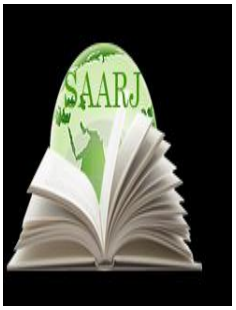

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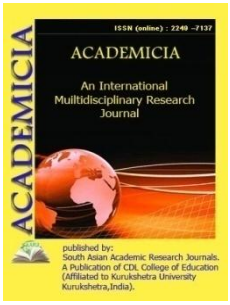

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AN OVERVIEW OF ANDROID OPERATING SYSTEM

Dr. Ajay Rana*; Mridul**

*Shobhit Institute of Engineering and Technology,
(Deemed to be University), Meerut, INDIA
Email id: ajay.rana@shobhituniversity.ac.in,

**School of Computer Science and Engineering,
INDIA
Email id: mridul@shobhituniversity.ac.in

ABSTRACT

The Android operating system is essentially a mobile operating system that is quickly gaining market share, with dozens of smart phones and tablets now available or soon to be available. It's a mobile operating system based on a modified version of the Linux kernel version 2.6. The Open Phone Alliance, a collection of more than 30 mobile and technology firms aiming to open up the mobile handset ecosystem, created Android. Because the Android developer kit supports many of the standard packages used by Jetty, as well as Jetty's modularity and small footprint, it was feasible to convert Jetty to it and make it operate on the Android platform. These days, the Android operating system is one of the most frequently utilized. The kernel, libraries, application framework, and apps are the four major layers of the Android Operating System. Its kernel is Linux-based. The Linux kernel is responsible for fundamental system functions including virtual memory, networking, drivers, and power management. Different aspects of Android OS architecture, as well as security features, are addressed in this article.

KEYWORDS: *Android, Framework, Linux, Operating System, Sandbox.*

1. INTRODUCTION

The Android operating system is now one of the most popular mobile operating systems. Google developed the Android mobile operating system, which is based on the Linux kernel. The Android operating system was created with smartphones and tablets in mind. Android is the fastest growing mobile operating system because it is open source. It has become a favorite of many consumers and developers due to its open nature. Furthermore, software developers can

easily modify and enhance it to meet the latest mobile technology requirements. Each month, Android users download over 1.5 billion apps and games from Google Play[1]. Users and software developers may build their own apps for a broad variety of devices thanks to its powerful development framework. Application Framework, Dalvik virtual machine, Integrated browser, Optimized Graphics, SQLite, Media Support, GSM Technology, Bluetooth, Edge, 3G, Wi-Fi, Camera, and GPS are some of the key features of the Android operating system. Android provides an Android Software Development Kit to assist developers in better software development (SDK). For application development, it provides the Java programming language[2].

A debugger, libraries, a handset emulator based on QEMU (Quick Emulator), documentation, sample code, and tutorials are all included in the Android software development kit. Android is the most widely used operating system on many mobile devices across the globe. By the end of 2020, it will have taken up roughly 75% of the global market[3]. Open Handset Alliance, for example, has created the first Android operating system that is based on a modified version of the Linux kernel as well as other open-source applications. Google first funded the initiative in 2005, and it eventually acquired the whole business. The first Android smartphone was launched in September 2008, and it quickly became the market leader owing to many characteristics such as user friendliness, community support, customization, and large-scale production of Android devices. As a result, the market assesses the need for clever developers to create Android-enabled gadgets. As a result, the Android operating system has evolved into a comprehensive collection of operating systems for a variety of devices, including wearables, mobile phones, laptop computers, smart TVs, tablets, set-top boxes, and more[4].

Android is a Linux-based operating system that is mainly intended for touch-screen mobile devices like smartphones and tablets. Starting with black and white phones and progressing to smartphones and small computers in the past 15 years, the operating system has evolved significantly[5]. Android is one of the most popular smartphone operating systems these days. Android is a piece of software that was created in 2003 in Palo Alto, California. Android is a sophisticated operating system that supports a wide range of Smartphone apps. These apps are more user-friendly and sophisticated. The ARM architectural platform underpins the hardware that runs Android software. Android is an open-source operating system, which means it is available for free and may be used by anybody. Android offers millions of applications that may help you manage your life in one way or another, and it is accessible for a cheap price in the market, which is why it is so popular[6].

The entire Java programming language is supported by Android development. Other API and JSE packages aren't supported either. The android developer kit (SDK) was originally published in 2008 with version 1.0, and the most recent upgrade is jelly bean.Android is a mobile software stack that consists of an operating system, middleware, and essential apps. Android is a mobile operating system that is built on a modified Linux kernel. The industry's growing interest stems from two main factors: its open source nature and its architectural model. Because Android is an open-source project, it can be thoroughly analyzed and comprehended, allowing for feature understanding, bug fixes, new functions, and, ultimately, porting to new hardware. On the other hand, its Linux kernel-based architectural paradigm brings Linux to the mobile sector, enabling

users to benefit from Linux's expertise and capabilities. Both of these features make Android a desirable target for usage in a variety of settings[7].

Another thing to keep in mind while using Android is that it has its own Virtual Machine (VM) environment. Android apps are written in Java, which necessitates the usage of a virtual machine (VM), which has both benefits and drawbacks[8]. A solution stack is a collection of software subsystems or components required to provide a fully functioning solution, such as a product or service, in computing. Middleware is a kind of computer software that links software components or individuals with their applications. Software that connects two or more different software programs. Because it links two programs and transfers data between them, middleware is often referred to as plumbing[9].

Data from one database may be accessible via another using middleware. On top of Java core libraries running on a Dalvik virtual machine with JIT compilation, the Android opensource software stack comprises of Java apps running on a Java-based, object-oriented application framework. Surface manager, Open Core media framework, SQLite relational database management system, OpenGL ES 2.0 3D graphics API, WebKit layout engine, SGL graphics engine, SSL, and Bionic libc are just a few of the C libraries. The Android operating system, which includes the Linux kernel, has around 12 million lines of code, including 3 million lines of XML, 2.8 million lines of C, 2.1 million lines of Java, and 1.75 million lines of C++. WAVE and CALFIT are used by Android. WAVE is an Android API that makes it simple to administer sensor networks (BSNs) on mobile devices[10].

1.1 Architecture Of Android Operating System:

The Android operating system is made up of a number of different software components. The Linux kernel, native libraries, Android Runtime, Application Framework, and Applications are the main components of the Android Operating System Architecture or Software Stack and shown in Figure 1.

- *Linux Kernel:*The Linux Kernelis the software stack's lowest layer. The whole Android operating system is based on this layer, with a few tweaks from Google. It includes the following features, much as the core Operating System: Process management, memory management, and device management (camera, keyboard, display, and so on) are all things to consider. This layer is how the Android operating system communicates with the device's hardware. Many essential hardware device drivers are also found at this layer. Virtual memory, networking, drivers, and power management are all managed by the Linux kernel.
- *Layer Native Libraries:* Android's native libraries sit on top of the Linux Kernel layer. This layer allows the device to process a variety of data kinds. Data is hardware-specific. These libraries are all developed in the C or C++ programming languages. The java interface is used to access these libraries. The following are some of the most significant native libraries: Surface Manager: This program is used to control the device's display. Surface Manager is a program that allows you to arrange windows on your screen. SQLite is the database that Android uses to store data. It is a relational database that can be accessed by any program. Web Kit is the HTML content display engine of the Safari browser. Playback and recording of numerous audio, video, and image formats are provided via the Media Framework.MP3, AAC, AMR, JPG, MPEG4, H.264, and PNG are just a few examples.

- *Runtime for Android:* Dalvik Virtual Machine and Core Java libraries make up the Android Runtime. It shares the same layer as the library layer [5]. Dalvik Virtual Machine is a Java Virtual Machine that is used to execute apps on Android devices. Every Android application may operate in its own process, with its own instance of the Dalvik virtual computer, thanks to the Dalvik VM. Multiple instances of the Dalvik Virtual Machine may be generated at the same time, offering security, isolation, memory management, and threading support. Unlike the Java Virtual Machine, which is based on processes, the Dalvik Virtual Machine is based on registers. The Dalvik Virtual Machine runs.dex files generated by the dx tool from.class files. The dx tool is part of the Android SDK. DVM is designed for settings with limited processing power and memory.DVM was created by Google's Dan Bornstein.
- *Framework for Applications:*In the form of Java classes, the Application Framework layer offers numerous higher-level services or key APIs to applications. These services are permitted to be used in apps by application developers. These are the building elements that developers' programs interface with directly. The following are important components of the application framework: The Activity Manager is in charge of the application life cycle. Content Providers: This component controls data sharing across apps and how data is accessed from other applications. The Telephony Manager is in charge of all voice call-related functions. Location Manager: This program is designed to manage locations using GPS or cell towers. Manage the different kinds of resources that are utilized in application.
- *Application Layer:* The top layer of the Android architecture is the Applications Layer. Some apps, such as an SMS client app, a dialer, a web browser, and a contact manager, come preloaded on every device. A developer may create his own application and then replace it with one that already exists.

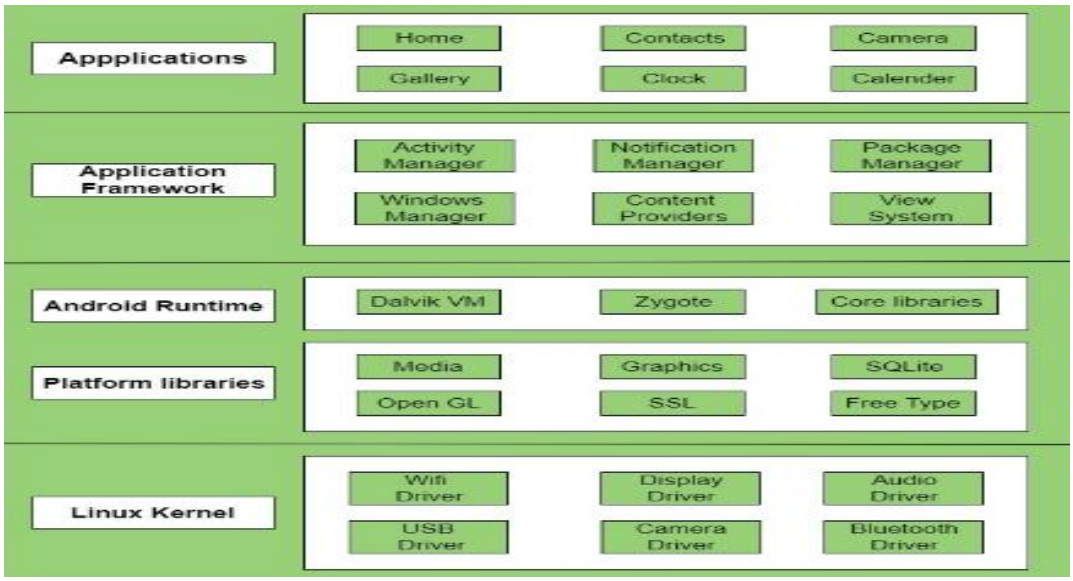

Figure 1: Diagrammatic Representation of Architecture of Android Operating System [GEEKSFORGEEKS]

1.2 Feature Of android operating system :

- *User Interaction:* The Android operating system offers a stylish, appealing, and pleasant user interface.
- *Smartphone Layout:* For the purpose of storing data in databases, SQLite, a lightweight relational database, is utilized. Android supports a variety of connection protocols, including Bluetooth, Wi-Fi, and Wi Max. In the Android operating system, you may send SMS, MMS, and use the android cloud to device messaging infrastructure.
- *Web browser:* The Android operating system's browser relies on web kit, which is combined with Chrome's V8 JavaScript engine to support it.
- *Support for Java:* Although the majority of Android apps are written in Java, the platform lacks a Java virtual machine, therefore DVM is used instead. DVM is optimized for Android and battery-powered mobile devices.
- *Multitasking:* Android offers multitasking, which allows you to go from one program to another or run several apps at the same time.
- *Multitouch:* Android includes native multitouch capability, which was originally introduced in the HTC Hero. Video or still cameras, touch screens, GPS, accelerometers, gyroscopes, magnetometers, proximity and pressure sensors, thermometers, and other hardware are all supported by Android.
- *GCM (Google Cloud Messaging):* Google Cloud Messaging is a service that enables users on Android smartphones to send brief messages to other users. Transferring files, accessing the phonebook, voice calling, and sending contacts between phones are all supported via Bluetooth. Support for keyboard, mouse, and joystick is provided. The many versions of Android operating systems, as well as their versions logos, are given below.

1.3 Security features of android operating system:

- *Linux Kernel:* the Linux kernel underpins the Android operating system. Many research developers investigate, attack, and repair it due to its open source nature. As a result, Linux has developed into a reliable and secure kernel. Android comes with a number of important security measures, including:

a. A permissions model based on the user each file and directory in the Linux file system has three user-based permissions. Other users, group, and owner - The Owner permissions only apply to the file or directory's owner. Group - Only the group that has been allocated to the file or directory is affected by the group permissions. Other users - This term refers to a group of people that aren't Permissions granted to one user are granted to all other users on the system. There are three fundamental permission kinds for any file or directory: read - The read permission indicates that the user has the ability to read the file's contents. Write - A user's ability to write or modify a file or directory is defined by their write permissions. Execute - A user's ability to run a file or see the contents of a directory is defined by the execute permission. This permission model guarantees that while accessing Android files, appropriate security is maintained.

b. Process isolation: The Android operating system gives each Android application a unique user ID (UID) and executes it as a distinct process.

c. Secure IPC extensible mechanism

d. The ability to delete insecure and unneeded kernel components .

- *The Application Sandbox:* A sandbox is a security feature that separates running applications and limits the device's resources to the application. It's often used to run untested code or applications from untrustworthy individuals or websites. Sandboxing is a method that restricts access to a device's resources. As a result, the system's security is enhanced. Sandboxing technology is often used to test unknown applications for the presence of a virus or other malicious code without causing damage to the host device. Untrusted programs can only access those resources of the device for which permission has been given with the aid of sandbox. If it attempts to access the device's other resources, permission is refused.
- *Inter-process communication that is secure*: For inter-process communication, some of the programs still utilize conventional Linux methods like network connections, file systems, and shared files. However, the Android operating system has additional IPC features like as Binder, Services, Intents, and Content Providers. All of these mechanisms enable developers to authenticate an application's identity and define security rules.
- *Signing the Application:* Applications must be digitally signed in order to be installed and operate on Android OS. Android OS uses this technique to identify an application's creator. This functionality may also be used to build confidence between apps. If a program is not correctly signed, it will not be able to be installed on the emulator. To create keys and sign applications, common tools like Key tool and Jarsigner are utilized. apk files
- *Permissions specified by the application and given by the user:* Permissions are a security feature in Android that allows or restricts application access. Android apps have no permissions by default, which keeps them secure by preventing them from accessing protected APIs [14]. Camera functions, location data (GPS), Bluetooth functions, Telephony capabilities, SMS/MMS functions, and network or data connections are just a few of the APIs that are secured. Only the operating system has access to these resources.

2. DISCUSSION

Android has become one of the most significant competitors in the mobile industry because to widespread backing from major corporations, particularly Google. Because smartphones and tablets are so widely used and available, manufacturers may customize the system to meet their specific requirements, including both the hardware and software layers. However, the platform's unpleasant feature, fragmentation, continues to exist. Manufacturers require time to integrate a new version of Android into previously launched devices on the market. Typically, they do not offer constant assistance to everyone. Despite the challenges, a new version is released about once a year. As additional hardware and software firms join the initiative, the scope of the development may expand. It's worth noting that the platform has a lot of support outside of the core Android project. Android is a mobile operating system. In today's economy, mobile phones are popular commodities. Mobile features are determined by software. Because mobile phones are low-powered devices that operate on batteries and are rechargeable, the operating system for mobile phones has played a critical role. The need for creating apps that can operate on mobile devices is increasing these days. Google created Android in order to provide such functionalities.

The Dalvik Virtual Machine makes the runtime environment easier. To build the apps, you'll need Android components. Google created the Android operating system, which was subsequently adopted by the Open Handset Alliance. The Android operating system offers a versatile environment for developing Java apps. This operating system is free, stable, and easy to use.

3. DISCUSSION

It is apparent from the preceding explanation that the Android Operating System employs a number of security mechanisms. When a developer installs an application, it creates a new user profile for that program. Each program runs on its own Dalvik VM instance. As a result, apps are unable to access each other's data. Permissions are required for apps to access shared data or resources. All Android apps are signed, so consumers know they're getting the real deal. Developers may use the signature process to regulate which apps can give access to other applications on the system.

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