

An Evolution of Android Operating System and Its Version

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Abstract— Android operating system is one of the most widely used operating system based on the Linux kernel and currently developed by Google. Android is a software bunch comprising not only operating system but also middleware and key applications. Android Operating System is mainly divided into four main layers: the kernel, libraries, application framework and applications. Android is designed primarily for 9 touch screen mobile devices such as smart phones and tablet computers, with specialized user interfaces for televisions (Android TV), cars (Android Auto), and wrist watches (Android Wear). The OS uses touch inputs that loosely correspond to real-world actions, like swiping, tapping, pinching, and reverse pinching to manipulate on-screen objects, and a virtual keyboard. Despite being primarily designed for touchscreen input, it also has been used in game consoles, digital cameras, regular PCs and other electronics. In this paper different features of architecture and versions of Android OS are discussed.

Index Terms— Android , Runtime, Versions

I. INTRODUCTION

Android operating system is one of the most widely used mobile Operating System these days. Android mobile operating system is based on the Linux kernel and is developed by Google. Android operating system is primarily designed for smartphones and tablets. Since Android is an open source it has become the fastest growing mobile operating system. Due to its open nature it has become favorite for many consumers and developers. Moreover software developers can easily modify and add enhanced feature in it to meet the latest requirements of the mobile technology. Android users download more than 1.5 billion applications and games from Google Play each month. Due to Its Powerful development framework users as well software developers are able to create their own applications for wide range of devices. Some of the key features of Android operating system are: Application Frame work, Dalvik virtual machine, Integrated browser, Optimized Graphics, SQLite, Media Support, GSM Technology, Bluetooth, Edge, 3G, Wi-Fi, Camera and GPS etc. To help the developers for better software development Android provides Software development kit (SDK). It provides Java programming Language for application development. The Android software development kit includes a debugger, libraries, a handset emulator based on QEMU (Quick Emulator),

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documentation, sample code, and tutorials. Android, have various versions each major version has a dessert-based nickname, and they are all in alphabetical order.

II. BACKGROUND & HISTORY

Android is described as a mobile operating system, initially developed by Android Inc. Android was sold to Google in 2005. Android is based on a modified Linux 2.6 kernel. Google, as well as other members of the Open Handset Alliance (OHA) collaborated on Android (design, development, distribution). Currently, the Android Open Source Project (AOSP) is governing the Android maintenance and development cycle .

To reiterate, the Android operating system is based on a modified Linux 2.6 kernel. Compared to a Linux 2.6 environment though, several drivers and libraries have been either modified or newly developed to allow Android to run as efficiently and as effectively as possible on mobile devices (such as smart phones or internet tablets). Some of these libraries have their roots in open source projects. Due to some licensing issues, the Android community decided to implement their own *c* library (*Bionic*), and to develop an Android specific Java runtime engine (*Dalvik Virtual Machine* – DVM). With Android, the focus has always been on optimizing the infrastructure based on the limited resources available on mobile devices. To complement the operating environment, an Android specific application framework was designed and implemented. Therefore, Android can best be described as a complete solution stack, incorporating the OS, middle-wear components, and applications. In Android, the modified Linux 2.6 kernel acts as the hardware abstraction layer (HAL). To summarize, the Android operating environment can be labeled as:

- An open platform for mobile development
- A hardware reference design for mobile devices
- A system powered by a modified Linux 2.6 kernel
- An application and user interface (UI) framework
- A run time environment

III. ARCHITECTURE OF ANDROID OPERATING SYSTEM

Android operating system is a stack of software components. Main components of Android Operating system Architecture or Software Stack are Linux kernel, native libraries, Android Runtime, Application Framework and Applications. Linux kernel is used to manage core system services such as virtual memory, networking, drivers, and power management

A. Linux Kernel

Linux Kernel (Linux 2.6) is at the bottom layer of the software stack. Whole Android Operating System is built on this layer with some changes made by the Google. Like main Operating System it provides the following functionalities: Process

management, Memory Management, device management (ex. camera, keypad, display etc). Android operating system interacts with the hardware of the device with this layer. This layer also contains many important hardware device drivers. Linux kernel is also responsible for managing virtual memory, networking, drivers, and power management. Android was unveiled as its first product, a mobile device platform built on the Linux kernel version 2.6.25.



Fig 1. Android architecture

B. Native Libraries Layer

On the top of the Linux Kernel layer is Android's native libraries. This layer enables the device to handle different types of data. Data is specific to hardware. All these libraries are written in C or C++ language. These libraries are called through java interface. Some important native libraries are:

Surface Manager: it is used to manage display of device. Surface Manager used for composing windows on the screen.

SQLite: SQLite is the database used in android for data storage. It is relational database and available to all applications.

WebKit: It is the browser engine used to display HTML content.

Media framework: Media framework provides playbacks and recording of various audio, video and picture formats.(for example MP3, AAC, AMR, JPG, MPEG4, H.264, and PNG).
Free Type: Bitmap and Font Rendering

OpenGL | ES: Used to render 2D or 3D graphics content to the screen

libc: It contains System related C libraries.

C. Android Runtime

Android Runtime consists of Dalvik Virtual machine and Core Java libraries. It is located on the same level as the library layer. Dalvik Virtual Machine is a type of Java Virtual Machine used for running applications on Android device. The Dalvik VM enables every Android application to run in its own process, with its own instance of the Dalvik virtual machine. The Dalvik VM allows multiple instance of Virtual machine to be created simultaneously providing security,

isolation, memory management and threading support. Unlike Java VM which is process-based, Dalvik Virtual Machine is register-base. Dalvik Virtual Machine run .dex files which are created from .class file by dx tool. dx tool is included in Android SDK. DVM is optimized for low processing power and low memory environments. DVM is developed by Dan Bornstein from Google .

D. Application Framework

The Application Framework layer provides many higher-level services or major APIs to applications in the form of Java classes. Application developers are allowed to make use of these services in their applications. These are the blocks with which developer's applications directly interact. Important blocks of Application framework are:

Activity Manager: It manages the life cycle of applications.
Content Providers: It is used to manage the data sharing between applications, manages how to access data from other applications.

Telephony Manager: it manages all voice call related functionalities.

Location Manager: It is used for Location management, using GPS or cell tower.

Resource Manager: Manage the various types of resources used in Application .

E. Application Layer

The Applications Layer is the top layer in the Android architecture. Some applications come pre-installed with every device, such as: SMS client app, Dialer, Web browser and Contact manager. A developer can write his own application and can replace it with the existing application.

IV. VERSIONS

The version history of the Android mobile operating system began with the release of first commercial version, Android 1.0, was released in September 2008. Android is under ongoing development by Google and the Open Handset Alliance (OHA), and has seen a number of updates to its base operating system since its initial release and later it is developed under a confectionery- themed code name and released in alphabetical order; each version features slightly differ from its functionality, behaviour and user interface.

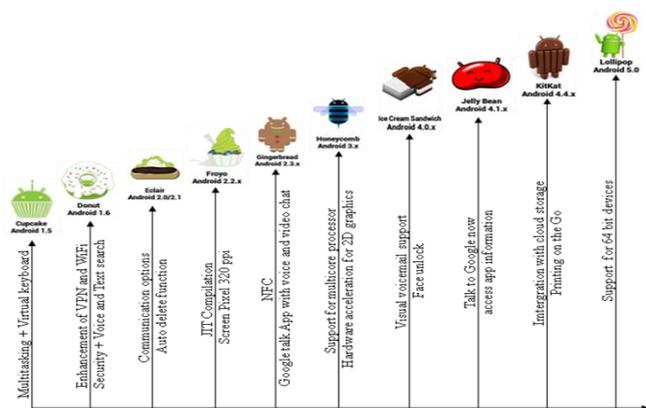


Fig 2.Version feature enhancement

The first release is **CUPCAKE 1.5** in the year 2009 april 30. The 1.5 release of Android (cupcake) for the G1/ADP1 used Linux version 2.6.27 kernel. The features of cupcake 1.5 is arrival of android own virtual keyboard, support for third party keyboard. It includes live and update of widgets. Video recording and playback also formed a significant step forward in 1.5. The added support of this version is multi-task friendly while uploading to youtube and picasa.

The second release is **DONUT 1.6** in the year 2009 September 15, the kernel/common.git tree for Android has a 2.6.29 kernel. It introduced Top paid, Top free, and newly released app categories and also screenshot capability, so for the first time you could actually preview what you were about to download. Search functions were also improved, both for voice and text. Searches are no longer simply a Google search and now incorporate bookmarks, history, contacts, apps, folders and so on. Camera and gallery interfaces have been improved and camera usage speed has been made much quicker and more responsive, additionally Virtual Private Network(VPN) support and Wi-Fi security options were enhanced.

The third version **ECLAIR 2.0** was released in the year 2009 October 26, the kernel/common.git tree for Android has a 2.6.32 kernel. Messaging was updated with a search function, allowing you to search through both SMS and MMS messages. It also added an auto-delete function meaning old messages could be deleted after an inbox limit is reached.

The fourth version is **FROYO 2.2** was released in the year 2010 May 20, the kernel used by this version is 2.6.35. This release brings many updates from the past versions, in this RAM was freed up for use on apps this improves the stability and speed as well as optimising memory and performance of the operating system. For the first time, froyo was build up with JIT compilation to get the system performance faster than the previous. The display capabilities could support screens with pixel densities as high as 320 pixels-per-inch (ppi). A major step forward for the platform was USB and WIFI hotspot tethering, this allows the user to connect to the internet directly from the phone, additional changes allowed the optional use of PIN passwords rather than touch signatures.

The fifth release is **GINGERBREAD 2.3** in the year 2010 December 6. This becomes the user friendly in all ways and that have been used by many consumers till now. The features like speed, copy/ paste power management and UI are improved and upgraded from the earlier version, it brings the major difference in the field of network world Near Field Communication (NFC) that helps to identify the short range communication between the devices.

The next version is **HONEYCOMB 3.0.X** released in the year 2011 February 22. Basically designed for the purpose of large screen mobiles particularly for tablets, brings a lot of new UI elements to the table. Things like a new System bar at the bottom of the screen to replace the Status bar we see on phones. Elegant notification bar and action bar is present in the home screen to run the apps concurrently this makes much more convenient to the users. Honeycomb is the first version of the platform designed to run on either single or multi-core

processor architectures. It offers a new hardware-accelerated OpenGL renderer, which offers a performance boost to many common graphics operations for applications running in the Android framework.

The seventh version released in December 2011, **ICE CREAM SANDWICH 4.0** is based on Linux kernel 3.0.1. This introduced a number of new features, including a refreshed home screen, near-field communication (NFC) support and the ability to "beam" content to another user using the technology, an updated web browser, a new contacts manager with social network integration, the ability to access the camera and control music playback from the lock screen, visual voicemail support, face recognition for device unlocking ("Face Unlock"), the ability to monitor and limit mobile data usage, and other internal improvements.

The next release is **JELLYBEAN 4.1** was released in 2012 July 9 and the kernel used in this version is 3.0.31. Jelly Bean brings multi-user accounts, actionable notifications, lock screen widgets, quick-settings in the notification bar, Android camera and Google talk which works like a Siri-like functionality and that converts the spoken command to our inane. Some of the features are Enhanced from previous versions, like Equalise your music, Turn notifications off, Rearrange your home screens, Fling to remove, Access App info, Volume controls, Talkback, Offline speech-to-text and Reboot to safe mode.

The next release is **KITKAT 4.4** in the year 2013 September 3, this brings a number of improvements, some of which lie behind the scenes, that improves an Android user's experience. The most notable features are designed to run on devices with as little as 512MB of RAM, support for cloud storage solutions such as Google Drive built into the operating system, printing on the go and that allows to print the document through WiFi or Bluetooth. The upcoming version is **LOLLIPOP 5.0** is a new design language and support for 64-bit devices.

V. CONCLUSION

Android powers hundreds of millions of mobile devices in more than 190 countries around the world. It's the largest installed base of any mobile platform and growing fast—every day another million users power up their Android devices for the first time and start looking for apps, games, and other digital content. Android gives a world-class platform for creating apps and games for Android gives you everything you need to build best-in-class app experiences. It gives you a single application model that lets you deploy your apps broadly to hundreds of millions of users across a wide range of devices—from phones to tablets and beyond. Android is used by many peoples in the world, a total of 261.1 million smart phones were shipped during this quarter, 81 percent of which run Google's operating system. The next versions of Android have will be more and more powerful and enhanced from the last releases overcome the actual expectations and that the future possibilities became a reality and may this software is also developed to use in PC's also.

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