers wish to target their applications at older devices. Development tools are downloadable components, so after one has downloaded the latest version and platform, older platforms and tools can also be downloaded for compatibility testing.[79]

Android applications are packaged in .apk format and stored under /data/app folder on the Android OS (the folder is accessible to root user only for security reasons). APK package contains .dexfiles[80] (compiled byte code files called Dalvik executable), resource files, etc.

[edit] Android Market

Main article: Android Market

Android Market is the online software store developed by Google for Android devices. An application program ("app") called "Market" is preinstalled on most Android devices and allows users to browse and download apps published by third-party developers, hosted on Android Market. As of December 2010 there were about 200,000 games, applications and widgets available on the Android Market, with an estimated 2.5 billion total downloads.[81]

Only devices that comply with Google's compatibility requirements are allowed to preinstall Google's closed-source Android Market app and access the Market.[82] The Market filters the list of applications presented by the Market app to those that are compatible with the user's device,
and developers may restrict their applications to particular carriers or countries for business reasons.\[83\]

Google announced the Android Market on 28 August 2008, and it was available to users on 22 October 2008. Support for paid applications was available from 13 February 2009 for US and UK developers,\[84\] with additional support from 29 countries on 30 September 2010.\[85\] In February 2011, the Android Market was made fully accessible on the web, allowing users to browse and pick up applications using their PCs, send them to their mobile phone and make comments on them. All this functionality was previously accessible only from mobile phone devices.\[86\]

Users can install apps directly using APK files, or from alternative app markets. Unlike Apple, Google allows independent app stores to operate for Android.\[87\]

**[edit] App Inventor for Android**

Main article: Google App Inventor

On 12 July 2010 Google announced the availability of App Inventor for Android, a Web-based visual development environment for novice programmers, based on MIT's Open Blocks Java library and providing access to Android devices' GPS, accelerometer and orientation data, phone functions, text messaging, speech-to-text conversion, contact data, persistent storage, and Web services, initially including Amazon and Twitter.\[88\] "We could only have done this because Android’s architecture is so open," said the project director, MIT's Hal Abelson.\[89\] Under development for over a year,\[90\] the block-editing tool has been taught to non-majors in computer science at Harvard, MIT, Wellesley, and the University of San Francisco, where Professor David Wolber developed an introductory computer science course and tutorial book for non-computer science students based on App Inventor for Android.\[91][92\]

**[edit] Android Developer Challenge**

Main article: Android Developer Challenge

The Android Developer Challenge was a competition for the most innovative application for Android. Google offered prizes totaling 10 million US dollars, distributed between ADC I and ADC II. ADC I accepted submissions from 2 January to 14 April 2008. The 50 most promising entries, announced on 12 May 2008, each received a $25,000 award to fund further development.\[93][94\] It ended in early September with the announcement of ten teams that received $275,000 each, and ten teams that received $100,000 each.\[95\] ADC II was announced on 27 May 2009.\[96\] The first round of the ADC II closed on 6 October 2009.\[97\] The first-round winners of ADC II comprising the top 200 applications were announced on 5 November 2009. Voting for the second round also opened on the same day and ended on November 25. Google announced the top winners of ADC II on November 30, with SweetDreams, What the Doodle!? andWaveSecure being nominated the overall winners of the challenge.\[98][99\]

**[edit] Google applications**
Google has also participated in the Android Market by offering several applications for its services. These applications include Google Voice for the Google Voice service, Sky Map for watching stars, Finance for their finance service, Maps Editor for their MyMaps service, Places Directory for their Local Search, Google Goggles that searches by image, Gesture Search for using finger-written letters and numbers to search the contents of the phone, Google Translate, Google Shopper, Listen for podcasts and My Tracks, a jogging application.

In August 2010, Google launched "Voice Actions for Android,"[100] which allows users to search, write messages, and initiate calls by voice.

[edit] Third party applications

With the growing number of Android handsets, there has also been an increased interest by third party developers to port their applications to the Android operating system.

As of December 2010, the Android Marketplace had over 200,000 applications,[81] with over 1 billion downloads. This is up from 70,000 in July 2010.[103][102]

Obstacles to development include the fact that Android does not use established Java standards, i.e. Java SE and ME. This prevents compatibility among Java applications written for those platforms and those for the Android platform. Android only reuses the Java language syntax, but does not provide the full-class libraries and APIs bundled with Java SE or ME.[103] However, there are multiple tools in the market from companies such as Myriad Group and UpOnTek that provide J2ME to Android conversion services. [104][105][106]

Developers have reported that it is difficult to maintain applications on multiple versions of Android, owing to compatibility issues between versions 1.5 and 1.6,[107] especially the different resolution ratios in use among various Android phones.[108] Such problems were pointedly brought into focus as they were encountered during the ADC2 contest.[109] Further, the rapid growth in the number of Android-based phone models with differing hardware capabilities also makes it difficult to develop applications that work on all Android-based phones. [110][111][112][113] As of August 2010, 83% of Android phones run the 2.x versions, and 17% still run the 1.5 and 1.6 versions.[114]

[edit] Mobile gaming

Android had a huge showing at the 2011 Mobile World Congress in regards to smartphone gaming, with many well established game developers showcasing Android games. The trend in mobile gaming on smartphone devices is predicted to shrink the game specialist device market, affecting devices such as the upcoming Next Generation Portable.[115]

[edit] Native code

Libraries written in C and other languages can be compiled to ARMnative code and installed using the Android Native Development Kit. Native classes can be called from Java code running
under the Dalvik VM using the `System.loadLibrary` call, which is part of the standard Android
Java classes.[116][117]

Complete applications can be compiled and installed using traditional development tools.[118] The
ADB debugger gives a root shell under the Android Emulator which allows native ARM code
to be uploaded and executed. ARM code can be compiled using GCC on a standard PC.[118]
Running native code is complicated by the fact that Android uses a non-standard C library (libc,
known as Bionic). The underlying graphics device is available as a framebuffer at
/dev/graphics/fb0. [119] The graphics library that Android uses to arbitrate and control access to
this device is called the Skia Graphics Library (SGL), and it has been released under an open
source license.[120] Skia has backends for both win32 and Unix, allowing the development of
cross-platform applications, and it is the graphics engine underlying the Google Chrome web
browser. [121]

[edit] Community-based firmware

There is a community of open-source enthusiasts that build and share Android-based firmware
with a number of customizations and additional features, such as FLAC lossless audio support
and the ability to store downloaded applications on the microSD card.[122] This usually involves
rooting the device. Rooting allows users root access to the operating system, enabling full control
of the phone. In order to use custom firmwares the device's bootloader must be unlocked.
Rooting alone does not allow the flashing of custom firmware. Modified firmwares allow users
of older phones to use applications available only on newer releases.[123]

Those firmware packages are updated frequently, incorporate elements of Android functionality
that haven't yet been officially released within a carrier-sanctioned firmware, and tend to have
fewer limitations. CyanogenMod and VillainROM are two examples of such firmware.

On 24 September 2009, Google issued a cease and desist letter[124] to the modder Cyanogen,
citing issues with the re-distribution of Google's closed-source applications[125] within the custom
firmware. Even though most of Android OS is open source, phones come packaged with closed-
source Google applications for functionality such as the application store and GPS navigation.
Google has asserted that these applications can only be provided through approved distribution
channels by licensed distributors. Cyanogen has complied with Google's wishes and is
continuing to distribute this mod without the proprietary software. He has provided a method to
back up licensed Google applications during the mod's install process and restore them when it is
complete.[126]

[edit] Security issues

In March 2011, Google pulled 58 malicious apps from the Android Market, but not before the 58
apps were downloaded to around 260,000 devices.[127] These apps were malicious applications in
the Android Market which contained trojans hidden in pirated versions of legitimate
apps.[128] The malware (called DroidDream) exploited a bug which was present in versions of
Android older than 2.2.2.[129] Android device manufacturers and carriers work in tandem to
distribute Android based updates and had not uniformly issued patches to their customers for the
DroidDream exploit, leaving users vulnerable.\[^{130}\] Google said that the exploit allowed the apps to gather device specific information, as well as other possible information. Within days, Google remotely wiped the apps from infected users and rolled out an update that would negate the exploits that allowed the apps to view information. They also announced that they would be resolving the issue to ensure that events like this did not occur again.\[^{131}\] Security firms such as AVG and Symantec have released antivirus software for Android devices.

In August 2010, an SMS Trojan called Trojan-SMS.AndroidOS.FakePlayer.a infected a number of mobile devices, according to security firm Kaspersky Lab. Disguised as a harmless media player application, the trojan, once installed sends out SMS text messages without the users knowledge or consent. According to Denis Maslennikov, Senior Malware Researcher at Kaspersky Lab, there's not an exact number of infected devices available at present, but the outbreak is currently regional. For now, only Russian Android users can actually lose money after installing the Trojan, but anyone can be infected.\[^{132}\]

[edit] Marketing

Android logo

[edit] Logos

The Android logo was designed with the Droid font family made by Ascender Corporation.\[^{133}\]

Android Green is the color of the Android Robot that represents the Android operating system. The print color is PMS 376C and the RGB color value in hexadecimal is #A4C639, as specified by the Android Brand Guidelines.\[^{134}\]

[edit] Typeface

The custom typeface of Android is called Norad, only used in the text logo.\[^{135}\]
[edit] Market share

Research company Canalys estimated in Q2 2009 that Android had a 2.8% share of worldwide smartphone shipments.\[136]\ By Q4 2010 this had grown to 33% of the market, becoming the top-selling smartphone platform. This estimate includes the Tapas and OMS variants of Android.\[137]

In February 2010 ComScore said the Android platform had 9.0% of the U.S. smartphone market, as measured by current mobile subscribers. This figure was up from an earlier estimate of 5.2% in November 2009.\[138] By the end of Q3 2010 Android's U.S. market share had grown to 21.4 percent.\[138]

In May 2010, Android's first quarter U.S. sales surpassed that of the rival iPhone platform. According to a report by the NPD group, Android achieved 25% smartphone sales in the US market, up 8% from the December quarter. In the second quarter, Apple's iOS was up by 11%, indicating that Android is taking market share mainly from RIM, and still has to compete with heavy consumer demand for new competitor offerings.\[139] Furthermore, analysts pointed to advantages that Android has as a multi-channel, multi-carrier OS, which allowed it to duplicate the quick success of Microsoft's Windows Mobile.\[140]

In early October 2010, Google added 20 countries to its list of approved submitters. By mid-October, purchasing apps will be available in a total of 32 countries.\[141] For a complete list of countries that are allowed to sell apps and those able to buy them see Android Market.

As of December 2010 Google said over 300,000 Android phones were being activated daily,\[142] up from 100,000 per day in May 2010.\[143]

In February 2011, during the 2011 Mobile World Congress, Eric Schmidt announced that Android has reached 350,000 activations per day.\[144]

[edit] Fragmentation
Data collected during two weeks ending on February 2, 2011

Android OS fragmentation data collected during two weeks ending on February 2, 2011

<table>
<thead>
<tr>
<th>Platform</th>
<th>API Level Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Android 2.3 (Gingerbread)</td>
<td>9/10 0.8%</td>
</tr>
<tr>
<td>Android 2.2 (Froyo)</td>
<td>8 57.6%</td>
</tr>
<tr>
<td>Android 2.0/2.1 (Eclair)</td>
<td>7 31.4%</td>
</tr>
<tr>
<td>Android 1.6 (Donut)</td>
<td>4 6.3%</td>
</tr>
<tr>
<td>Android 1.5 (Cupcake)</td>
<td>3 3.9%</td>
</tr>
</tbody>
</table>

The Android platform has suffered from some forms of fragmentation. A large support of hardware devices from low end to high end, along with device manufactures and wireless carriers controlling Android updates, and multiple application stores present on the platform, has lead to some degree of hardware, OS and application market fragmentation. Android fragmentation takes several forms: differing processor power, screen size and performance, operating system version, memory size, keyboard type, and button placement. Google is trying to smooth over some of the issues with a new interface, called the fragment of all things, set to debut in Android 3.0 "Honeycomb." With the release of Android Honeycomb 3.0 for tablets, Dianne Hackborn, a Google Android programmer commented on Android fragmentation in a blog post. "For developers starting work on tablet-oriented applications designed for Android 3.0, the new Fragment API is useful for many design situations that arise from the larger screen. Reasonable use of fragments should also make it easier to adjust the resulting application's UI to new devices in the future as needed--for phones, TVs, or wherever Android appears," Hackborn said.

In a interview with Jay Wilbur vice president of Epic Games, Jay Wilbur explains the reasons that are stopping Epic Games from developing for Android at this point in time. One being the hardware fragmentation issue, second is the actual Android Market and what Jay Wilbur calls the Market Fragmentation. "One of the problems with the Android marketplace is hardware fragmentation, that’s a really big issue” said Wilbur. He continued: “The other thing is marketplace fragmentation, there are so many different appstores out there.” Wilbur defended the Android app-shopping experience as “robust,” he said that the Google platform lacked Apple’s “very tight control.” This is proving prohibitive when it comes to developing for the relatively open Android platform.

"The other thing is marketplace fragmentation, there are so many different appstores out there. The Android marketplace is a little more difficult [to develop for] because there is less control. I think the Android marketplace is robust … I find it very easy to buy things on it, it’s just that Apple has very tight control. So anything in the Apple world is perfect. It’s just perfect. We like that, we like that a lot. We know that it’s just gonna work. Sometimes that’s not always the case in the Android marketplace." - Jay Wilbur, Vice President, Epic
Steve Jobs offered his thoughts on Android fragmentation is that Android is fragmented and that the open vs. closed dilemma is not important as long as Apple's proprietary mobile operating system manages to provide a better user experience.

"Many Android OEMs install proprietary user-interfaces to differentiate themselves from the commodity Android experience. The user is left to figure it all out. Compare this with iPhone where ever handset works the same. (...) We think the open vs closed is just a smokescreen to try and hide the real issue, which is: What's best for the customer? Fragmented vs. integrated. We think Android is very very fragmented and becoming more fragmented by the day."[151]

Steve Jobs on Android's Fragmentation
Steve Jobs talks about Android's Fragmentation

Problems listening to this file? See media help.

[edit] Linux compatibility

Android's kernel was derived from Linux but has been tweaked by Google outside the main Linux kernel tree.[152] Android does not have a native X Window System nor does it support the full set of standard GNU libraries, and this makes it difficult to port existing GNU/Linux applications or libraries to Android.[153] However, support for the X Window System is possible.[154] Google no longer maintains the code they previously contributed to the Linux kernel as part of their Android effort, creating a separate version or fork of Linux.[155][156] This was due to a disagreement about new features Google felt were necessary (some related to security of mobile applications).[157] The code which is no longer maintained was deleted in January 2010 from the Linux codebase.[158]

Google announced in April 2010 that they will hire two employees to work with the Linux kernel community.[159]

However, as of January 2011, points of contention still exist between Google and the Linux kernel team: Google tried to push upstream some Android-specific power management code in 2009, which is still rejected today.[160]

Furthermore, Greg Kroah-Hartman, the current Linux kernel maintainer for the -stable branch, said in December 2010 that he was concerned that Google was no longer trying to get their code changes included in mainstream Linux.[161] Some Google Android developers hinted that "the Android team was getting fed up with the process," because they were a small team and had more urgent work to do on Android.[162]

[edit] Claimed infringement of copyrights and patents

On 12 August 2010, Oracle, owner of Java since it acquired Sun Microsystems in April 2009, sued Google over claimed infringement of copyrights and patents. The lawsuit claims that, "In
developing Android, Google knowingly, directly and repeatedly infringed Oracle's Java-related intellectual property."[163]

Specifically the patent infringement claim references seven patents including United States Patent No. 5,966,702, entitled "Method And Apparatus For Preprocessing And Packaging Class Files," and United States Patent No. 6,910,205, entitled "Interpreting Functions Utilizing A Hybrid Of Virtual And Native Machine Instructions."[164] It also references United States Patent No. RE38,104, ("the '104 patent") entitled “Method And Apparatus For Resolving Data References In Generated Code” authored by James Gosling, best known as the father of the Java programming language.[165]

In response Google submitted multiple lines of defense, saying that Android did not infringe on Oracle's patents or copyright, that Oracle's patents were invalid, and several other defenses. They said that Android is based on Apache Harmony, a clean room implementation of the Java class libraries, and an independently developed virtual machine called Dalvik.[166][167][168]

The Free Software Foundation has called this suit a "clear attack against someone's freedom to use, share, modify, and redistribute software."[169] However, the FSF also criticized Google, saying that Google could have avoided the suit by building Android on top of IcedTea, whose GPL license provides some protection against patents, instead of implementing it independently under the Apache License. The FSF wrote "It's sad to see that Google apparently shunned those protections in order to make proprietary software development easier on Android." and remarked that Google had not taken any clear position or action against software patents