# Android (operating system)

Android is a [mobile operating system](http://en.wikipedia.org/wiki/Mobile_operating_system) initially developed by Android Inc. Android was bought by [Google](http://en.wikipedia.org/wiki/Google) in [2005](http://en.wikipedia.org/wiki/2005). Android is based upon a modified version of the [Linux kernel](http://en.wikipedia.org/wiki/Linux_kernel). Google and other members of the [Open Handset Alliance](http://en.wikipedia.org/wiki/Open_Handset_Alliance) collaborated on Android's development and release. The Android Open Source Project (AOSP) is tasked with the maintenance and further development of Android. Unit sales for Android OS smartphones ranked first among all [smartphone](http://en.wikipedia.org/wiki/Smartphone) OS handsets sold in the U.S. in the second and third quarters of 2010, with a third quarter market share of 43.6%.

Android has a large community of developers writing [application programs](http://en.wikipedia.org/wiki/Application_software) ("*apps*") that extend the functionality of the devices. There are currently over 200,000 apps available for Android. [Android Market](http://en.wikipedia.org/wiki/Android_Market) is the online app store run by Google, though apps can be downloaded from third-party sites ([AT&T](http://en.wikipedia.org/wiki/AT%26T) permits third-party apps only on their Aria phone. Developers write primarily in the [Java language](http://en.wikipedia.org/wiki/Java_%28programming_language%29), controlling the device via Google-developed Java libraries. [Python](http://en.wikipedia.org/wiki/Python_%28programming_language%29), [Ruby](http://en.wikipedia.org/wiki/Ruby_%28programming_language%29) and other languages are also available for Android development via the [Android Scripting Environment](http://code.google.com/p/android-scripting/).

The unveiling of the Android distribution on 5 November 2007 was announced with the founding of the [Open Handset Alliance](http://en.wikipedia.org/wiki/Open_Handset_Alliance), a consortium of 79 [hardware](http://en.wikipedia.org/wiki/Computer_hardware), [software](http://en.wikipedia.org/wiki/Computer_software), and [telecom](http://en.wikipedia.org/wiki/Telecommunication) companies devoted to advancing [open standards](http://en.wikipedia.org/wiki/Open_standard) for mobile devices. Google released most of the Android code under the [Apache License](http://en.wikipedia.org/wiki/Apache_License), a [free software](http://en.wikipedia.org/wiki/Free_software_license) and [open source license](http://en.wikipedia.org/wiki/Open_source_license).

The Android operating system [software stack](http://en.wikipedia.org/wiki/Software_stack) consists of [Java applications](http://en.wikipedia.org/wiki/Java_%28programming_language%29) running on a Java-based, [object-oriented](http://en.wikipedia.org/wiki/Object-oriented) [application framework](http://en.wikipedia.org/wiki/Application_framework) on top of [Java core libraries](http://en.wikipedia.org/wiki/Java_Class_Library) running on a [Dalvik virtual machine](http://en.wikipedia.org/wiki/Dalvik_%28software%29) featuring [JIT compilation](http://en.wikipedia.org/wiki/Just-in-time_compilation). Libraries written in C include the surface manager, OpenCore [media framework](http://en.wikipedia.org/wiki/Multimedia_framework), [SQLite](http://en.wikipedia.org/wiki/SQLite) relational [database management system](http://en.wikipedia.org/wiki/Relational_database_management_system), [OpenGL ES 2.0](http://en.wikipedia.org/wiki/OpenGL_ES) [3D graphics](http://en.wikipedia.org/wiki/3D_computer_graphics) [API](http://en.wikipedia.org/wiki/Application_programming_interface), [WebKit layout engine](http://en.wikipedia.org/wiki/WebKit), [SGL](http://en.wikipedia.org/wiki/Skia_Graphics_Engine) graphics engine, [SSL](http://en.wikipedia.org/wiki/Transport_Layer_Security), and [Bionic libc](http://en.wikipedia.org/wiki/GNU_C_Library#Use_in_small_devices). The Android operating system consists of 12 million [lines of code](http://en.wikipedia.org/wiki/Source_lines_of_code) including 3 million lines of [XML](http://en.wikipedia.org/wiki/Xml), 2.8 million lines of [C](http://en.wikipedia.org/wiki/C_%28programming_language%29), 2.1 million lines of [Java](http://en.wikipedia.org/wiki/Java_%28programming_language%29), and 1.75 million lines of [C++](http://en.wikipedia.org/wiki/C%2B%2B)

## History

In July 2005, [Google](http://en.wikipedia.org/wiki/Google) [acquired](http://en.wikipedia.org/wiki/List_of_Google_acquisitions) Android Inc., a small [startup company](http://en.wikipedia.org/wiki/Startup_company) based in [Palo Alto, California, USA](http://en.wikipedia.org/wiki/Palo_Alto,_CA). Android's co-founders who went to work at Google included [Andy Rubin](http://en.wikipedia.org/wiki/Andy_Rubin) (co-founder of [Danger](http://en.wikipedia.org/wiki/Danger_%28company%29)), [Rich Miner](http://en.wikipedia.org/wiki/Rich_Miner) (co-founder of Wildfire Communications, Inc.), [Nick Sears](http://en.wikipedia.org/w/index.php?title=Nick_Sears&action=edit&redlink=1) (once VP at [T-Mobile](http://en.wikipedia.org/wiki/T-Mobile)), and Chris White (headed design and interface development at [WebTV](http://en.wikipedia.org/wiki/WebTV)). At the time, little was known about the functions of Android, Inc. other than that they made software for mobile phones. This began rumors that Google was planning to enter the [mobile phone](http://en.wikipedia.org/wiki/Mobile_phone) market.

At Google, the team led by Rubin developed a mobile device platform powered by the [Linux kernel](http://en.wikipedia.org/wiki/Linux_kernel) which they marketed to handset makers and [carriers](http://en.wikipedia.org/wiki/Mobile_network_operator) on the premise of providing a flexible, upgradable system. It was reported that Google had already 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. More speculation that Google's Android would be entering the mobile-phone market came in December 2006. Reports from the [BBC](http://en.wikipedia.org/wiki/BBC) and [*The Wall Street Journal*](http://en.wikipedia.org/wiki/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](http://en.wikipedia.org/wiki/Handset#Telephony). More speculation followed reporting that as Google was defining technical specifications, it was showing prototypes to cell phone manufacturers and network operators.

In September 2007, [*InformationWeek*](http://en.wikipedia.org/wiki/InformationWeek) covered an [Evalueserve](http://en.wikipedia.org/wiki/Evalueserve) study reporting that Google had filed several [patent](http://en.wikipedia.org/wiki/Patent) applications in the area of mobile telephony

### Open Handset Alliance

On the 5th of November 2007 the [Open Handset Alliance](http://en.wikipedia.org/wiki/Open_Handset_Alliance), a [consortium](http://en.wikipedia.org/wiki/Consortium) of several companies which include [Texas Instruments](http://en.wikipedia.org/wiki/Texas_Instruments), [Broadcom Corporation](http://en.wikipedia.org/wiki/Broadcom_Corporation), [Google](http://en.wikipedia.org/wiki/Google), [HTC](http://en.wikipedia.org/wiki/High_Tech_Computer_Corporation), [Intel](http://en.wikipedia.org/wiki/Intel_Corporation), [LG](http://en.wikipedia.org/wiki/LG_Group), [Marvell Technology Group](http://en.wikipedia.org/wiki/Marvell_Technology_Group), [Motorola](http://en.wikipedia.org/wiki/Motorola), [Nvidia](http://en.wikipedia.org/wiki/Nvidia), [Qualcomm](http://en.wikipedia.org/wiki/Qualcomm), [Samsung Electronics](http://en.wikipedia.org/wiki/Samsung_Electronics), [Sprint Nextel](http://en.wikipedia.org/wiki/Sprint_Nextel) and [T-Mobile](http://en.wikipedia.org/wiki/T-Mobile) was unveiled with the goal to develop [open standards](http://en.wikipedia.org/wiki/Open_standard) for mobile devices. Along with the formation of the Open Handset Alliance, the OHA also unveiled their first product, Android, a mobile device [platform](http://en.wikipedia.org/wiki/Platform_%28computing%29) built on the [Linux kernel](http://en.wikipedia.org/wiki/Linux_kernel) version 2.6.

On 9 December 2008, it was announced that 14 new members would be joining the Android Project, including [PacketVideo](http://en.wikipedia.org/wiki/PacketVideo), [ARM Holdings](http://en.wikipedia.org/wiki/ARM_Holdings), [Atheros Communications](http://en.wikipedia.org/wiki/Atheros_Communications), [Asustek Computer Inc](http://en.wikipedia.org/wiki/Asustek), [Garmin Ltd](http://en.wikipedia.org/wiki/Garmin), [Softbank](http://en.wikipedia.org/wiki/Softbank), [Sony Ericsson](http://en.wikipedia.org/wiki/Sony_Ericsson), [Toshiba Corp](http://en.wikipedia.org/wiki/Toshiba), and [Vodafone Group Plc](http://en.wikipedia.org/wiki/Vodafone).

### Licensing

With the exception of brief update periods, Android has been available under a [free software](http://en.wikipedia.org/wiki/Free_software) / open source license since 21 October 2008. Google published the entire [source code](http://en.wikipedia.org/wiki/Source_code) (including network and telephony stacks) under an [Apache License](http://en.wikipedia.org/wiki/Apache_License). Google also keeps the reviewed issues list publicly open for anyone to see and commen

### Update history

Android has seen a number of updates since its original release. These updates to the base operating system typically fix bugs and add new features. Generally each update to the Android operating system is developed under a code name based on a dessert item. The code names are in alphabetical order.

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| 1.0 | Released 23 September 2008 |
| 1.1 | On 9 February 2009, Android 1.1 update for Android was released for T-Mobile G1 Only. Included in the update were:   * Multiple resolved issues * API changes * Maps adds details and reviews * Screen timeout longer when using speakerphone * "Show" & "Hide" Dialpad included in-call menu * Support for saving attachments from MMS * Support for marquee in layouts |
| 1.5 (Cupcake) Based on Linux Kernel 2.6.27 | On 30 April 2009, the official 1.5 (Cupcake) update for Android was released. There were several new features and UI updates included in the 1.5 update:   * Ability to record and watch videos through camcorder mode * Uploading videos to YouTube and pictures to Picasa directly from the phone * A new soft-keyboard with text-prediction * Bluetooth [A2DP](http://en.wikipedia.org/wiki/A2DP) and [AVRCP](http://en.wikipedia.org/wiki/AVRCP) support * Ability to automatically connect to a Bluetooth headset within a certain distance * New widgets and folders that can populate the Home screens * Animated screen transitions |
| 1.6 (Donut) Based on Linux Kernel 2.6.29 | On 15 September 2009, the 1.6 (Donut) SDK was released. Included in the update were:   * An improved Android Market experience * An integrated camera, camcorder, and gallery interface * Gallery now enables users to select multiple photos for deletion * Updated Voice Search, with faster response and deeper integration with native applications, including the ability to dial contacts * Updated search experience to allow searching bookmarks, history, contacts, and the web from the home screen * Updated technology support for [CDMA](http://en.wikipedia.org/wiki/IS-95)/[EVDO](http://en.wikipedia.org/wiki/Evolution-Data_Optimized), [802.1x](http://en.wikipedia.org/wiki/IEEE_802.1X), [VPNs](http://en.wikipedia.org/wiki/Virtual_private_network), and a [text-to-speech](http://en.wikipedia.org/wiki/Speech_synthesis) engine * Support for [WVGA](http://en.wikipedia.org/wiki/Wide_VGA) screen resolutions * Speed improvements in searching and camera applications * Gesture framework and GestureBuilder development tool * Google free [turn-by-turn navigation](http://en.wikipedia.org/wiki/Turn-by-turn_navigation) |
| 2.0 / 2.1 (Eclair) Based on Linux Kernel 2.6.29 | On 26 October 2009, the 2.0 (Eclair) SDK was released. Changes include:   * Optimized hardware speed * Support for more screen sizes and resolutions * Revamped UI * New Browser UI and [HTML5](http://en.wikipedia.org/wiki/HTML5) support * New contact lists * Better contrast ratio for backgrounds * Improved Google Maps 3.1.2 * Microsoft Exchange Server by [Exchange ActiveSync](http://en.wikipedia.org/wiki/Exchange_ActiveSync) 2.5 support * Built in flash support for Camera * Digital Zoom * MotionEvent class enhanced to track multi-touch events * Improved virtual keyboard * Bluetooth 2.1 * Live Wallpapers   The 2.0.1 SDK was released on 3 December 2009.  The 2.1 SDK was released on 12 January 2010. |
| 2.2 (Froyo)  Based on Linux Kernel 2.6.32 (2.2.2 latest release) | On 20 May 2010, the 2.2 (Froyo) SDK was released. Changes included:   * General Android OS speed, memory, and performance optimizations * Additional application speed improvements courtesy of [JIT](http://en.wikipedia.org/wiki/Just-in-time_compilation) implementation * Integration of [Chrome](http://en.wikipedia.org/wiki/Google_Chrome)'s [V8 JavaScript engine](http://en.wikipedia.org/wiki/V8_%28JavaScript_engine%29) into the Browser application * Increased Microsoft Exchange support (security policies, auto-discovery, GAL look-up, calendar synchronization, remote wipe) * Improved application launcher with shortcuts to Phone and Browser applications * USB tethering and Wi-Fi hotspot functionality * Added an option to disable data access over [mobile network](http://en.wikipedia.org/wiki/Mobile_network) * Updated Market application with batch and automatic update features * Quick switching between multiple keyboard languages and their dictionaries * Voice dialing and contact sharing over Bluetooth * Support for numeric and alphanumeric passwords * Support for file upload fields in the Browser application * Support for installing applications to the expandable memory * [Adobe Flash](http://en.wikipedia.org/wiki/Adobe_Flash) 10.1 support * Support for extra high DPI screens (320 dpi), such as 4" 720p |
| 2.3 (Gingerbread)  Based on Linux Kernel 2.6.35 | On 6 December 2010, the 2.3 (Gingerbread) SDK was released. Changes included:   * Updated user interface design * Support for extra-large screen sizes and resolutions ([WXGA](http://en.wikipedia.org/wiki/WXGA) and higher) * Native support for [SIP](http://en.wikipedia.org/wiki/Session_Initiation_Protocol) [VoIP](http://en.wikipedia.org/wiki/Voice_over_IP) telephony * Support for [WebM](http://en.wikipedia.org/wiki/WebM)/VP8 video playback, and [AAC](http://en.wikipedia.org/wiki/Advanced_Audio_Coding) audio encoding * New audio effects such as reverb, equalization, headphone virtualization, and bass boost * Support for [Near Field Communication](http://en.wikipedia.org/wiki/Near_Field_Communication) * System-wide [copy–paste](http://en.wikipedia.org/wiki/Cut,_copy,_and_paste) functionalities * Redesigned multi-touch software keyboard * Enhanced support for native code development * Audio, graphical, and input enhancements for game developers * Concurrent [garbage collection](http://en.wikipedia.org/wiki/Garbage_collection_%28computer_science%29) for increased performance * Native support for more sensors (such as [gyroscopes](http://en.wikipedia.org/wiki/Gyroscope) and [barometers](http://en.wikipedia.org/wiki/Barometer)) * A [download manager](http://en.wikipedia.org/wiki/Download_manager) for long-running downloads * Improved [power management](http://en.wikipedia.org/wiki/Power_management) and application control * Native support for multiple cameras * Switched from [YAFFS](http://en.wikipedia.org/wiki/YAFFS) to the [ext4](http://en.wikipedia.org/wiki/Ext4) filesystem |
| 3.0 (Honeycomb) | On 26 January 2011, a preview of the 3.0 (Honeycomb) SDK was released. Changes include:   * Optimized tablet support with a new user interface * Three dimensional desktop with redesigned widgets * Refined multi-tasking * Browser enhancements including tabbed web pages, form auto-fill, bookmark syncing with [Google Chrome](http://en.wikipedia.org/wiki/Google_Chrome), and private browsing * Support for video chat using [Google Talk](http://en.wikipedia.org/wiki/Google_Talk) * Hardware acceleration * Support for multi-core processors |
| Ice Cream Sandwich | Possible mid-2011 release. |

## Features

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| Handset layouts | The platform is adaptable to larger, [VGA](http://en.wikipedia.org/wiki/Video_Graphics_Array), [2D graphics](http://en.wikipedia.org/wiki/2D_computer_graphics) library, [3D graphics](http://en.wikipedia.org/wiki/3D_computer_graphics) library based on [OpenGL ES](http://en.wikipedia.org/wiki/OpenGL_ES) 2.0 specifications, and traditional smartphone layouts. |
| Storage | [SQLite](http://en.wikipedia.org/wiki/SQLite), a lightweight [relational database](http://en.wikipedia.org/wiki/Relational_database), is used for data storage purposes |
| Connectivity | Android supports connectivity technologies including [GSM](http://en.wikipedia.org/wiki/GSM)/[EDGE](http://en.wikipedia.org/wiki/Enhanced_Data_Rates_for_GSM_Evolution), [IDEN](http://en.wikipedia.org/wiki/Integrated_Digital_Enhanced_Network), [CDMA](http://en.wikipedia.org/wiki/Code_division_multiple_access), [EV-DO](http://en.wikipedia.org/wiki/Evolution-Data_Optimized), [UMTS](http://en.wikipedia.org/wiki/Universal_Mobile_Telecommunications_System), [Bluetooth](http://en.wikipedia.org/wiki/Bluetooth), [Wi-Fi](http://en.wikipedia.org/wiki/Wi-Fi), [LTE](http://en.wikipedia.org/wiki/LTE_Advanced), and [WiMAX](http://en.wikipedia.org/wiki/WiMAX). |
| Messaging | [SMS](http://en.wikipedia.org/wiki/SMS) and [MMS](http://en.wikipedia.org/wiki/Multimedia_Messaging_Service) are available forms of messaging, including threaded [text messaging](http://en.wikipedia.org/wiki/Text_messaging) and now Android Cloud to Device Messaging Framework ([C2DM](http://en.wikipedia.org/w/index.php?title=C2DM&action=edit&redlink=1)) is also a part of Android Push Messaging service. |
| Web browser | The web browser available in Android is based on the open-source [WebKit](http://en.wikipedia.org/wiki/WebKit) layout engine, coupled with [Chrome](http://en.wikipedia.org/wiki/Google_Chrome)'s [V8](http://en.wikipedia.org/wiki/V8_%28JavaScript_engine%29) JavaScript engine. The browser scores a 93/100 on the [Acid3](http://en.wikipedia.org/wiki/Acid3) Test. |
| Java support | While most Android applications are written in [Java](http://en.wikipedia.org/wiki/Java_%28programming_language%29), there is no [Java Virtual Machine](http://en.wikipedia.org/wiki/Java_Virtual_Machine) in the platform and Java byte code is not executed. Java classes are compiled into Dalvik executables and run on the [Dalvik virtual machine](http://en.wikipedia.org/wiki/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](http://en.wikipedia.org/wiki/J2ME) support can be provided via third-party-applications. |
| Media support | Android supports the following audio/video/still media formats: [WebM](http://en.wikipedia.org/wiki/WebM), [H.263](http://en.wikipedia.org/wiki/H.263), [H.264](http://en.wikipedia.org/wiki/H.264) (in [3GP](http://en.wikipedia.org/wiki/3GP) or [MP4](http://en.wikipedia.org/wiki/MP4) [container](http://en.wikipedia.org/wiki/Container_format_%28digital%29)), [MPEG-4 SP](http://en.wikipedia.org/wiki/MPEG-4_Part_2), [AMR](http://en.wikipedia.org/wiki/Adaptive_multi-rate_compression), [AMR-WB](http://en.wikipedia.org/wiki/AMR-WB) (in 3GP container), [AAC](http://en.wikipedia.org/wiki/Advanced_Audio_Coding), [HE-AAC](http://en.wikipedia.org/wiki/HE-AAC) (in MP4 or 3GP container), [MP3](http://en.wikipedia.org/wiki/MP3), [MIDI](http://en.wikipedia.org/wiki/Musical_Instrument_Digital_Interface), [Ogg Vorbis](http://en.wikipedia.org/wiki/Vorbis), [WAV](http://en.wikipedia.org/wiki/WAV), [JPEG](http://en.wikipedia.org/wiki/JPEG), [PNG](http://en.wikipedia.org/wiki/Portable_Network_Graphics), [GIF](http://en.wikipedia.org/wiki/Graphics_Interchange_Format), [BMP](http://en.wikipedia.org/wiki/BMP_file_format).[[67]](http://en.wikipedia.org/wiki/Android_%28operating_system%29#cite_note-mediaformats-66) |
| 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.[[68]](http://en.wikipedia.org/wiki/Android_%28operating_system%29#cite_note-67) Apple HTTP Live Streaming is supported by RealPlayer for Mobile[[69]](http://en.wikipedia.org/wiki/Android_%28operating_system%29" \l "cite_note-68) and planned to be supported by the operating system in Android 3.0 (Honeycomb).[[63]](http://en.wikipedia.org/wiki/Android_%28operating_system%29#cite_note-honeycomb-highlights-62) 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](http://en.wikipedia.org/wiki/Touchscreen), [GPS](http://en.wikipedia.org/wiki/Global_Positioning_System), [accelerometers](http://en.wikipedia.org/wiki/Accelerometer), [gyroscopes](http://en.wikipedia.org/wiki/Gyroscope), [magnetometers](http://en.wikipedia.org/wiki/Magnetometer), [proximity](http://en.wikipedia.org/wiki/Proximity_sensor) and [pressure sensors](http://en.wikipedia.org/wiki/Pressure_sensor), [thermometers](http://en.wikipedia.org/wiki/Thermometer), accelerated 2D [bit blits](http://en.wikipedia.org/wiki/Bit_blit) (with hardware orientation, scaling, pixel format conversion) and accelerated 3D graphics. |
| Development environment | Includes a device emulator, tools for [debugging](http://en.wikipedia.org/wiki/Debugging), memory and [performance profiling](http://en.wikipedia.org/wiki/Software_performance_analysis). The [integrated development environment](http://en.wikipedia.org/wiki/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](http://en.wikipedia.org/wiki/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](http://en.wikipedia.org/wiki/Multi-touch) which was initially made available in handsets such as the [HTC Hero](http://en.wikipedia.org/wiki/HTC_Hero). The feature was originally disabled at the kernel level (possibly to avoid infringing Apple's patents on touch-screen technology). Google has since released an update for the [Nexus One](http://en.wikipedia.org/wiki/Nexus_One) and the [Motorola Droid](http://en.wikipedia.org/wiki/Motorola_Droid) which enables multi-touch natively. |
| Bluetooth | Supports [A2DP](http://en.wikipedia.org/wiki/A2DP), [AVRCP](http://en.wikipedia.org/wiki/AVRCP), sending files ([OPP](http://en.wikipedia.org/wiki/Bluetooth_profile#Object_Push_Profile_.28OPP.29)), accessing the phone book ([PBAP](http://en.wikipedia.org/wiki/Bluetooth_profile#Phone_Book_Access_Profile_.28PBAP.2C_PBA.29)), voice dialing and sending contacts between phones. Keyboard, mouse and joystick ([HID](http://en.wikipedia.org/wiki/Bluetooth_profile#Human_Interface_Device_Profile_.28HID.29)) 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](http://en.wikipedia.org/wiki/UMTS) network (like the [Samsung Galaxy S](http://en.wikipedia.org/wiki/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 |

## Hardware running Android

The Android OS can be used as an operating system for cellphones, netbooks and [tablets](http://en.wikipedia.org/wiki/Tablet_personal_computer), including the [Dell Streak](http://en.wikipedia.org/wiki/Dell_Streak), [Samsung Galaxy Tab](http://en.wikipedia.org/wiki/Samsung_Galaxy_Tab) and other devices. The first commercially available phone to run the Android operating system was the [HTC Dream](http://en.wikipedia.org/wiki/HTC_Dream), released on 22 October 2008. In early 2010 Google collaborated with [HTC](http://en.wikipedia.org/wiki/HTC) to launch its flagship Android device, the [Nexus One](http://en.wikipedia.org/wiki/Nexus_One). This was followed later in 2010 with the [Samsung](http://en.wikipedia.org/wiki/Samsung)-made [Nexus S](http://en.wikipedia.org/wiki/Nexus_S).

The world's first TV running Android, called Scandinavia, has also been launched by the company People of Lava.

## Software development

The early feedback on developing applications for the Android platform was mixed. 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.) 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."* Despite this, Android-targeted applications began to appear the week after the platform was announced. The first publicly available application was the [Snake game](http://en.wikipedia.org/wiki/Snake_%28video_game%29). The [Android Dev Phone](http://en.wikipedia.org/wiki/Android_Dev_Phone) is a [SIM](http://en.wikipedia.org/wiki/Subscriber_Identity_Module)-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.

### Software development kit

The Android [software development kit](http://en.wikipedia.org/wiki/Software_development_kit) (SDK) includes a comprehensive set of development tools. These include a [debugger](http://en.wikipedia.org/wiki/Debugger), [libraries](http://en.wikipedia.org/wiki/Software_library), a handset [emulator](http://en.wikipedia.org/wiki/Emulator) (based on [QEMU](http://en.wikipedia.org/wiki/QEMU)), documentation, sample code, and tutorials. Currently supported development platforms include computers running [Linux](http://en.wikipedia.org/wiki/Linux_kernel) (any modern desktop [Linux distribution](http://en.wikipedia.org/wiki/List_of_GNU/Linux_distributions)), [Mac OS X](http://en.wikipedia.org/wiki/Mac_OS_X) 10.4.9 or later, [Windows XP](http://en.wikipedia.org/wiki/Windows_XP) or later. The officially supported [integrated development environment](http://en.wikipedia.org/wiki/Integrated_development_environment) (IDE) is [Eclipse](http://en.wikipedia.org/wiki/Eclipse_%28software%29) (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](http://en.wikipedia.org/wiki/Command_line) tools ([Java Development Kit](http://en.wikipedia.org/wiki/Java_Development_Kit) and [Apache Ant](http://en.wikipedia.org/wiki/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).

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.

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. On 23 September 2008 the Android 1.0 SDK (Release 1) was released. 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

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.

Android applications are packaged in [.apk](http://en.wikipedia.org/wiki/APK_%28file_format%29) 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 .dex files (compiled byte code files called [Dalvik](http://en.wikipedia.org/wiki/Dalvik_Virtual_Machine) executable), resource files, etc.

### 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[[update]](http://en.wikipedia.org/w/index.php?title=Android_%28operating_system%29&action=edit) there were about 200,000 games, applications and widgets available on the Android Market, with an estimated 2.5 billion total downloads.

Only devices that comply with Google's compatibility requirements are allowed to preinstall Google's closed-source Android Market app and access the Market. 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. 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, with additional support from 29 countries on 30 September 2010.

Since apps can be installed using "apk"-files, alternatives, such as [GetJar](http://en.wikipedia.org/wiki/GetJar), coexist with the official Android Market.

### App Inventor for Android

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. "We could only have done this because Android’s architecture is so open," said the project director, MIT's [Hal Abelson](http://en.wikipedia.org/wiki/Hal_Abelson). Under development for over a year, 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.

### 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](http://en.wikipedia.org/wiki/US_dollar), 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. It ended in early September with the announcement of ten teams that received $275,000 each, and ten teams that received $100,000 each. ADC II was announced on 27 May 2009. The first round of the ADC II closed on 6 October 2009. 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!? and WaveSecure being nominated the overall winners of the challenge.

### Google applications

Google has also participated in the Android Market by offering several applications for its services. These applications include [Google Voice](http://en.wikipedia.org/wiki/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](http://en.wikipedia.org/wiki/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", which allows users to search, write messages, and initiate calls by voice.

### 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, with over 1 billion downloads. This is up from 70,000 in July 2010.

Obstacles to development include the fact that Android does not use established Java standards, i.e. [Java SE](http://en.wikipedia.org/wiki/Java_SE) and [ME](http://en.wikipedia.org/wiki/Java_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. However, there are multiple tools in the market that provide J2ME to Android conversion services, which enable the developer to convert Java into Android. Companies like [Myriad Group](http://en.wikipedia.org/wiki/Myriad_Group) and UpOnTek provide these services.

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, especially the different resolution ratios in use among various Android phones. Such problems were pointedly brought into focus as they were encountered during the ADC2 contest. 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. As of August 2010, 83% of Android phones run the 2.x versions, and 17% still run the 1.5 and 1.6 versions

### Native code

Libraries written in [C](http://en.wikipedia.org/wiki/C_%28programming_language%29) and other languages can be compiled to [ARM](http://en.wikipedia.org/wiki/ARM_architecture) [native code](http://en.wikipedia.org/wiki/Native_code) and installed using the Android [Native Development Kit](http://en.wikipedia.org/wiki/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

Complete applications can be [compiled](http://en.wikipedia.org/wiki/Compiler) and installed using traditional development tools. The ADB debugger gives a root shell under the Android Emulator which allows native [ARM code](http://en.wikipedia.org/wiki/ARM_architecture) to be uploaded and executed. ARM code can be compiled using [GCC](http://en.wikipedia.org/wiki/GNU_Compiler_Collection) on a standard PC. Running native code is complicated by the fact that Android uses a non-standard C library (libc, known as [Bionic](http://en.wikipedia.org/w/index.php?title=Bionic_%28libc%29&action=edit&redlink=1)). The underlying graphics device is available as a [framebuffer](http://en.wikipedia.org/wiki/Framebuffer) at */dev/graphics/fb0*. The graphics library that Android uses to arbitrate and control access to this device is called the [Skia Graphics Library](http://en.wikipedia.org/wiki/Skia_Graphics_Engine) (SGL), and it has been released under an open source license. Skia has backends for both [win32](http://en.wikipedia.org/wiki/Win32) and [Unix](http://en.wikipedia.org/wiki/Unix), allowing the development of cross-platform applications, and it is the graphics engine underlying the [Google Chrome](http://en.wikipedia.org/wiki/Google_Chrome) web browser.

### 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](http://en.wikipedia.org/wiki/FLAC) lossless audio support and the ability to store downloaded applications on the [microSD](http://en.wikipedia.org/wiki/MicroSD) card. This usually involves [rooting](http://en.wikipedia.org/wiki/Rooting_%28Android_OS%29) the device. Rooting allows users root access to the operating system, giving more control over their environment variables. In order to use custom firmwares the devices 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.

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](http://en.wikipedia.org/wiki/CyanogenMod) and [VillainROM](http://en.wikipedia.org/w/index.php?title=VillainROM&action=edit&redlink=1) are two examples of such firmware.

On 24 September 2009, Google issued a [cease and desist](http://en.wikipedia.org/wiki/Cease_and_desist) letter to the modder Cyanogen, citing issues with the re-distribution of Google's closed-source applications 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.

## Marketing

### Logos

The Android logo was designed with the [Droid font family](http://en.wikipedia.org/wiki/Droid_%28font%29) made by [Ascender Corporation](http://en.wikipedia.org/wiki/Ascender_Corporation).

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.

### Typeface

The custom typeface of Android is called Norad, only used in the text logo.

### Market share

Research company [Canalys](http://en.wikipedia.org/wiki/Canalys) estimated that by Q2 2009, Android had a 2.8% share of the worldwide [smartphone](http://en.wikipedia.org/wiki/Smartphone) market.

In February 2010 [ComScore](http://en.wikipedia.org/wiki/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. By the end of Q3 2010 Android's U.S. market share had grown to 21.4 percent.

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](http://en.wikipedia.org/wiki/Research_In_Motion), and still has to compete with heavy consumer demand for new competitor offerings. 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.

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. For a complete list of countries that are allowed to sell apps and those able to buy them see [Android Market](http://en.wikipedia.org/wiki/Android_Market#Availability_for_users).

As of December 2010[[update]](http://en.wikipedia.org/w/index.php?title=Android_%28operating_system%29&action=edit) Google said over 300,000 Android phones were being activated daily, up from 100,000 per day in May 2010.

|  |  |  |
| --- | --- | --- |
| Platform | API Level | Distribution |
| Android 2.3 (Gingerbread) | 9 | 0.4% |
| Android 2.2 (Froyo) | 8 | 51.8% |
| Android 2.0/2.1 (Eclair) | 7 | 35.2% |
| Android 1.6 (Donut) | 4 | 7.9% |
| Android 1.5 (Cupcake) | 3 | 4.7% |

## Linux compatibility

Android's kernel was derived from [Linux](http://en.wikipedia.org/wiki/Linux) but has been tweaked by Google outside the main [Linux kernel](http://en.wikipedia.org/wiki/Linux_kernel) tree.Android does not have a native [X Window System](http://en.wikipedia.org/wiki/X_Window_System) nor does it support the full set of standard [GNU](http://en.wikipedia.org/wiki/GNU) libraries, and this makes it difficult to port existing GNU/Linux applications or libraries to Android.However, support for the X Window System is possible. Google no longer maintains the code they previously contributed to the [Linux kernel](http://en.wikipedia.org/wiki/Linux_kernel) as part of their Android effort, creating a separate version or [fork](http://en.wikipedia.org/wiki/Fork_%28software_development%29) of Linux.This was due to a disagreement about new features Google felt were necessary (some related to security of mobile applications).The code which is no longer maintained was deleted in January 2010 from the Linux [codebase](http://en.wikipedia.org/wiki/Codebase).

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

However, as of January 2011, points of contention still exist between Google and the Linux kernel team: Google tried to push [upstream](http://en.wikipedia.org/wiki/Upstream_%28software_development%29) some Android-specific power management code in 2009, which is still rejected today.

Furthermore, [Greg Kroah-Hartman](http://en.wikipedia.org/wiki/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 Some Google Android developers hinted that "the Android team were getting fed up with the process", because they were a small team and had more urgent work to do on Android.