A Literature Review on Android -A Mobile Operating system

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Abstract -It has been observed that now a days most of the people are using Android devices like mobile, smartphone and tablet. The android operating System has become one of the most popular operating system based on Linux kernel and it currently developed by Google. These days, millions of new users use Android platforms every year. There are four basic part of Android Operating System i.e., the kernel, libraries, application framework and Application. In this paper we describe the history, framework, feature of each version of android operating system.

Key Words: Android OS, Linux Kernel, Open-Source Platform, DVM, Android Version

A. INTRODUCTION:

Android Operating is primarily designed for touchscreen devices like mobile, tablet and smartphone. Android OS is based on a Linux kernel and other open-source software. We know that Android is open-source, so it is becoming the fastest growing operating system for mobiles [1]. Mobile operating system is also referred to as mobile OS which includes touchscreen, cellular, Bluetooth, Wi-Fi, GPS mobile navigation, HD camera, video Camera, speech recognition, music player, voice Recorder, browser [12].

B. History of Android Operating System:

The Open-source android platform initially developed by Android Inc, in polo Palo Alto of California, U.S in 2003. later on, in 2005 android sold to Google [2]. In 2007 Google in collaborate with OHA (Open handset alliance) released as AOSP (Android Open-Source platform). The aim of OHA is to developed open standard for mobile device, innovation in mobile phone and in lower cost provide better experience to costumer [3]. Android operating system is based on Linux 2.6 kernel. Android has its own operating system, middleware, key mobile and applications, and Android OS has its own virtual machine called DVM, which is used to run Android exec applications.

The Figure 1 shows that the evolution of Android Operating system.

Fig-1: An evolution of Android Operating system

C. Android Architecture:

Fig -2: Architecture of Android OS

Above figure shows that Android operating system contain a stack of software components layers. The main layer of Android components is-

i.   Linux kernel

ii.   ii. Native Library

iii.   Application Framework Layer

iv.   iv. Application Layer [3]

i. Linux Kernel Layer:

The bottom layer of the Android operating system is the Linux kernel layer. This layer does not interact directly with the developer [3]. This layer contains many important hardware device drivers and responsible for power management, memory management, device management and resource access [4].

ii.Native Library:

On the top of the Linux kernel there is Native Library layer. Native libraries contain WebKit, OpenGL, FreeType, SQLite, Media, C runtime library (libc) etc. [4]. Libraries are written in C or C++ language. To display HTML on browser engine used WebKit library. To display 2D or 3D graphics content to the screen OpenGL is used. Surface Manager is used to manage display of device. SQLite is the database used for data storage. SQLite is relational database and available to all applications [1].

iii. Application Framework Layer:

The Android Framework layer exists on top of the native library and the Android runtime. The Android Framework layer contains Android APIs such as UI (user interface), telephony, resources, locations, content providers (data) and package managers. This layer contains a collection of classes and interfaces for Android application development. [4]

vi.Application:

Applications are on the top of the Android framework layer. All applications i.e., home, contact, settings, games, browsers are using an android framework that uses android libraries and runtime [4]. The user of the Android device directly interacts with this layer. All android application is written in java Programming language. [4].

D. DVM (Dalvik Virtual Machine):

In Iceland Dalvik is the name of Town. The Dalvik virtual Machine (DVM) is an android virtual machine made for mobile device. DVM manage the virtual machine for performance, battery and memory. [10]

Working Structure of DVM:

The Java Compiler(javac) converts the Java Source Code into Java Byte-Code(.class). Then DEX Compiler converts this (.class) file into in ". dex" file i.e., Dalvik Byte Code.
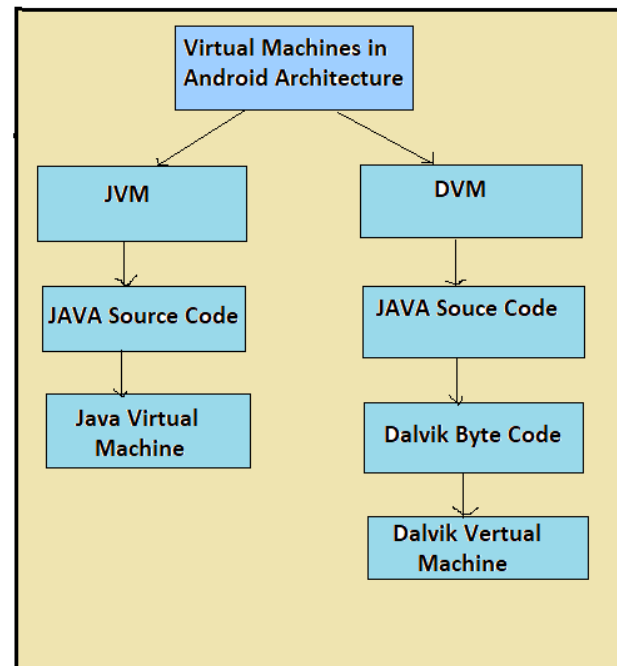

Fig-3: Working of Dalvik virtual Machine

Application:

Google developed new virtual machine for Android operating system. It uses registers of the CPU to store the operands. There is no requirement of any pushing and popping of instructions therefore making execution faster. The instructions operate on virtual registers, being those virtual registers memory positions in the host device. Register-based models are good at optimizing and running on low memory. They can store common sub-expression results. This can possible only by DVM. Dalvik Virtual Machine uses its own byte-code and runs Dalvik Executable File .dex file [11].

Advantages

- Only Android operating system Support DVM

- Faster execution

- In DVM executable is APK.

- From Android 2.2 SDK Dalvik has it's own JIT (Just in Time) compiler.

- With the help of DVM device can run multiple instances effectively.

- Applications are given their own instances

Disadvantages

- Only Android operating system Support DVM

- For DVM very few Re-Tools are available.

- Requires more instructions than register machines to implement the same high-level code.

- App Installation takes more time due to dex.

- More internal storage is required.

E. Android Version History:

In 2003 the development of the Android operating system was started by Android, Inc. Android OS is updating day by day. The first commercial version of Android 1.0 was released in September 2008[1]. Since the initial release Android was continuously developed by Google and the Open Handset Alliance (OHA)[5]. The Android OS updates mainly focuses on new features and fixes bugs. Table 1 shows the evolution of the Android version. It also shows that the basic versions 1.0 and 1.1 have no code name and the later version of Android has a dessert name and version 9 pie stops the dessert code name system after Android and starts a system called Android 10, Android 11.

Table 1. Version list of Android Operating System [9]

SR. No	Version	Code Name	Date Of Realease
1	1.0	No Codename	September 23, 2008
2	1.1	No Codename	February 9, 2009
3	1.5	Cupcake	April 27, 2009
4	1.6	Donut	September 15, 2009
5	2.0 − 2.1	Eclair	October 26, 2009
6	2.2 − 2.2.3	Froyo	May 20, 2010
7	2.3 − 2.3.7	Gingerbread	December 6, 2010
8	3.0 − 3.2.6	Honeycomb	February 22, 2011
9	4.0 − 4.0.4	Ice Cream Sandwich	October 18, 2011
10	4.1 − 4.3.1	Jelly Bean	July 9, 2012
11	4.4 − 4.4.4	KitKat	October 31, 2013
12	5.0 − 5.1.1	Lollipop	November 12, 2014
13	6.0 − 6.0.1	Marshmallow	October 5, 2015
14	7.0 − 7.1.2	Nougat	August 22, 2016
15	8.0 − 8.1	Oreo	August 21, 2017
16	9	Pie	August 6, 2018
17	10	Android 10	September 3, 2019
18	11	Android 11	September 8, 2020

1. Android Version 1.0 to 1.1: No codename:

The first official version of Android debuted publicly in 2008 as Android 1.0. The first release did not even have a codename.[6]. It supports Web browser to show web pages, camera, access web email server. This version includes Google Calendar, Google Maps, Google Sync, Google Search, Google Talk, Instant messaging, Media player, Notifications appear in the status bar, wallpaper, YouTube video player, AlarmClock, Calculator, Pictures (Gallery), Wi-Fi and Bluetooth support.[5]

2. Android version 1.5: Cupcake:

The Android updated to 1.5 released On April 27, 2009.The codename of the update was dessert item (Cupcake). It has Linux kernel 2.6.27. This version of android supports third-party virtual keyboard, Video recording and playback in MPEG-4, Copy and paste feature, Animated screen translations, auto-rotation option and also has the ability to upload a video on YouTube, upload photos to Picasa, check phone usage history [5].

3. Android version 1.6: Donut:

Android 1.6 was released On September 15, 2009, with the name Donut. This version includes various new features such as voice and text entry search, bookmark history, contacts, web, "speak" a string of text, faster camera access and user can delete multiple photos in same time, support text-to-speech engine, WVGA screen resolutions [5][6].

4. Android version 2.0 to 2.1: Eclair

Android 2.0 was released On October 26, 2009, with codename Eclair. It was based on Linux kernel 2.6.29. This contains the many new features such as expanded account sync, Microsoft Exchange email support, Bluetooth 2.1, ability to tap a Contact photo and select to call, SMS, ability to search all saved SMS, MMS messages, delete the oldest message automatically when the defined limit is reached, Minor API, bug fixes [5].

5. Android version 2.2 to 2.2.3: Froyo

Android 2.2 was released on May 20, 2010. The update was codenamed Froyo. This update is based on the Linux kernel 2.6.32. This version introduces many features like speed, memory, performance optimization. JIT Compilation, the integration of Chrome's V8, will support the JavaScript engine in the browser application, support the Android Cloud to Device Messaging service, Adobe Flash support, update security features, and improve performance.[5]

6. Android version 2.3 to 2.3.7: Gingerbread

Android 2.3 version with Gingerbread codename was released on December 6, 2010. It is based on Linux kernel 2.6..35. This version makes the following changes: support for extra-large screen sizes and resolutions, updated user interface design with increased simplicity and speed, enhanced copy/paste functionality, select a word by press-

holding, Near Field Communication (NFC), headphone virtualization, new download manager.

This version of android fixes bug fixes for Nexus S, voice or video chat using Google Talk, network performance for Nexus S4G, Gmail application, battery performance, voice search bug, Google Wallet support for Nexus S4G[2, 5].

7. Android version 3.0 to 3.2.6: Honeycomb

Android 2011.0 was released on February 22, 2011. The codename for this version is Honeycomb. It was the first Android-based tablet on the Linux kernel 2.6.66. This version includes a "holographic" user interface for tablets, an attached system bar, simplified multitasking tapping in the recent application system bar, redesign of keyboards that make typing faster, quick access to camera exposure, hardware acceleration, multi-core processor, multi-core processor, Support for joysticks and gamepads, high-performance Wi-Fi lock, improved hardware support, Google Books, and fixed data connectivity issues when exiting airplane mode [2] [5].

8. Android version 4.0 to 4.0.4: Ice Cream Sandwich

Android 4.0.1 was released On October 19, 2011, with codename Ice Cream Sandwich. This was based on Linux kernel 3.0.1. This was the last version of officially support Adobe System Flash player. This version introduces the various new features: refinements to "Holographic " interface, separation of widgets in a new tab, integrated screenshot capture, improved error correction on the keyboard, improved copy and paste functionality, build-in photo editor, spell-checking feature, fixed minor bugs, improvement to graphics, better camera performance [5][6].

9. Android version 4.1 to 4.3.1: Jelly Bean

Google announced the Android 4.1 version of the android operating system at the Google I/O conference on June 27, 2012. The codename of the update was Jelly Bean. This version is based on Linux kernel 3.0.31. This version updates many features such as smoother user interface, enhance accessibility, expandable notification, fixed bug on Nexus 7, one-finger gestures to expand/collapse notifications, lock screen improvement, for tablet can add multiple user accounts, clock application in a new format, Bluetooth low energy support, volume for an incoming call, 4K resolution support, native emoji support, bug fixes for the Nexus 7

10. Android version 4.4 to 4.4.4: KitKat

Android 4.4 version released on September 3, 2013 with codename KitKat. Initial code name was "Key Lime Pie". On October 31, 2013 Google started on Google's Nexus

5. The minimum required amount of RAM should available to Android is 340 MB. The other devices with less than 512 MB of RAM must report themselves as "low RAM" devices. It includes several new features as clock no longer display bold hours, wireless printing capability, Web Views are based on Chromium engine, sensor batching, built-in screen recording feature, better application compatibility, camera application loads Google+ Photo instead of Gallery.

11. Android version 5.0 to 5.1.1: Lollipop

In 2014 google release new version Android 5.0 with codename lollipop. On November 12, 2014 it was released officially. This version introduces many features like redesigned user interface, support for 64-bit CPUs, print preview feature, material design, Project Volta for battery life improvement, more than one user accounts, audio input/output through USB devices, join Wi-Fi networks, support for multiple SIM cards, device protection, HD voice calls, native Wi-Fi calling support [5][6].

12. Android version 6.0 - 6.0.1: Marshmallow

On May 28,2015 google release new version Android 6.0 with codename "Marshmallow", for Nexus 5 and Nexus 6 phones, Nexus 9 tablet. Android lunches "Marshmallow" for all android devices On October 5, 2015. This version includes many new features as App Standby, the Doze mode to save battery life, native fingerprint reader support, run-time permission requests, USB-C support, Unicode 7.0 & 8.0 emoji support.[2][5].

13. Android version 7.0 to 7.1.2: Nougat

Google major release for the Android operating system was the Android 7.0 with codename "Nougat". The initial codename for this version was "Android N". It first appeared for developer preview on March 9, 2016, with a factory image. The final version released On August 22, 2016. This version introduces many new versions file-based encryption, zoom in the screen, multi-window support, new Data Saver mode, JIT compiler makes 75 percent faster app installation, picture-in-picture support, support manager APIs, circular app icons support, send GIFs directly from the default keyboard, battery usage alerts [2][5].

14. Android version 8.0 to 8.1: Oreo

The 8th major release of the Android operating system was Android 8.0 with codename "Oreo". It first appeared for developer preview on March 21, 2017 and its final developer preview was released on July 24, 2017.The fixed version of this releases On August 21, 2017 with many new features like picture-in-picture support, support for Unicode 10.0 emoji (5.0), restructured settings, adoptive icons, notification channels, notification dots, increase boot time, Google Play Protect, support Integrated printing,

Neural network API, shared memory API, Android Oreo Go Edition, autofill framework, automatic light.[2][5].

15. Android version 9.0: Pie

The ninth major version of the Android operating system was Android 9.0. The codename for this version was "Pie". Google released and previewed the first version on March 7, 2018, and it was officially released on August 6, 2018. Some of the new features of this version are that the clock moves to the left side of the notification bar, screenshots are added, buttons, percentages are always shown in the display [2][5].

16. Android version 10:

The tenth updated version of the Android operating system is "Android 10". The codename of Android 10 is Android Q. Initially, it was announced by Google on March 13, 2019. On the same day first beta version was released. On April 3, 2019, its second beta version was released. The fixed version of Android 10 was released on September 3, 2019. This version includes some new features like permissions to access location, floating setting panel, support for an AV1 video codec, support for biometric authentication, support the WPA3 Wi-Fi security.[5][2]

17. Android 11:

Android 11 is the big launch of Android Operating System. It is the 18th version of Android mobile OS. This version was released on 8 September 2020. The code-naming system of Android based on deserts, was stopped in Android 10 version. This operating system has name as "Android 11"[5].

CONCLUSIONS

Today, Android mobile devices are used in more than 190 countries around the world. Each new version of Android introduces various new features with its release. Today, using an Android phone, a smart phone changes the life of every person. Android devices cost less than devices that use other operating systems because of their open-source features. Application used in android are made with java programming so these applications also provide the security because java is secured language. This paper also provides the information about different version of Android OS and Architecture of Android operating system.

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