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A Comparative Study of Mobile Operating Systems with Special Emphasis on Apple iOS

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Abstract: **In the era of technology, the usage of mobile phone has increased tremendously. In today's world, everybody from a lay man to an industrialist is using a mobile phone. It becomes more challenging to provide best features and easy to use GUI to its customers for the mobile industries. A simple mobile phone convert to smart phone with highly advanced features like high resolution touch screen display, WiFi connectivity, capability to access the web browser and ability to run sophisticated applications. Every smart phone needs an operating system to run its services like making call, sending or receiving SMS, playing games, web browsing etc. Smartphone's needs the operating system to run all services. Operating system is act as a heart for the Smartphone's. Android, iOS, Blackberry operating system and Windows operating system are the some popular operating systems. In this paper we have reviewed and comparative study on smart phone operating systems android, iOS.**

Keywords: **Mobile operating System, Android, iOS,**

I INTRODUCTION

Nowadays, technology is heavily used by human being in every area. As people move from one place to another, many wireless technologies are innovated to remain in contact with other people, without regard of the location. The increasing acceptance of Smart Phones has drawn the attention of almost everybody. Along with making and receiving calls, user is able to send and receive SMS, access Internet, digital media, incorporate audio/video recording etc.

Smartphone's transformed the way of communication with each other by simple call to video call, video conferencing, sharing any format of data and many more [1].

Following are a few common facts that come useful to a buyer when he/she is buying a Smartphone:

1. A mobile operating system (OS) is hearts that runs and manage all the other programs in the Smartphone's. It is initially loaded by a boot program on the device (Smartphone). The other programs that are run by the OS are called applications or application programs.
2. A mobile operating system is a system software program which is specially designed for the mobile devices, tablets etc. it provide the platform to the developer to create various applications that fulfill the user requirements.
3. There are number of mobile operating systems like Android, iOS, Windows Phone, Blackberry.
4. The most popular operating systems for smart phones and tablets Apple's iOS and Google's Android.

The rest of the paper is organized as follows: section 2 presents the Brief History of iOS, section 3 presents scope of iOS app development, section 4 presents iOS security overview, section 5 presents comparison with android, section 6 presents interesting facts, figures and statistics.

II BRIEF HISTORY OF IOS:

In 2005, when late Steve Jobs (Founder of Apple), was under the process of making the iPhone, he basically had two main options.

- Either he could make a miniature version of Mac Book or
- Enlarge the iPod's software which was Apple's main portable product at that time.

So, in order to decide which one would be a better fit for the iPhone, Steve assigned two different teams within Apple to take both options into consideration, the team in charge of scaling down the Mac created the iPhone OS now known as iOS. Steve Jobs decided to go with the scaled version of mac primarily because of two main reasons; the first one being that the macOS was already complete and it had much functionality that were already ahead of its competition. So, building a new one didn't seem like the optimal solution when you can just optimize the OS running on the Mac Book and get it to fit in a smaller package. The second one being; Steve wanted an OS that could easily integrate with other Apple's devices.

Such deep involvement is rare for a modern CEO, which raises a question that how exactly did Steve know the software so well? This calls for a little more detail as it turns out that MacOS was actually made from the remnants of software called "NeXT Step" which was developed by Steve Jobs when he was fired by Apple in 1985. In 1987 Apple bought NeXT Step which brought Steve Jobs back as the CEO. Over the years, NeXT Step was developed further too finally become MacOS which as we know finally became iOS.

App Store

The App store is like a shop for all sorts of third-party applications be it games, entertainment etc. develop by various developers world-wide and offered to end users by iOS in iPhone, iPad and iPod as all these three Apple's devices runs on the same platform – iOS.

These applications are developed by individuals as well as large organizations specifically dedicated to app development. Once the app is developed it is then submitted to Apple. Apple on its end reviews the applications on multiple stringent parameters and makes sure that the app complies with all the strict standards laid down by Apple and also doesn't carry any malware or The app store itself is the most popular application on iOS which allows the user to choose between more than 2 Million Apple verified third-party applications [2]. Users can find applications about almost anything. Google, Facebook, Microsoft, Amazon are all big names and they have multiple applications listed under their banner on the App Store.

III SCOPE OF IOS APP DEVELOPMENT

Mobile app development is a "Hot Cake" in the market today, with the increase in the demand for Smartphone's there is a dire need for app developers. iPhone, iPad, iPod are one of the most popular tech gadgets in the technological industry and they rely on iOS to serve as an operating system. This is one of the major reasons why iOS app developers are highly demanded.

The reason why iOS is such a lucrative platform for app developers is primarily because of the revenue that comes with it. The buying behavior on the iOS App Store is a lot more favorable to the developer as compared to any other platform out there and this is the main driving force behind the rising popularity of iOS App development. Here are some key reasons why iOS is all set to become the future of mobile application development:

- **Swift –** The foundation of app development lies in the programming, if that is weak; the app will not be a great one. Swift is a relatively newly launched programming language which has great demand in iOS app development. The language promises and delivers great results with minimal coding.
- **High quality Simulators** – iOS simulators are definitely faster when compared to other OS, especially Android's Emulator, simply because Apple only allows programming an iOS on a mac and not on any other platform and the fact that iOS and macOS have many thing in common makes it even better.
- **Less time consumption** – Since iOS is supported by Swift, which requires shorter codes to do a specific task and faster simulators it requires way less time to develop an app on iOS platform.
- **Minimal Fragmentation** – Even a flawlessly designed app in Android can contain bugs because they have to deal with too many brands, screen sizes, screen types, different processors and many important things. But this is not the case with iOS, as there are limited numbers of devices with limited screen sizes as a result there no or few bugs found in iOS applications.

harmful intent. If the application is approved by Apple then only it is listed on the App Store. The developers have the freedom to decide the price of the application that they want the customers to pay or they can also make the app available for free just like majority of the applications like: Instagram, Snapchat, Fortnight, Pokémon GO, and Amazon etc. Also, the publisher can have some "In-App" purchases i.e. the app will remain free to download but after downloading the app the user can make some purchases. In case of paid applications, apple keeps 30% of the revenue generated and the remaining 70% of the revenue is given to the publisher.

- **Giant Revenues** – Many surveys have found that devices that run on iOS are bought mostly by high income group people, thereby increasing the chances of spending on quality apps and eventually creating more revenue for the developers.

IV IOS SECURITY OVERVIEW

iOS has been one of the most popular mobile OS globally, ever since it was first released in 2007. Apple is rightly famous for providing top-notch, world-class security features; one of the prime reasons is because Apple creates products with integrated hardware, software (iOS) and services.

iOS makes full use of numerous security features present in both software and hardware. Following are the summary of the most eminent features:-

- Secure Booting process – During the booting procedure, iOS uses a mechanism called "Secure Boot Chain" which ensures that the software is not compromised and that iOS is running on an approved iOS device. Each step in Secure Boot Chain confirms that next step is authorized and signed by Apple, thereby making it tough for intruders to hack though the booting process.
- Secure Enclave – It is a coprocessor that comes fabricated with a Unique ID (UID). It is responsible for decrypting and processing the fingerprints received from the Touch ID and verifying that whether the fingerprints received matches with the registered fingerprints or not. Same process applies with the Face ID as well.
- Passcode – iOS supports six-digits, four digits and alpha numeric passcodes. By enabling passcode protection on an iOS device, the user automatically enables data protection. There's also some delay enforced according to the number of attempts to slow down the "Brute force" attempt to find the passcode.

Delays imposed between passcode attempts

Attempts	Delay Enforced
1–4	None
5	1 minute
6	5 minutes
7–8	15 minutes
9	1 hour

A six-digit passcode would take more than five years to try all the combinations. If Settings > Touch ID & Passcode > Erase Data is turned on, all the data will be erased if ten consecutive incorrect attempts are made to enter a passcode.

- **Touch ID** – It is a fingerprint scanner that is embedded in the home button that can be used for unlocking the device, making payments, purchasing apps from the app store and making secure payment through Apple Pay. Touch ID temporarily stores the fingerprint data in an encrypted manner in the Secure Enclave, as described above. This technology reads fingerprints of the user from any angle and learns more about user's fingerprint over time, the sensor expands the fingerprint map overtime with each use.
- **Face ID** – Slightly more secure and reliable than Touch ID, it unlocks the Apple device with a simple glance that have the feature. It is powered by True Depth camera, which uses breakthrough technologies to accurately and precisely map the geometry of your face. It uses neural networks to determine attention and anti-spoofing. Face ID automatically adapts to the changes in your face and safeguards your biometric data.
- **Key Chain** – It is like an advanced extension of a Password Manager, which safely and securely stores the confidential data of the user like login id, password all these data is securely encrypted using a AES 128 in Galois/Counter Mode (GCM) and is stored in a special secure memory area in which all these sensitive information is stored.
- **App Security** – Third party applications distributed through App Store are code-signed with an Apple-issued certificate. This continues the chain of trust all the way from the Secure Boot process as mentioned above to the action of the applications installed on the device by user. Apple verifies the identity of all the developers before allowing them to participate in the Apple Developer Program. Apps in App store are reviewed by Apple to ensure they don't contain any malicious code or compromise the privacy of the user.
- **Sandboxing** – This technique basically means that each and every app runs in own walled-off space(Sandbox) where it can do what it intends to do, but cannot interact with other apps. This means even if the app did carry a malware or malicious code, the attack couldn't get outside the sandbox to do more damage.
- **iMessage Security** – It is a messaging service for devices running on iOS, macOS, watchOS devices. Users can exchange texts and attachments like photos, videos and documents. When a user turns on iMessage on a device, the device generates two pairs of keys for use with the service: an RSA 1280-bit key for encryption and an ECDSA 256-bit key on the NIST P-256 curve for signing [6]. The private keys for both key pairs are saved in the device's Keychain and the public keys are sent to Apple identity service (IDS)
- **Two-factor Authentication** – It is a security feature enforced by Apple to make sure that even if a person somehow knows the Apple ID and password combination, they cannot gain access to the account as Apple sends a verification code that is send to an already trusted device so that the owner of the Apple ID can deny the access to the unrecognized device.

V COMPARISONS WITH ANDROID

The Smartphone battle is been going for decades now, two different philosophies, two different concepts, two different types of users and almost two different worlds. One side values openness, options, customizations and flexibility – this is Google's Android. The other side values ease of use, simplicity, stability and consistency – this is Apple's iOS. The rivalry between these two Operating Systems is world famous and also personal to majority of the population who owns a Smartphone. **Android** is an open-source operating system developed by Google. Currently Android is having the largest market share with about more than 85% of the Smartphone's running android globally [4] and Google is not looking to lose its humongous lead any time soon. Android is the preferred OS for the majority of people simply because it comes with plethora of choices in terms of: brand, price segment, customizability etc. Few advantages of choosing Android over iOS are as follows:-

- Better multitasking capabilities.
- Highly customizable (notification, widgets, launchers).
- Active "Root" community.
- Slightly more apps on the Google Play Store.
- Pricing choice – From easily affordable range to the premium segment.

iOS on the other hand is a closed-source operating system developed and marketed only by Apple i.e. iOS is made to be used only on Apple's devices which is not the case with Google's Android. It's true that Android has a considerable market share. But we also can't deny the significance of iOS platform. Also, when it comes to applications comparison i.e. Google Play & App Store, Android apps are leading in numbers but when it comes to the revenue earned iOS is a clear winner. With about 18% market share and combined share of 99.6% with Android [7], Apple's iOS is one of the most happening operating systems of the world and here are some of the advantages of choosing iOS over Android apart from the simplicity and consistency that it offers:-

- Convenience of syncing your content among various iOS/macOS devices.
- Greater level of security and privacy.
- Faster iOS updates for all at once, globally.
- Mostly, applications are released first on Apple's App store and offers better integration.
- Seamless user experience (No or minor lags).

iOS vs. Android is simply a choice between simplicity and consistency offered by iOS and flexibility and customizability provided by Android OS.

Basis	iOS	Android
Source Model	Closed-source	Open-source
Developed in:	C,C++,Objective-C,	C,C++,Java
Initial release	29-July-2007	23-Sep-2008
Latest stable release	iOS 12.1.4, 7-Feb-	Android 9 (Pie),
OS Family	Darwin	Linux
Voice Command	Siri	Google Now
SDK Platform	macOS	Linux, macOS,
IDE	Xcode	Eclipse
Runs on	Only Apple's Hardware like iPhone,iPad	Various distributors apart from Google like: Samsung, Motorola, OnePlus etc.
Security/ Privacy	Highly secure and offers advance level of soundness and reliability	Offers weaker level of safety and protection
Official Application Store	App Store	Google Play
Update Method	iTunes or OTA	Over-The-Air
Available in	40+ Languages	100+ Languages
CPU Architecture	ARM, x86, MIPS	ARM 64
Market Share[7]	13.2%	86.8%
Market Size	High	Very High
Documentation available at	www.apple.com/ios/	www.android.com

VI INTERESTING FACTS, FIGURES AND STATISTICS

- As of 2019, Apple is the only public company in the world right now to be valued at $1Trillion and second company in the world to do so in the history of mankind.[9]
- Apple has got $178 billion of cash reserve which is more than enough to buy all of Uber, Ola, Space X, Tesla, Twitter, Netflix, Snapchat, Airbnb, and would still have around $20 Billion leftover. These figures are regarding only Apple's Cash-in-hand and not including any asset or stock valuation of the company.[9]
- Apple sells about only 18% of the smartphones (iPhones) globally and earns 87% of the profit generated by smartphone industry.[10]
- As of 1st Jan, 2019, more than 75% of iOS users have upgraded to the latest software version (iOS 12) within 4 months of its release compared to 6% of Android users (Android Pie, 9) using the latest Android version in about 11 months.
- Facebook is the most popular app of all time on iOS devices followed by Facebook Messenger, YouTube and Instagram.

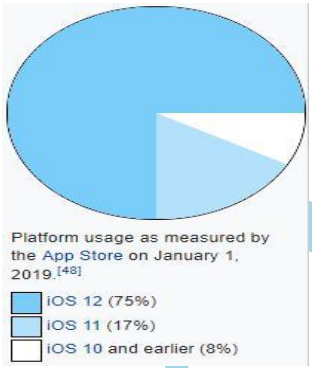

Fig. 2 – Usage of latest iOS version [11]

Fig. 3 – Most popular apps on App Store

VII CONCLUSION

iOS is a mobile Operating System that is developed and marketed by Apple and it is the second most widely used OS used but arguably the best one yet which has more than 1 Billion active iOS devices as of 2016[11]. Through this literature review we have discovered the history about how iOS came into existence from macOS, which in turn was developed from the remains of NeXT Step and how iOS has evolved over the period of time with every new release and is famous for want it is now. This paper covered how the positives of iOS App development overpowers its negatives as well as the positives of its competitions also giving you a detailed analysis about how iOS stacks with its contender – Android, followed by eye opening facts and figures about Apple and its iOS

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