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Evolution of Android Operating System

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ABSTRACT: In the past, mobile phones were used to make calls, but the mobile phone has developed into a low-powered portable processing system with the advent of a smartphone. This development was triggered by the mobile phone operating system making them smart who have their own processing and storage. Now the smartphone offers multiple functionalities from calling to text multimedia messaging, emails, device socializing, word processor, sheets of excellence to various multiplayer games and more. For these handheld devices, the operating system is IOS from Apple Inc., Windows from Windows Inc., and Google from
Android. Android holds the largest market share among the competitors in the smartphone operating system industry in terms of units shipped worldwide and number of users. Android is an open source operating system built on the Linux kernel, with applications running on an application framework that manages library-supported operations and a virtual machine that compiles and transforms all Java class files into one file. There can be a lot of virtual machines running at the same time on a single device that handles various applications or application instances. Android operating system provides running applications with memory management, process management, and utilities. Through android update enhanced user experience and brought improved features. This paper presents an analysis of the evolution brought to the android operating system by each launch.

KEYWORDS*:* Android, Android Security, Features, Services, Applications, Java, Mobile phone, Version History.

I.INTRODUCTION

Android is mobile device software and operating system based on the Linux kernel, developed by Google, and later by the Open Handset Alliance. It allows developers to write managed code in the Java language, monitoring the device through Java libraries developed by Google. Android is present in open source format [1]. Android is a freely downloadable stack of open source software for mobile devices which includes a Linux and Java-based operating system, middleware and key applications. Google purchased the Android developer in 2005 and it unveiled Android in 2007. Under the Apache License Google has released the Android code as an open source. Android has many applications (software) written by developers all over the world. First developers write their script in Java, and then download the apps from third party websites or online stores.
With International Data Corporation (IDC) statistical estimates, last year the smartphone industry expanded by 1.1 per cent and more than 350 million units were shipped worldwide by the third quarter of the year [2]. Android has kept a market share of 86.8 percent on the scoreboard. As the market for android phones grows, consumers are worried about choosing and purchasing the phone that meets their requirements at an affordable price. Different vendors are trying to make profit in the present age of competition by using the Android OS because of its consumer acceptance. Every day, efforts have been made to provide an operating system that is compatible with most hardware and provides users with all the required functionality in an efficient way to increase Android development [3]. Every corporation wants to give its Android phones the best quality and improve their features to be its main goal. The enormous use of android leads to the advance method of usability, multitasking, accessibility, protection of end-user-private data and much more, in which each release is expected to address the aforementioned issues [4].

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II.VERSION HISTORY

As of its release, Android is updating day by day. These updates mainly focus on fixing bugs and adding new features to the base operating system to provide a more comfortable environment. Typically every latest version of the Android operating system is created under a code name based on a dessert object. Recent updates included Cupcake and Donut. Android's latest releases are:

1.0 to 1.1:
Android produced its official debut with Android 1.0 in 2008— a release so dated it didn't even have a trendy codename. Things were pretty simplistic back then, but the applications included a suite of early Google apps such as Gmail, Maps, Calendar and YouTube, all of which were incorporated into the OS [5].

1.5 (Cupcake):
With the introduction of Android 1.5 Cupcake in early 2009, the tradition of naming for versions of Android has been born. Cupcake implemented several refinements to the Android app, including the first on-screen keyboard - something that would be inevitable as phones moved away from the physical keyboard layout that was once commonplace. Cupcake also developed the framework for third-party device widgets, which would quickly become one of Android's most distinguishing features, and it introduced the platform's first-ever video recording function.

1.6 (Donut):
Android 1.6, Donut, was rolled into the world in 2009. Donut filled in some important holes in the center of Android, including the ability of the OS to operate on a variety of different screen sizes and resolutions— a factor that would be critical over the coming years. It also added support for CDMA networks such as Verizon, which would play a key role in the imminent proliferation of Android.

2.0 to 2.1 (Eclair):
Revamping the user interface, and introducing support for HTML5 and Exchange ActiveSync 2.5.

2.2 (Froyo):
It implemented performance enhancements with JIT and Chrome V8 JavaScript engine optimization, and integrated Wi-Fi hotspot tethering and Adobe Flash support [6].

2.3 (Gingerbread):
This enhanced the user interface, strengthened soft keyboard and copy / paste features and introduced Near Field Communication support.

3.0 (Honeycomb):
A tablet-oriented update supporting larger screen devices and adding many new user interface technologies, enabling multi-core processors and graphics hardware acceleration. The Honeycomb SDK was released, and in February 2011, the first computer using this version, the Motorola Xoom laptop, went on sale. Google has decided to withhold the source code for development which calls into question this Android release's "openness." Google says this is done to avoid manufacturers placing a tablet-specific OS on phones, much like the autumn before, where smartphone manufacturers put a non-tablet-optimized phone OS (Android 2.x) on their tablets leading in bad user experiences.

4.0 (Ice Cream Sandwich):
It is a version of operating system Android mobile created by Google. Unveiled on October 19, 2011, Android 4.0 builds on the major changes made by the tablet-only version of Android 3.0 "Honeycomb" in an effort to create a unified platform for both smartphones and tablets while simplifying and modernizing Android's overall experience with a new set of human interface guidelines. As part of these efforts, a new visual appearance codenamed "Holo" was introduced by Android 4.0 which is built around a cleaner, minimalist design and a new default typeface called Roboto.

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4.1 to 4.3 (Jelly Bean):
Spread through three impactful versions of Android, the 2012 and 2013 launches of Jelly Bean focused on the fresh base of ICS and made significant steps in fine tuning and building on it. The releases added plenty of poise and polish to the operating system, and made Android more inviting to the average user a long way. Apart from graphics, Jelly Bean produced first glimpse of Google Now — the amazing predictive-intelligence tool that has unfortunately become glorified news feed ever since. It gave expandable and interactive alerts, an improved voice search system, and a more advanced system for generally displaying search results, focusing on card-based results that attempted to respond directly to question [7].

4.4 (KitKat):
Late-2013 arrival of KitKat marked the end of the dark era of Android, as the Gingerbread blacks and the Honeycomb blues eventually made their way out of the operating system. Lighter textures and more subtle highlights have taken their place, with a clear status bar and white icons that offer the OS a more modern feel. Android 4.4 saw the earliest version of OK Google" support — but in KitKat, the hands-free activation prompt only operated while phone was already on, and were either on home screen or inside the Google app. KitKat debuted on Google's Nexus 5 on October 31, 2013 and was optimized to run on a wider range of devices than previous versions of Android, with a recommended minimum of 512 MB of RAM; these improvements were internally referred to as Google's "Project Svelte." The minimum amount of RAM available for Android is 340 MB, and smartphones with a RAM of less than 512 MB will identify themselves as "low RAM" devices.

5.0/5.1.1(Lollipop):
With its Android 5.0 Lollipop update in fall 2014, Google practically reinvented Android once more. Lollipop launched the current Material Design model, adding a whole new look to Android, its devices and even other Google products. The card-based idea that had been spread throughout Android became a core UI pattern that would guide the appearance everything from notifications that now showed up for at-a-glance access on the lock screen to the Recent Apps list, which took on an unabashedly card-based look. Lollipop implemented plenty of new features to Android, such as actually hands-free voice control via the "OK, Google" command, multiple user support on phones, and a priority mode to help manage notification. Unfortunately it changed so much that it also introduced a bunch of troubling bugs, many of which wouldn't be completely ironed out until the release of 5.1 the following year.

6.0 (Marshmallow):
In the big scheme of things, Marshmallow was a relatively minor release of Android one that seemed more like a 0.1-level upgrade than anything that warranted a full-number boost. But it began Google's trend of launching one new version of Android per year and that version still gets its own full number. The most attention-grabbing part of Marshmallow was a screen-search feature called Now on Tap — something that had loads of promise that wasn't fully exploited. Google never optimized the system completely and the next year ended up gradually removing the logo and putting it out of the spotlight [8].

7.0 And 7.1 (Nougat):
Google's 2016 releases of Android Nougat provided Android with a native split-screen mode, a new bundled-by-app notification management system, and a Data Saver feature. Nougat has also introduced a few smaller but still important features, such as an Alt-Tab-like shortcut to snap between devices. Perhaps most crucial among Nougat's updates, however, was the introduction of the Google Assistant— which came alongside Google's unveiling of the first fully self-made tablet, the Pixel, just two months after Nougat's release. The Assistant will continue to be a critical component of Android and most other Google products, and is arguably the biggest move the company is making today.

8.0 And 8.1 (Oreo):
Android Oreo introduced a range of pleasantries to the platform such as a native picture-in-picture mode, a snoozing notification option, and notification channels that provide fine control over how apps will warn you. The 2017 release

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also included notable elements which supported the mission of Google to align Android and Chrome OS and improve the experience of using Android apps on Chrome books, and this was the first Android version to incorporate Project Treble — an innovative effort to create a modular Android code base with the hope of making timely software updates simpler for device-makers.

9 (Pie):
In August 2018, Android Pie's freshly baked scent, a.k.a. Android 9, wafted into the Android ecosystem. Pie's most formative reform was its hybrid gesture / button navigation system that exchanged Android's traditional Back, Home, and Overview keys for a large, multifunctional Home button and a small Back button that appeared alongside it when needed. Pie also included some notable usability features, such as a universal suggested-reply messaging notification system, a new Digital Wellbeing control dashboard and smarter power and screen brightness management systems. And, there was no shortage of smaller but still significant advances hidden throughout Pie's filling, including a more intelligent way to handle Wi-Fi hotspots, a welcome twist to Android's Battery Saver mode and a variety of privacy and security improvements.

Table 1: Versions of Android Operating System

Name	Version	Year
Cupcake	1.5	April, 2009
Donut	1.6	September, 2009
Eclair	2.0	October, 2009
Froyo	2.2	May. 2010
Gingerbread	2.3	December. 2010
Honeycomb	3.0	February, 2011
Ice cream sandwich	4.0	October, 2011
Jellybean	4.1	July, 2012
Kitkat	4.4	October, 2013
Lollypop	5.0	November, 2014
Marshmallow	6.0	October, 2015
Nougat	7.0	August, 2016
Oreo	8.0	August, 2017
Pie	9.0	August, 2018

III.FEATURES OF ANDROID OPERATING SYSTEM

*(1) Storage:*SQLite, a lightweight relational database, is used for storing the data.

*(2) Connectivity:*Android supports GSM EDGE, IDEN, CDMA, EVDO, UMTS, Wi-Fi, LTE, NFC, and WI MAX networking technologies.

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(3) Messaging: SMS and MMS are available ways of messaging including threaded text messaging and Android Cloud to Mobile Messaging (C2DM) and now updated version of C2DM, and The Google Cloud Messaging (GCM) is also part of Android Push Messaging.

*(4) Multiple language support:*Supports multiple languages.

*(5) Web browser:*The web browser available in Android, combined with the Chrome V8 JavaScript engine, is based on the open source Web Kit software engine. The browser scores 100/100 on the Android 4.0 Acid3 Check [9].

*(6) Java support:*While most Android programs are developed in Java, the platform does not have Java Virtual Machine, and Java Byte Code is not executed. The Java classes are compiled into Dalvik executable and run on Dalvik, a modified virtual machine specifically designed for Android and optimized for mobile devices with limited memory and CPU battery power. Support for J2ME may be provided through third party applications.

*(7) Multi-touch:*Android has native multi-touch support that was originally made accessible in handsets such as the HTC Hero. Originally, the feature was disabled at the kernel level (possibly to avoid infringing Apple's patents at the time on touch screen technology). Google has since released an update for both the Nexus One and the Motorola Droid that allows native multi-touch.

*(8) Bluetooth:*Supports A2DP, AVRCP, file sending (OPP), phonebook access (PBAP), voice dialing, and phone-to-phone touch sending. Keyboard, mouse, and joystick (HID) support is present in Android 3.1 + and early versions through the customization of manufacturers and third party applications [10].

*(9) Tethering:*Android supports tethering which makes it possible to use a phone as a wireless / wired Wi-Fi hotspot. This had been supported by third-party applications or manufacturer customizations prior to Android 2.2.

IV.CONCLUSION

The market for smartphones is rising every day with Android being the most popular platform and having the largest market share for use and number of units shipped worldwide, which is 350 million units and 86.8 percent market share. Android has grown rapidly over the past 4 years becoming the most used smartphone operating system in the world. It's because Android doesn't release 1 phone from 1 company with 1 new OS every year, but countless phones from numerous companies, adding their own twist, throughout the year, developing gradually day-by-day. Android's configuration feature is unparalleled compared to Apple's and Microsoft's software that allows users to change and customize almost every aspect of Android that most iPhone and Windows 7 users wouldn't dream of.

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