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A Review of the Android Operating System's Evolution

Jasdeep Singh

Assistant Professor, Department of Computer Science & Engineering, RIMT University, Mandi Gobindgarh, Punjab, India

Correspondence should be addressed to Jasdeep Singh; jasdeepsingh@rimt.ac.in

ABSTRACT- Traditionally, telephones were only used for making telephone conversations; however, with the introduction of the artificial intelligence gadget, the savvy handset has evolved into a minimal hand-held computer device. The system software for cellular telephones, that empowered smartphones toward becoming technological advancements with their own computation and storage, sparked this innovation. The mobile phone currently offers a lot of functionality, including calling, messaging, audiovisual streaming, blogs, online media apps, document editors, data files, and a range of online play. The OS for these portable gadgets include Apple's iOS, Microsoft's Windows, and Google's Android. Android has the biggest industry presence amid competitors in terms of devices shipped and customers in the android mobile os system industry. The Android OS is centred on the Code base, and apps are controlled by a programming interface that coordinates the actions of modules and the Dalvik hypervisors, that builds and combines all standard java assets as an unified package. Numerous compute nodes can run at the given moment on a physical unit, each handling different workloads or replicas of a program. The Android OS provides resource administration and control activities to running mobile applications. Each new edition of Android introduced innovative functionality and enhanced the customer journey. The paper looks at how the Android has evolved with every latest incarnation.

KEYWORDS- Android, Dalvik Machine, Google, Kernel, Linux, Operating System, Smartphone.

I. INTRODUCTION

Smartphones and tablets have become so ubiquitous in modern environment that the devices possesses a large economic marketplace and a large volume of traffic, all of whom utilize diverse types of smart phones with different qualities [1,2]. The most obvious feature that distinguishes the smartphone business and its user base is the operating system that is utilized, with Android, iOS, and Windows Phone being the most popular. According to data from Intercontinental Documents Company (IDC), the smart phone market increased by 2.1 percent, with more than 350 million devices delivered globally. With a market share of 86.8%, Android has engaged its habitation on the best top operating systems for the smartphones [3-6].

Along with increasing request for Android phones, consumers' core worry is discovering and buying a phone that fits their needs at a reasonable price. Because of its widespread popularity midst clients, various builders are endeavouring to take advantage from the Android OS in today's competitive environment [7,8]. The debate and efforts to produce an os that really is interoperable with the bulk of equipment plus offers every one of the important functions to users together in suitable way are intensifying for every approaching day. So each firm aims to give the best grade Android phones available whilst simultaneously enhancing capabilities. Because of the extensive usage of Android, sophisticated techniques for friendliness, concurrency, mobility, and the protection of end-user-private information, along with other factors, have been developed, with each update expected to solve the aforesaid issues even while providing anything really unique to the consumer. Android Inc. was the first to design the Android platform., which is nowadays maintained by Google, and released as AOSP (Androids Operating System Plan) in 2007 [9-10]. The founding of the OHA adopted such declaration (Open Handset Alliance). Its software was released as open source under the Apache license. The Open Handset Alliance is a assemblage of hardware, software, and industries working in the field of telecom sector. Intel, Google, NVIDIA, HTC, and T-Mobile are among the companies that use Android as their operating system. Its main goal is to develop advanced equipment based on its technology, which will save time and money while also improving services and providing the finest features to customers. Kit Kat, Marshmallow, and Gingerbread are the current Android versions in use. The Android operating system's history is shown in Table 1 from its inception to the present day [11-13]. Android OS is a kind of OS that serves as a link among the operator & device. When we speak about the Android operating system, the most recent version is Nougat, which has been updated to 6.1-6.23 and is constructed on the UNIX 3.3.2 kernel, which is made up of layers, as revealed in Fig 1. In Android OS, the application layer is the top layer, which contains utilities such as SMS, contacts, phone, browser, camera, media player, cleaning, and so on [14-17]. All of them were created using the Java programming language. To set up and operate, utilities or apps need an application framework. An application framework is a wide collection of analyses used to create an app with an appealing user interface, which may

include a direction-finding list of options, check list, text box, buttons, checkbox, & more importantly, a fixed and approachable browser. Access to resources is provided by a Resource Manager, without accessing the programming such as limited String, GUI, or design.

Table 1: Hierarchy of Android OS [18]

Android version	API Level	Linux Kernel in (AOSP)	Release
Cupcake	3	2.6.27	2009
Donut	4	2.6.29	2009
Eclair	5	2.6.29	2010
Froyo	8	2.6.32	2010
Ginger-bread	9	2.6.35	2011
Honey-comb	11	2.6.36	2011
Ice cream-sandwich	14	3.0.1	2011
Jelly bean	16	3.4.39	2012
kitkat	19	3.10	2013
Lollipop	21	3.16.1	2015
Marsh-mallow	23	3.18.10	2015
Nougat	25	4.4.1	2016

All applications may use the Notification Manager to display regular alerts over display. The Movement Supervisor manages the lifetime of applications and includes a standard routing backend. The collection cover is made up of a collection of java archive libraries that are used by a variety of Android operating system operations and also provide application framework maintenance. The Runtime layer in Android focuses on a collection of essential collections and a Java Dalvik VM, which Google may rebuild and modify to become a viable source for Android OS. The Linux kernel is installed at the lowest layer of Android OS to serve as the quickest layer among Android's hardware and applications. It may also offer key operating system structure services such as fortification/safekeeping, recollection supervision, methods functions, networking systems, driver segments, and support for features like Dalvik virtual machine thread management contained in the system or kernel of the UNIX based systems [19,20].

The Android OS is based on the UNIX kernel, and its app is coded in Java, thus its job is to run them on a Java virtual machine called Dalvik VM [21,22]. Google rebuilt and optimized Dalvik for device aspects of mobile units. In the smart phone software development kit, there is a program called.dx that converts Java files compiled with a typical Java compilation tool into.dex types, which combines altogether every Java class docs and removes superfluous records in every Java doc [23-25]. The following are the characteristics of the Dalvik virtual machine: A Dalvik virtual machine is used to execute a smart phone application. On a single system, several Dalvik virtual machine instances may exist, each of which operates in chunks or as a distinct Linux process. For execution, isolation memory management, and thread support, the Dalvik VM relies on the innovative kernel of Linux OS. Dalvik is a register-based virtual machine.

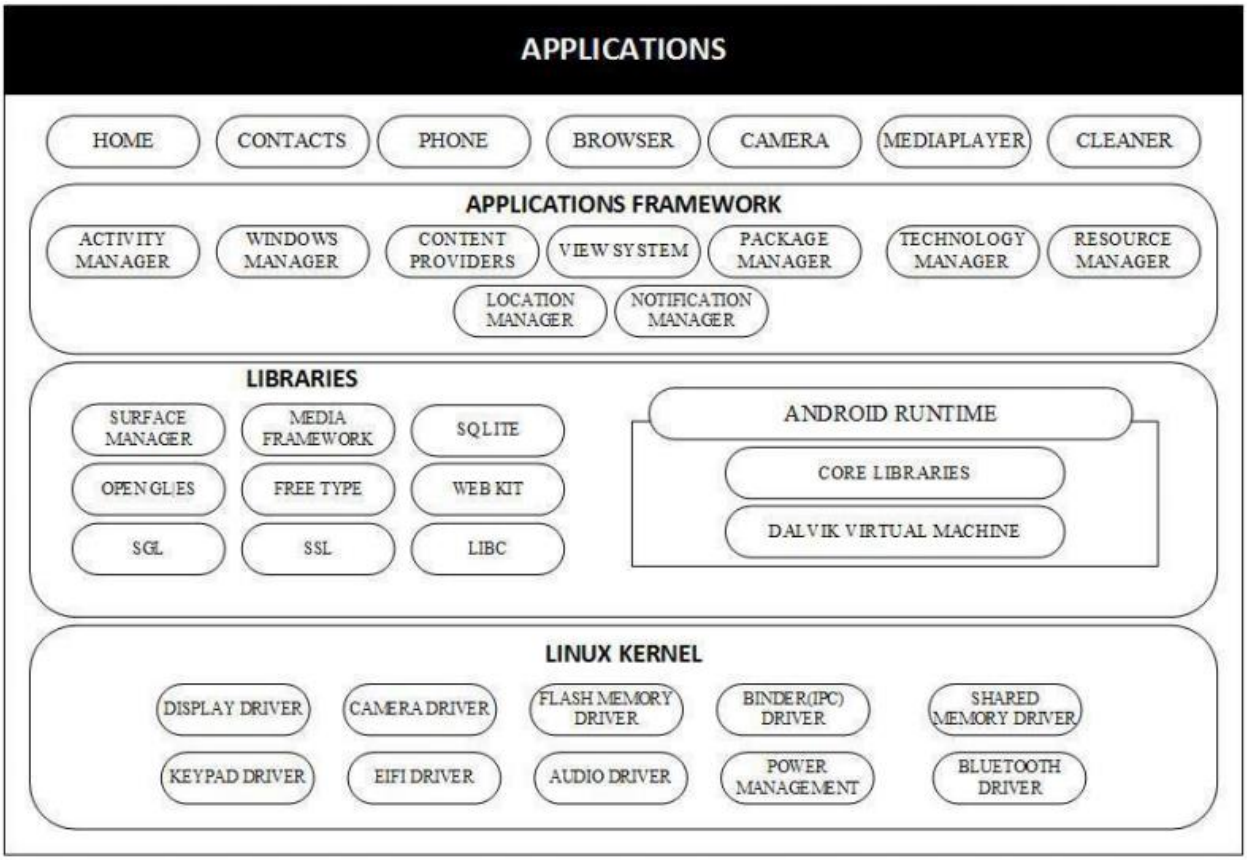

Figure 1: Architecture of Android Operating System

II. LITERATURE REVIEW

Each program in the Android OS runs independently of the others and having own memory area, making its data unavailable to others. Message parsing is used to communicate between programs. API level 3 was utilized with the introduction of Android Cupcake in 2009, and the OS allowed thingamabobs, searching engines, and navigation apps that incorporated free map data to serve as a navigation device. Without the need of a computer system, content may be updated and synced via the internet. Along with the capabilities offered in cupcake, the donut OS, which was launched the alike year as cup-cake, utilized the level 4 interface to enable phone screenshot capturing and voice commands. To improve the operator involvement, Android Éclair utilized 5th level of the API, which allowed the OS to handle display of extremely low density usually ranging from 320x240 to a very high-density displays of 854x480 pixels. Instead of separate navigation, the user was given centralized access by choosing a contact on which they could make a call, send a message, or send an email with a single touch. With a universal account, you may manage numerous email accounts. Search and deletion of sms and mms depending on time. The camera and browser capabilities were enhanced, and a virtual keyboard with sophisticated autocorrect was added. For improved performance, the hardware graphics architecture was changed.

With the latest edition of Google's froyo, it stood said to have the extremely fast and secure browsers of any smart phone in 2010, using API level 8, with an enactment degree that was 1.5 intervals faster than any prior forms published. To enhance device security, alpha and numeric choices were introduced to passwords and secluded accessing methods to re-set mobile info in the event of loss or any kind of robbing incident, protecting users' concealment and truthfulness. Before the introduction of the froyo, users could install programs on the unit's reminiscence, but with froyo, consumers may now load apps on external storage as well. YUV pictures were also supported by the operating system, in addition to enhanced camera capabilities and cloud APIs for gesture recognition for multi touch.

Because the Android OS basically was created by Android Inc. that generally was derived from UNIX modules, the tech giant Google did not start from scratch and instead concentrated on improving the handler familiarity by enduring Android Inc.'s efforts. Android Inc. was the first company to create the platform. As a result of the introduction of Ginger-bread OS having level 9 program interface, the UNIX kernel was updated to 3.4.22, allowing the OS to accomplish authority more effectively and provide a more sophisticated user interface. New gadgets with big screens and the requirement for internet connection were gaining popular in the market. Near field communication (NFC) was introduced to Android Gingerbread, allowing for high-frequency communication within a 10 cm radius.

Gingerbread supports SIP to fulfil market demand. With the advent of SIP, consumers no longer had to worry about communication obstacles or payment concerns. Other capabilities encompassed auditory indoctrination, movie replay, a multi-touch computer-generated console, and a gyro-sensor, which, in conjunction with the accelerometer, determines the rate of rotation around the x, y, and z axes, also known as twists. The inclusion of an accelerometer that recorded linear movement and a gyroscope that monitored rotational movement opened the door for virtual reality compatibility.

In 2010, the tech giant Google announced its very initial smart phone, the Nexus S, in collaboration with LG, alongside the second major release of Honeycomb. Honeycomb changed the Android operating system by enabling multitasking with all displays active at the same time thanks to the up keeping of a multi-core workstation atmosphere having symmetric multi-processing. This operating system upgrade included a number of improvements, including improved web surfing, GoogleTalk, 3D paraphernalia in Google Maps, & numerous home displays that permit users to personalize the layout to their liking. The icecream level 13 API release was the last release of 2011, and it was well-matched equally with high & low resolution gadgets. The OS's multitasking capability was improved further, allowing users to move between open programs by seeing a list of running applications. The look of notifications has been improved by eliminating pop-ups and placing the same at uppermost area of display, where a specific notice may be tapped to see its details. The OS now has an open mic voice facility, which means the systems are constantly set to accept and execute voice commands rather than having to launch the service first. While all apps are halted and cannot be accessed while the device is locked, the OS permits the consumer to accept inbound calls, navigate between playing media, and authorize the consumer with the help of alpha and numeric input. Face lock is a new feature that verifies the user's identity. Camera capabilities such as improved speed of snap shot, incessant emphasis, nil cover up, panoramic for picture, and simultaneous recording of high-definition movies were refined in response to customer demand. The introduction of the icecream version of OS opened the path for an upcoming in which consumers may get new, engaging, and personalized apps and features. One example is the Android Beem, which is based on NFC and allows users to exchange information at a far faster rate than previously allowed.

In 2015, Android Lollipop was launched with API level 21 to improve users' familiarity through three dimentional views. Element shadows may now be seen in real time as the item moves. Transitioning components from one state to another is fluid and seamless using common graphic elements. Threads are produced for smooth animation execution using the new architecture, even if there is an interruption in the consumer edge chief strand. The performance of the system is not compromised in the Lollipop version, which operates in advance and Android codes developed from the ground up to suit the requirements of 64-bit MIPS and ARM architecture. This upgrade met the need of effectively reducing trash while maintaining application responsiveness without impacting performance. To back up its promise of great performance, Android Kitkat uses pipelining to improve audio and video synchronization for smooth output. New sensors for productivity were added, including a heart rate sensor, interaction sensors for detecting interactions like as flicks, swipes, and pinches, and a tilt sensor for activity identification. Cell recital, user-friendliness, web view, display, and camera capabilities were all enhanced with the new APIs. Fingerprint detection was introduced in marshmallow Level 22 interface the same year as Kitkat, allowing users to perform a variety of tasks including hardware unlock methods, picking incoming calls and holding up out-callings, surfing pics within galleries, apprehending and foraging in the camera, and many others. However, safekeeping genuineness and reliability of people's device and data operating systems are paramount. Previously, when installing an application, it is essentially required to give almost all of the authorizations requested during software loading, and this could not be changed afterwards. To empower the user, marshmallow allows the user to modify the application permissions. Type C cable was added for rapid charging, and a special mode allows the OS to conserve high energy and nearly triple the cell life. While the screen is locked, you may still access notifications and the camera. Android Nougat, which was released in 2016 and has an API level of 25, is the most current version of the Android operating system. The most notable feature of the Nougat operating system is the ability to multitask apps in split screen. The greatest appearance, feel, and performance were given by marshmallow, while nougat's emphasis was on improving the current characteristics provided by marshmallow.

III. DISCUSSION

The first version of the Android Cupcake API level 3 was published in 2009, and it marked the beginning of the Android OS' development. The cupcake version has the benefit of improved rapidity and enactment, however not to the necessary level; nevertheless, the cup-cake edition has the disadvantage of being less responsive and lacking multitasking. Android level 3 interface was released in 2008 with goal of addressing the problems that plagued earlier versions of Cupcake. Donut has the power savor option as well as keyboard auto correct, allowing for a faster online surfing experience but slower typing. Éclair API level 5 was released in 2010, and it included capabilities that were not available in earlier Android versions. Éclair improves typing speed with a better vocabulary on a virtual keyboard, however no Flash type is reinforced. Afterwards API edition eight was released, with a focus on privacy protection and compatibility for Adobe Flash Media. However, Froyo slows while multiprocessing. The downside of ginger-bread is that it closes apps automatically.

Honey-comb comes after the release of the Ginger-bread edition of the android OS. Honey-comb or level 11 programming interface was introduced in 2011, with the primary goal of focusing on apps that can be shut routinely in Ginger-bread, and Honey-comb did not even shut apps until the user doesn't shut them. Honey-comb has very much

improved website surfing experience, G-Talk, 3D paraphernalia in Maps, & numerous home screens to let users to personalize the UI to their liking. However, battery loss in certain apps is a problem with honeycomb. Ice-cream edition of the android OS or the Sandwich edition was released in 2011 with API Level 14 and is much quicker than Honeycomb. It also does not drain the battery as much as Honeycomb. The operating system's multitasking capabilities was further improved, allowing users to move between open programs by seeing a list of running applications. The major issue with ice-cream sandwich was that when the device was locked, all applications were halted and could not be accessed. Jelly Bean API level 16 was released in 2012, and it is more responsive than previous Android versions. The main purpose of Jelly Bean is to provide security measures; however, one flaw in the schema was that the operating system did not prevent acquisition of device location even when Wi-Fi was turned off. After jelly bean Kitkat, API level 19 was released in 2013 and included edge to edge technology that allowed users to not only remotely access their device but also perform activities such as cloud printing, resource management, and more. Kitkat also provides a location address when Wi-Fi is turned off, which was a problem in previous jelly beans. Kitkat has a flaw in that it does not allow you to compose messages or send emails when in power saving mode.

Lollipop API level 21 was released in 2015, and although it is most likely Kitkat, it has some new features such as new sensors, such as a sensor for heart rate and the ability to detect interactions such as flicking and swiping. The issue with interaction sensors and tilt sensors for activity detection in Lollipop is that background applications are not near together, which causes battery loss to be quicker. Marshmallow API level 23 was released in 2015 after the successful completion of Lollipop. The API added stratums by pattern sensing units, granted all authorisations despite the fact that enabling application fast charging via type C cable, and introduced sleep mode, which allows the OS to save additional energy and more or less twice the life of the battery. While the screen is locked, you may still access notifications and the camera. Marshmallow focuses on the drawbacks of lollipop and kitkat, such as applications not closing in background processes in lollipop, which Marshmallow focuses on, and writing messages and emails in power saving mode, which is a drawback of kitkat. Another disadvantage in Marshmallow is that both Wi-Fi and hotspot do not work at the same time. Today's most popular Android version is Nougat, which was released in 2016 at API level 25. It's more than likely Marshmallow, and all of Marshmallow's features are included in the Nougat version, including the Split screen option and the ability to use both Wi-Fi and hotspot, which is Marshmallow's disadvantage.

IV. CONCLUSION

The plea for smart mobile phones is growing every other day, with Android OS being the top choice and utmost prevalent between consumers and having the greatest market share in terms of use and units shipped, with 350 million devices and an 86.8% market share. With features that amplified consumer adaptableness & met the requests with each release, Google's focus in emerging the Android OS shall also be on safekeeping and concealment, which is a most important menace to the OS and defencelessness fascinate burglars to take advantage of it & feat consumers by attaining access to their device's content. By doing so, along with improving user experience, the Android operating system will win the confidence of its consumers, increase its market share, and retain users. Until recently, Google has successfully marketed the Android operating system as an open source project that is compatible with a wide range of devices from various manufacturers. Now is the time for Google to set quality benchmarks for device makers that utilize the Android operating system in order to provide a positive user experience while also upholding operating system standards that ensure security procedures are followed. By doing so, the Android operating system will be able to overcome the flaws and criticisms that its rivals have experienced, and will emerge as a user-friendly platform that is concerned about its customers.

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