

# COMPARATIVE ANALYSIS OF SMART PHONE OPERATING SYSTEMS ANDROID, APPLE iOS AND WINDOWS

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## Abstract

A smart phone is a mobile phone with highly advanced features. A smart phone has a High resolution touch screen display, WiFi connectivity, web browsing capabilities and the ability to accept the sophisticated applications. The majority of these devices run on any of these popular mobile operating systems such as Android, iOS, Blackberry operating system and Windows operating system. Today the smart phone world is categorized into three aspects depends upon the mobile operating system which is used in a particular smart phone. These three major mobile operating systems are Android from Samsung, iOS from Apple and Windows from Microsoft. Technology and features may varies from one type of mobile operating system to another type of mobile operating system. This paper produces a comparative study on smart phone operating systems Android, iOS, Windows.

**Keywords:** Mobile operating system, Android, iOS, Windows.

## 1. History:

The term smart phone was first described by the company Ericsson in 1997. The term was given to the handsets which has difference from other feature handsets.

The most significant difference was that the advanced “Application Programming Interfaces (APIs)”. The first phone to feature cellular + Personal Digital Assistance (PDA) was developed by IBM in 1992 naming ‘simon personal

communicator’ which could be referred as ‘smart phone’. Later in 1996, Nokia released ‘Nokia 9000’ which has also PDA device with a QWERTY keypad with it. Later then mobile phone operating systems were introduced.

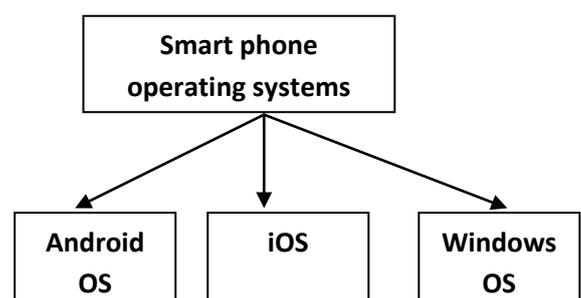
Depends upon the operating systems the mobile phones (now a day’s Smart phones) are classified. More than 80% of the world mobile market consist of smart phones as they’re more reliable and easier to use. Today in world about 43% there are Android users, 40% there are iOS users and are other users.

They have easier User Interface(UI) which makes every task easier. The user interface is everything designed into an information device with which a human being may interact.

## 2. Technology:

The technology and features of the smart phones are varies to one operating system to another. Depends upon the operating system used in the smart phones the smart phones are classified.

This classification mainly focuses on three major operating systems such as Android, iOS and Windows OS.



Apart from these three major smart phone operating systems the Symbian operating system and blackberry operating systems are used worldwide.

Totally there are five steps involved in smart phones application development.

1. Strategy
2. Design
3. Development
4. Marketing
5. Maintenance

At present various smart phone applications available. There are n number of smart phone applications are available today.

Some of the basic applications are in-build with the operating systems. Mobile app(smart phone app) is nothing but a computer program run on mobile devices such as smart phones and tablet PCs.

Most such devices are sold with several apps included as pre-installed software such as Web browser, e-mail client, calendar, mapping program and an app for buying music or other media or more apps.

## 2.1 Android:

Android OS is the most widely used operating system in 2012 and 2013. This is a software platform and operating system for mobile devices which is based on Linux kernel and is developed by Google but later on by Open Handset Alliance (OHA). Its native language is Java which is the officially supported language. Now a days Android 4.0 ice-cream sandwich, Android 4.1, 4.2 and 4.3 jelly bean are most widely used on September 3<sup>rd</sup> 2013, Android 4.4 kitkat is released by Google in its next Google Nexus 7. There are more than 1 million Apps in Google play which

makes users get freedom to do anything with their device.

Android allows us to go video calls, phone calls, instant messaging at almost no cost. Ticket bookings are just a click away. Though Android updates don't change but it features good crisp looks and HD format supporting features.

Some of the features of Android OS are: Messaging, Web browser, Multi-touch, Video calling, Multi tasking and etc. Some of the best Android smart phones are: Samsung Galaxy Note 3, Moto X, Google Nexus 7 etc. Google, Sony and Samsung are coming up with smart watches like Samsung Galaxy which are going to revolutionize the smart phone industry.

## 2.2 Apple iOS:

iOS is one of the best operating system from Apple. This strong but expensive operating system is developed by Apple whose native language is C. Recently released its one of the major update in iOS history that is iOS 7. iOS 7 allows us to function between various apps, a similar UI(User Interface) than previous versions. Paying electricity bills, bank accounts maintenance are a tap away.

It has improved Siri, Airdrop(programming concepts) to transfer files. Control center which allows us to toggle different functions just at a tap. Up to that level it is easier than other tasks.

Apple i phone 5S also contains world's first and fastest A7 chip with 64 bit architecture and M7 motion co-processor chip. Apple i phone 5S also includes a finger print sensor which is the first ever technology launched by Apple. Some of the best iOS smart phones are: i Phone 5(discontinued now), i Phone 5C, i Phone 5S, i Pad 4, i Pad Mini, Sony Xperia Z3+ etc.

Apple is now preparing to launch the update of its new software iOS 7. iOS 7 has some bugs need to be fixed, iOS 7.0.2 has been launched yet the software is not fully bus free.

Apple is preparing its next gen device fourth quarter of 2014 work on finger print sensor's efficiency is being done.

### 2.3 Windows:

Windows operating system is one which is the most widely used operating system developed by Microsoft Corporation. Windows phones has the world's best UI(User Interface) allowing us to hover over the apps with just a slide.

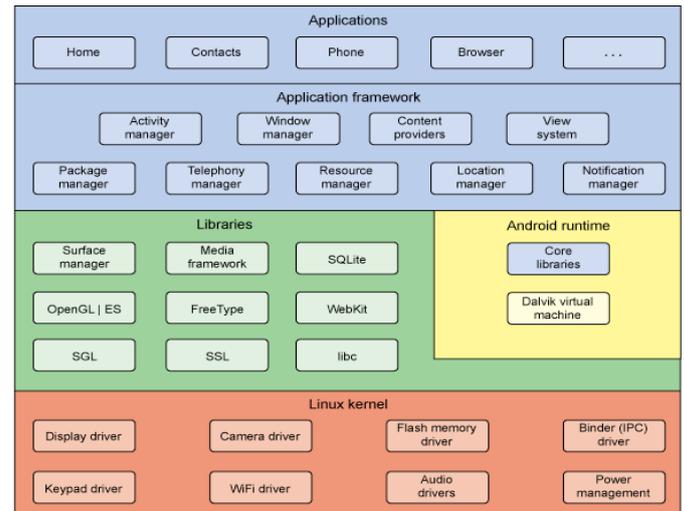
Windows phone 7 was launched by Microsoft in 2010 which was the further updated to Windows phone 8. Now Windows phone 8 is further updated to Windows 8.1. It consist X Box gaming which allows users to experience console level gaming. It allows Multi-tasking, installing third party apps.

Earlier the Windows phone OS was not compatible with large screen Phablets and Tablets but now Nokia is working on a 6-inch Phablet and Microsoft is making its OS to be compatible with it. Some of the best Windows smart phones are: Nokia Lumia 1020, Nokia Lumia 928, HTC Mobile Radar and etc.

Windows phone software are developing for large screen smart phones which means soon Windows Tablets and Phablets will be seen. Windows has launched its Surface 2 Computer which acts like a smart phone and as well as a computer.

## 3. Architecture:

### 3.1 Architecture of Android OS:



#### 3.1.1 Applications:

Android app will be shipped with a set of core applications including client, SMS program, calendar, maps, browser, contacts, and others. All these application programs are developed in Java.

#### 3.1.2 Application Framework:

The developer is allowed to access all the API framework of the core programs. The application framework simplifies the reuse of its components.

Any other app can release its functional components and all other apps can access and use this component (but have to follow the security of the framework).

Same as the users can be able to substitute the program components with this reuse mechanism.

#### 3.1.3 Libraries and Android Runtime:

The library is divided in to two components: Android Runtime and Android Library. Android Runtime is consisted of a Java Core Library and Dalvik virtual machine.

The Core Library provides Java core library with most functions. Dalvik virtual machine is register virtual machine and

makes some specific improvements for mobile device.

Android system library support the application framework, it is also an important link connecting between application framework and Linux Kernel. This system library is developed in C or C++ language.

These libraries can also be utilized by the different components in the Android system. They provide service for the developers through the application framework.

### 3.1.4 Linux Kernel:

The kernel system service provided by Android inner nuclear layer is based on Linux 2.6 kernel, Operations like internal storage, process management, internet protocol, bottom-drive and other core service are all based on Linux kernel

## 3.2 Architecture of Apple iOS:



### 3.2.1 Cocoa Touch Layer:

The Cocoa Touch Layer contains the key frameworks for building iOS applications.

The layer defines the basic application and support for key technologies such as multi-tasking, touch-based input, push notifications and many high-level system services. Cocoa touch follows a Model-View-Controller(MVC) software Architecture.

### 3.2.2 Media Layer:

The Media Layer contains the graphics, audio, and video technologies. Graphics technologies includes Core Graphics, Core Animation and OpenGL technologies which handles 2D vector and animating views and 2D and 3D figures.

Audio Technologies supports rich audio experience and audio formats like AAC, Apple Lossless(ALAC), A-law and Linear PCM.

Video technologies support the Playback of movie files with the .mov, .mp4, .m4v and .3gp filename extensions.

### 3.2.3 Core Services:

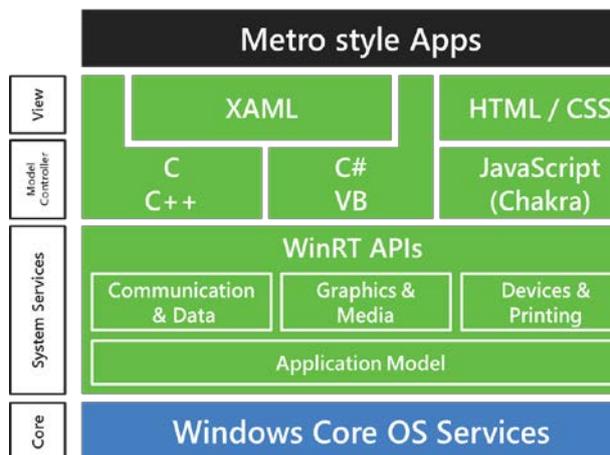
Contains the High-level features that all applications use such as iCloud Storage, Core services framework. iCloud Storage lets your application data to a central location and access those items from all user's computer and iOS device. Core services framework includes Accounts framework, Address book framework and Core Data framework for user accounts, contacts and for managing model-view-controller application.

### 3.2.4 Core OS:

Contains the low-level features such as Accelerate framework, Core Bluetooth framework and External accessory framework. Accelerate frame work contains interfaces for performing DSP, Linear algebra and image processing calculations. The Core Bluetooth framework allows developers to interact

specifically Bluetooth Low-energy accessories. External accessory framework provides support for communicating with hardware accessories attached to an iOS based device.

### 3.3 Architecture of Windows OS:



#### 3.3.1 Core OS Services:

The core operating system (OS) services consist of the kernel and other features. Core OS services enable low-level tasks, such as process, thread, and memory management. Basic device drivers are also part of the Core OS services.

#### 3.3.2 WinRT APIs:

WinRT APIs provide various features for enable the system services such as data communication, graphics and media and etc. This API is written in C++ on top of Win32 and the COM interface. It is exposed out to other languages (in particular C++/CX, C#, Visual Basic and Javascript) via API meta-data files (.winmd files).

#### 3.3.3 Metro Style Applications:

A Metro style app is an app built using HTML5 or XAML+(C#,VB or C++), on Microsoft's new APIs - in short, it's an app-widget-kind a-thing. Note that this is cross-platform compatible (Windows 8

will support ARM with metro apps) and that standard x86 apps built the "old way" will still continue to work, but are not considered metro apps, nor are they cross-platform compatible. There is also an app store for metro apps.

### 4. Comparison of Android, Apple iOS and Windows OS:

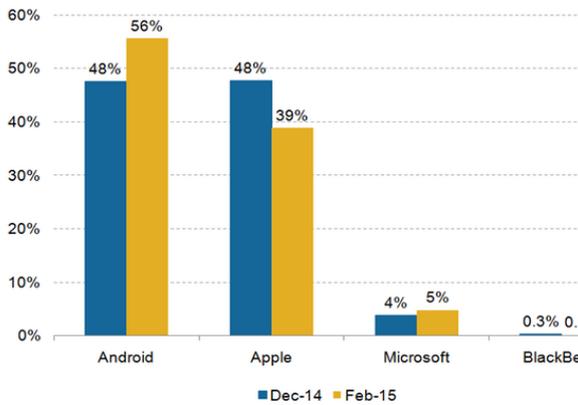
Parameter/O S	Android	iOS	Windows
Family	Linux	Darwin	Windows-NT
Vendor	Open handset Alliance, Google	Apple Inc	Microsoft Corp
Environment	Eclipse(Google)	Xcode(Apple)	Visual Studio
Source model	Open Source	Closed source	Closed source
License	Free and open source	Proprietary EULA Except for open source	proprietary
Written in	C, C++, Java	C, C++, Objective C, Swift	C#, VB.NET, F#, C++, JavaScript
Initial release	September 23, 2008	June 29, 2007	October 21, 2010
Latest Release	5.1 "Lollipop" March 10, 2015	iPhone 6 september 1, 2014	Windows phone 8.1 December 5, 2014
Runs on	Computers, smart phones, Tablets, TVs	iPhone, iPad, iPad touch	Personal computers, smart phones, Server computers
Market share	48.8%	17.2%	19.5%
Market size	Very high	High	Medium
Application store	Google play	App store	Windows phone store
Virtual Machine	Allowed	Not-allowed	Allowed
Non-English language support	Partial	Yes	Yes
Debugger	Available	Available	Available
Cross Platform deployment	Android only	iPhone, iPad, iPad touch	Windows mobile, FU, CE

GUI	Android	Cocoa Touch	Visual Studio
Future prospect	Very High	High	Medium

**Table 1: comparison on Android, iOS and Windows**

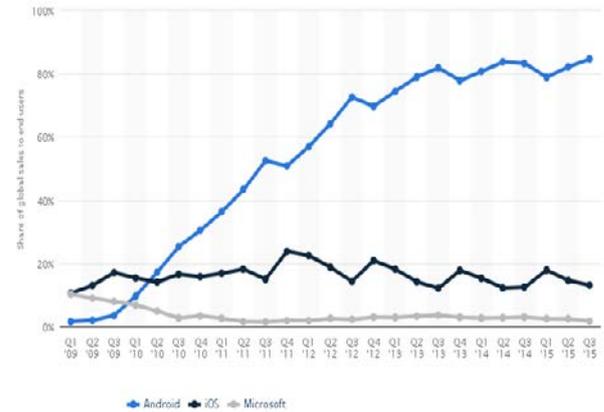
Table 1 shows the various parameters related to mobile operating systems Android, iOS and Windows.

**4.1 Smart phone Operating system marketing Share:**



The above Bar-Chat shows the marketing share of smart phone operating systems. In overall market share Android possesses 48% in Dec2014 and 56% in Feb2015. Apple possesses 48% in Dec2014 and 39% in Feb2015. Microsoft possesses 4% in Dec2014 and 5% in Feb 2015. BlackBerry and other operating systems possess 0.3% in Dec2014 and 0.1% in Feb 2015.

**4.2 Global market share held by the leading smart phone operating systems in sales to end users from 1st quarter 2009 to 3rd quarter 2015**



This Statistical Graph shows the global market share of Android, iOS and Windows mobile operating systems. From this graph we can assume that Android covers more percentage on Global share.

**4.3 Top Three Smartphone Operating Systems, Unit Shipments, Market Share, and Year-Over-Year Growth, Calendar Year 2014 Data (Units in Millions):**

Operating System	2014 Unit Volumes	2014 Market Share	2013 Unit Volumes	2013 Market Share	Year-Over-Year Change
Android	1,059.3	81.5%	802.2	78.7%	32.0%
iOS	192.7	14.8%	153.4	15.1%	25.6%
Windows Phone	34.9	2.7%	33.5	3.3%	4.2%
Others	7.7	0.6%	2.3	0.2%	234.8%
Total	1,300.4	100.0%	1,018.7	100.0%	27.7%

**Table 2: overall Unit Shipments of Android, iOS and Windows for the year 2014**

Thus the table shows that the Android is in the first position with 32.0% of overall unit shipments. The iOS is in the second position with 25.6% of overall unit shipments. Windows is in the third position with 4.2% of overall unit shipments.

**Conclusion:**

Smart phones like personal computer provide various functionalities like use of application, usability, web browsing, running GPS, expendable memory, multi-

tasking, multi-processing, playing games, social networking etc. In this paper we have presented a detail review and comparative analysis of smart phone operating systems Android, iOS and Windows OS. We have made comparison between Android, iOS and Windows OS.

From this comparative analysis we have found that Android and Windows operating systems are superior than other operating systems. Android gets 80.7% and is the best smart phone operating system in world today. We can also use it as an Educational tool. Due to Android an open source operating system the user can easily install third-party applications from the market and ever from unreliable sources. Due to this it has some limitations which lead to malware attacks like viruses, worms, spywares, adware and Trojan horse.

This paper provide a comparative analysis on smart phone operating systems and through this analysis we can said that at present Android is the Best operating system for the smart phone used by globally.

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4. Comparison of Android, Apple iOS, and Windows OS: Parameter/O S. This paper provide a comparative analysis on smart phone operating systems and through this analysis we can said that at present Android is the Best operating system for the smart phone used by globally. [5] Thomas Renner SNET Project Technische UniversitÄt at Berlin. Mobile OS - Features, Concepts and Challenges for Enterprise Environments. Popular operating systems include Appleâ€™s iOS, Googleâ€™s Android and Microsoftâ€™s Windows Phone but other operating systems such as BlackBerry OS, Nokia's Symbian and Samsungâ€™s Bada also exist. Do you have a favourite mobile operating system? Is the user interface or the number of available applications the most important factor for you? Does the tile-based user interface of Windows Phone appeal to you or do you prefer the larger choice of applications available on iOS and Android? If you were designing your perfect mobile phone for other giffgaff members, which operating system would you u iOS, Android, and Windows Phone are very different operating systems. For one thing they are developed by different companies (Apple, Google, and Microsoft respectively). Android is owned by Google and is a more â€œopenâ€™ operating system with many customisation options. Appleâ€™s iOS takes a more different approach, with a closed-source, proprietary structure. It focuses on user experience, with an (arguably) easier-to-use interface based around a central home screen. Unfortunately, iOS is only available on Apple devices and the OS is nowhere close to being as open as Android with less customisation options. Windows Phone is the oldest of the three, with its origins in Windows CE and Windows Mobile.