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Comparison of Mobile Operating Systems

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ABSTRACT: Mobile operating system is the heart of smart phone. Various mobile operating systems like Android, iOS, Windows Phone, Blackberry, Tizen, Sailfish OS, Ubuntu Touch, Firefox OS are available. Each of them has some common as well as unique specialized features. In this paper, we have considered four most commonly used operating systems, viz. Android, iOS, Windows Phone and Blackberry. We have discussed their various features like App support, OS updates, voice assistance, cloud services, map, camera, voice assistance, security, market share, customization rights etc.

KEYWORDS: Mobile operating System, Android, iOS, Blackberry, Windows phone, slide loading, customization.

I. INTRODUCTION

Technology is getting really advanced now-a-days and it is also becoming the most important part of our lives. In the early years mobiles phones were only capable of sending and receiving text messages and calls for communication purposes. However, times have changed and so has the face of mobile phones. Not only are the screens bigger and better in quality, but also is the internal hardware grown to such an extent that it can perform on levels in laptops and computers. Guess it is safe to call mobile phones a handheld computer that is able to configure daily schedules, save large documents, watch videos online, listen to music, use the internet and much more than the human mind can think of. Today smartphones carry all the features of a digital device as well as common phone features. As we can see, over the decade, smartphones have taken the world by storm, and recently tablets have entered the arena as well. Smart phones have transformed the way we access information and communicate with others. This not only depends on the device hardware but basically on the software these devices can run and especially their operating systems. Now, there is a lot of fanfare when it comes to which mobile OS is the best. Following are a few common facts that come handy to a buyer when he/she is at the brink of buying a smartphone:

- An operating system (OS) is a skeleton program that runs and manages all the other programs in the computer. It is a program that is initially loaded by a boot program. The other programs that are run by the OS are called applications or application programs.
- A mobile operating system is a base infrastructure software program specifically designed to run on mobile devices, tablets etc. It is a software platform on which developers create various programs or applications that are run and managed by the mobile OS.
- There are eight operating systems currently in working position namely; Android, iOS, Windows Phone, Blackberry, Tizen, Sailfish OS, Ubuntu Touch, Firefox OS. The discontinued software platforms are namely; Bada, Symbian, Windows mobile, Palm OS, Web OS, Maemo, MeeGo, Limo.
- The most popular and trending operating systems for smart phones and tablets in this era are Apple's iOS and Google's Android and are the only ones showing growth and potential.

II. POPULAR MOBILE OS PLATFORM

Before we get into the details, here is a quick summary of the major operating systems that will be compared in the paper in the later sections:

A. ANDROID

Android is a mobile operating system currently developed by Google and designed primarily for touchscreen devices such as smartphones and tablets. Android was initially released on 23rd September, 2008. Android released

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its latest OS version known as Android Marshmallow on 5th October, 2015. Android is an open source operating system, meaning its source code is made available to the manufacturers with an Apache Licence 2.0, in which the copyright holder provides the right to study, change and distribute the software to anyone and for any purpose.

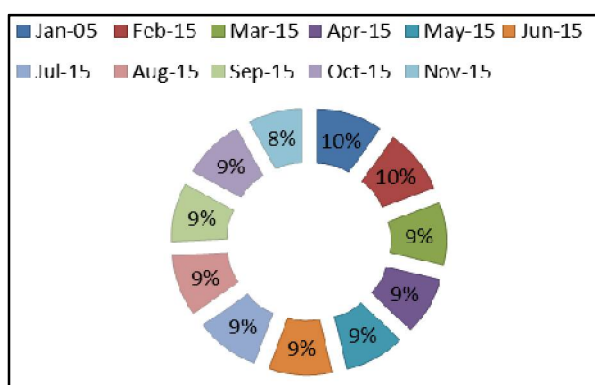


Figure 1. Market Share Percentage of Android

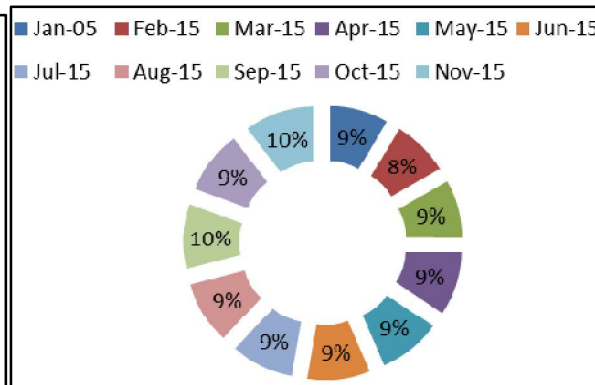


Figure 2. Market Share Percentage of iOS

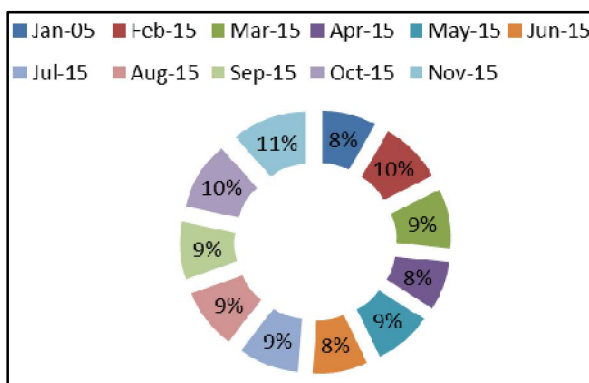


Figure 3. Market Share Percentage of Windows

Android is coded in C, C++ and Java programming languages. Figure 1 shows how the market has treated android in the year 2015.

B. iOS

iOS is a mobile operating system developed by Apple Inc. and designed primarily for touchscreen devices such as smartphones and tablets. iOS was initially released on 29th June, 2007. iOS released its latest OS version known as iOS 9.1 on 8th December, 2015. iOS is a proprietary operating system or in layman language closed source, which means its source code is not available for developers to develop applications or to build their own version of OS based on it. iOS is coded in C, C++ and Objective C programming languages. Figure 2 shows how the market has treated iOS in the year 2015:

C. WINDOWS

Windows is a mobile operating system currently developed by Microsoft Corporation and designed primarily for touchscreen devices such as smartphones and tablets. Windows was initially released on 8th November, 2010. Windows released its latest OS version known as Windows 10 on 20th November, 2015. Windows is a closed source or proprietary operating system. Windows is programmed in C, C++ programming languages. Figure 3 shows how the market has treated windows in the year 2015.



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D. BLACKBERRY

Blackberry is a mobile operating system developed by Blackberry Ltd. Blackberry was initially released on 30th January, 2013. Blackberry is a closed source or proprietary operating system. It is programmed in C, C++ and Java programming languages. Now let's discuss about how the market has treated blackberry in the year 2015:

Blackberry 10 saw a small increase in some regions, but its global growth gradually decreased. Its market share graph declined gradually from 0.5% to 0.3% and unfortunately to 0%.

Touch, Samsung Tizen and Sailfish OS. However, we are hoping that Firefox gains as much success as has other successful operating systems have in the future.

III. COMPARING MOBILE OPERATING SYSTEMS

How do you determine what makes a good OS? What makes any comparison between any operating systems not just about favouritism? Is it even possible to arrive at a scientific conclusion to this question? If we look at the entire ecosystem of mobile operating systems, Android and iOS are the obvious choices for buyers because of the sheer amount of applications they have available and the highest level of publicity they have gained. However, what is that got to do with an answer to the question: "What's the best designed creatively unique OS?" We believe it is quite possible to compare operating systems based on features, functionality and the implementation of those features or its usability.

In what follows, we will take a comparative tour of 5 mobile operating systems by comparing them with respect to their features one by one and come to a respective conclusion which will be helpful in clearing out the confusion that lingers around the question: Which smartphone OS is the best?

A. APPLICATIONS AND APP STORE USABILITY

No comparison is complete without comparing the number of applications each OS offers and the total number of downloads it gets. Apps and app store can make or break an operating system. Let's just keep windows phone, blackberry and Firefox out of the running here right now because they trail way behind android and iOS when it comes to overall app count and app quality. The tough competition here actually is between iOS and Android.

- Number of android apps: 1.3 Million
- Number of iOS apps: 1.2 Million [1]

iOS has a more lucrative platform for developers and is easier to develop for. Also, there is a tendency for new applications to appear there first. Spotify runs all its new videos in iOS first and Instagram releases all its new versions and updates on the iOS first. However, this scenario is changing very rapidly as Android's market share and popularity is continuously growing [1]. Google play store has a high percentage of free apps than the iOSApp store but it also introduces malware and malicious apps into the store due to its openness and it also consists of app clones that Google is trying to amend. However, when it comes to app quality, we have to give it to iOS.

- Number of windows store apps: 500,000

And then there is windows phone. Windows lags a distant third when it comes to app stores. It does contain all the big shot applications that maximum of the people use on a daily basis, but they are very rarely updated. Developers seem to release an app saying it now supports windows, but then turn their attention back to android and iOS [1].

Blackberry 10 announces a new dawn for applications on blackberry. Earlier, the developers tirelessly tried to develop something out of the box and unique. Now the result has been nothing but outstanding. Smooth and fast 3D games now populate the Blackberry world [2]. Functional applications of wide variety are also available including, finance, location, health, audio, photography, news, social, and plenty of others. Thanks to the dedicated runtime, now android applications can also be run on Blackberry and the tech-savvy users can also side load applications on their devices about which is discussed in the next feature [2]. All in all Blackberry 10 is not far behind iOS and Android when it comes to applications and app store usability.

B. SIDE LOADING

Side loading opens up the device to more applications than are available in the respective app stores. Not only does side loading introduce access to unreachable apps by app store but it also introduces malware and poses threat to the device since most of the time third party apps are not screened for malware. In Android, Side loading basically refers to installation of an APK file package onto the android device, initially downloaded on the computer. To enable side loading on android, the end user is required to simply check a box named "unknown sources" in the OS settings.



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Earlier, in iOS the end user was required to jailbreak the operating system in order to side load apps. However, now, all the user has to do is install Xcode and design and run their own applications [3]. Xcode is an integrated development environment (IDE) containing a suite of software development tools developed by Apple for developing software for iOS. Windows phone 8.1 didn't have the option to side load apps since the windows phone users stuck to their very own app stores fearing malware and viruses. However, the scenario has changed when windows phone 10 got released and with it came the option to side load apps on the device and also run the device on developer mode. Usually the windows SDK is required to test the app before launching it in public but now thanks to the windows 10 update; end users can use the same package or pre-launched app in their devices by enabling a simple option in the update and security option in the phone settings [10].

Ever since the release of Blackberry OS 10, the mobile phones support APK files on Blackberry devices which allows the users to use android applications on Blackberry, which eliminates the need to side load applications [2].

C. BATTERY LIFE AND MANAGEMENT

As one of the biggest vexation for smartphone owners, battery life is a huge factor. We know the fact for sure that heavier the operating system is, more is the battery consumed. Now, one of the heaviest operating systems today is Android. It's not the operating system that consumes the battery, it is how many applications the user has going on at any particular period of time [8]. There are two reasons why the iPhone consumes less battery. Firstly, if the user quits an app on android, the process might still be running in the background and hence consumes more battery. This is not the case with iOS. iOS provides the list of apps that consume battery in the background and provides an option to shut the door on them. Secondly, apple brews in-house hardware (Application processor) as well as operating system for the device which allows them to have fine tuning for power optimization [9]. Blackberry has a moderate battery usage and will get you through the day. However, the phone is required to be charged once 24 hours have passed. Blackberry OS also offers a great amount of standby time. Blackberry OS provides an option wherein the running of applications in the background can be decided by the user. Also, the running of android applications in Blackberry OS drains a lot of battery.

D. CUSTOMIZABILITY

In iPhone what you see is what you get. iOS has only one interface. However, that is not the case with android. Android has as many user interfaces as there are manufacturers. With the open architecture of Android, the options are practically unlimited for customization. Since Apple is the only manufacturer for the iPhone, interface options equal one [5]. iOS allows a few selected widgets to be applied on the notification panel whereas in Android the user can choose from thousands of widgets from music playback to weather and note-taking [1]. Better still Android allows the user to install new launchers or add a custom theme for the OS and keep multiple home screens which makes the phone look completely different. In order to unlock various customizations in iOS, the iPhone needs to be jailbroken which is not the first choice for most of the users. With windows phone, the only customization that the user gets is the resizable live tiles, various color schemes to choose from and the addition to add background images [1]. Microsoft has gradually improved the keyboard but is still locked down to its default to option. Also, android allows third party apps to be set as default for different kinds of things whereas the same customization is locked in windows and iOS. Alike iOS, customization options in blackberry OS as well, are limited. The only customizations that are available for the user in Blackberry OS are very much similar to iOS. For example, the user can change the options in the notification panel, and can add a few more shortcuts in it [1]. When it comes to customizability, Android takes the cake. Customizations can be added to iOS, Windows phone and blackberry OS up to a certain level with the use of applications but they none of them can win a fight with android on this feature.

E. OS UPDATES

All four platforms are regularly updated. There are big releases and then there are smaller releases. The big releases offer new features and occasional re-designs every few months. The smaller updates are released with greater number of frequency in order to deal with bug fixes [1]. Microsoft and Apple have greater control over their softwares and hence it is easier for them to roll out updates due to which users are able to update their OS in a timely fashion. Apple is not completely free of fragmentation, since it leaves behind a few devices whenever new software comes out, but it does better than Google, Blackberry and Microsoft. Apple is exempt [1]. In case of Windows, a Windows 7 phone cannot be upgraded to windows 8 or 9 but smaller updates like 8.1 or 8.2 can be installed. While in case of android, Google devices like Nexus phones and Motorola devices get the latest updates quickly, but devices other than these



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might not even get an update. Blackberry OS updates are released regularly [1]. The Blackberry OS updates are not as regular and as good as Apple OS updates but not as irregular as Google and Windows OS updates. According to the latest count, 0.5% of Android devices are running on Android Marshmallow 6.0 and 7% of windows phones are running on Windows 10 mobile, compared to 71% of iOS devices running iOS9 [1].

F. SECURITY AND RELIABILITY

All the operating systems have advantages and disadvantages. Currently, windows phones OS seems to be the hardest nut to crack [4]. Being proprietary, security comes in handy. If a malicious user has physical access of any device or attack is to be made over a network or via email then Android is usually the easiest and softest target [4]. Then comes iPhone and then the older versions of Blackberry. Blackberry has a long history of being very security-focused. Blackberry has different and unique unlock methods which makes it very secure. Android being open source, introduces tons of malware issues and bugs into the system. Most of the android users do not encounter any issues because they don't go beyond the Play Store. However, still Android is the least secure device only because it is open source. Apple secures its devices using Touch ID [1]. The tight lapse that Apple has on apps and the ability to push updates out to most of the devices, more quickly, gives it a definite advantage over Android, Windows and Blackberry.

G. CLOUD SERVICES

Cloud Services are one of the important factors for every smartphone. Cloud Services are internet based services where resources are shared and shared data is provided to the computer or smartphones which are connected to the service [6]. The cloud service used for Apple is known as iCloud and it works beautifully and seamlessly within the Apple ecosystem. It's extremely user-friendly. The user is able to access all the digital files and media anytime and from any one of their Apple devices without having to manually sync them.

H. MAPS

Most smart phones have full GPS capability on board, so navigation is a natural use for that. All that a user needs to get going is an application that assists in finding directions and in navigation. There are many options for all smart phone platforms like Google maps, Here maps, Apple and Blackberry maps as well but they don't run in some countries. Blackberry maps are good but lacks with lot of features [1]. Google maps and here maps are best of all maps used across all smart phones. Offline maps have so many benefits, ranging from avoiding roaming charges to faster, more reliable operation. Offline mapping is available for both Google maps and Here maps, but Google maps have limited functionality whereas here maps are best used offline. In navigating offline Google maps only offers the car option whereas Here maps offers all three options - Car, Walk, Transit [1].

I. VOICE ASSISTANTS

Each of the OS platforms has its own voice assistants, which are getting smarter each passing year. Google Now gives best results for web searches. It also provides with summaries of information that interests the user. Google Now also sets interests for the user according to their choice and makes it easily accessible to them. Unlike Google now, Siri lacks in web searches. It mainly concentrates on actually being an assistant to the user. When asked about a particular location, Siri comes up with different locations misinterpreting the actual location. Blackberry voice assistant assists the user best with emails, reminders, events, contacts, all basic commands like turning on Bluetooth or wifi, basically including all business needs of the user. Alike Siri, blackberry assistant is also not good with location based queries. Cortana, out of all the above operating systems, is the best voice assistant. Mainly because, it interprets the queries perfectly and replies with an accurate answer. It provides best and accurate results for location based queries.

J. CAMERA

Is Camera an important factor when buying a Smartphone? Yes it is an important factor. It's not that all the time user carries a DSLR and what if a photo opportunity arises? However, everyone carries their phone all the time. So let's open a discussion on which OS is best for camera. The 12-megapixel camera in the iPhone 6s has been numerically surpassed by all smart phones, but there's more to a great camera than just the megapixel count. Apple does the best job capturing lighting, colouring, and other details. "Live photos" is an amazing feature of newly arrived iPhone 6s. However, photos taken from Windows phone 10 (Lumia 950 XL) are simply amazing – it has excellent details, rich colours and minimal visible noise. The camera interface is easy-to-use and you can get manual control access with a simple swipe. The User can install additional lenses from Windows store for expanding the features of Windows

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camera app. The Android Camera app is not that great and nowhere near as feature-rich, and in-effect, as functional, as the camera apps on other platforms, BlackBerry and Windows Phone included. The Blackberry smartphones camera is no such great like iPhone. However, the pictures taken from this Smartphone are not bad at all. The interface is straightforward and doesn't have an overabundance options, but all the important features are present. There are a handful of scene modes and four shooting modes: normal, Time Shift, Burst, and Panorama.

Table 1.shows the comparison of mobile operating system based on the various parameters.

Table 1. Comparison of different Mobile OS

		Mobile Operating System			
		Android	iOS	Blackberry	Windows
PARAMETER	Vendor	Open Handset Alliance	Apple	Blackberry Ltd.	Microsoft
	Symbol				
	Official Site	www.android.com\	www.apple.com\ios\	Us.blackberry.com/apps-software/blackberry7\	www.windowphone.com\
	Developed in programming Language	C, C++, Java	C, C++, Objective-C, Swift	C, C++, HTML5, Javascript, CSS, ActionScript, Java	C#, VB.NET, F#, C++, Jscript
	License	Open source	Proprietary	Proprietary	Proprietary
	App Store	Google Play	App Store	BlackBerry World	Windows Phone Store
	No. of App	1.3 million	1.2 million	234,500	500,000
	Side loading	Available	Done by installing Xcode7	----	Available with windows phone 10, not in earlier version
	Battery Demand	Highest	Less	Moderate	Least
	Customizability	Highest	Provide few option (allows a few selected widgets to be applied on the notification panel)	User can change the options in the notification panel, and can add a few more shortcuts in it	Allow re-sizable live tiles, various colour schemes can be chosen in addition to background images
	Security	Softest to crack	Hard to crack	Hard to crack	Hardest to crack
	Voice Assistance	Google now	Siri	Blackberry voice assistance	Cortana

IV. CONCLUSION

Every mobile operating system has its own features. Being open source with highest degree of customization widespread the use of Android OS. At the same time, because of this peculiarity, it became more prone to bugs and malwares. On the other hand iOS is the proprietary and provide little option for customization. Thus launching updates or addressing security concerns is comparatively easy. Blackberry and Microsoft phone are bit behind in a race but they are coming up with the updates using which the existing issue scan be resolved.

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