Smartphone: Android Vs IOS

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Abstract—The increasing importance of Smartphone has triggered intense competition among technology like Symbian, Google, Microsoft and Apple. This Paper presents a brief review and comparison of the Android operating System from Google and iphone operating System from Apple. The Comparison is done on the basis of their platform, their performances and the growth in mobile land. The Salient new key Features introduced in Android and IOS are also described.

Keywords—Android; Apple; Applications; Google's Android; iPhone; Java; Jelly Bean; Mobile Operating System; Objective C; Smartphone's.

Abbreviations—Code Division Multiple Access (CDMA); Iphone Operating System (IOS); Open Handset Alliance (OHA); Personal Digital Assistant (PDA); Software Development Kit (SDK).

I. INTRODUCTION

TODAY'S mobile devices are multi-functional devices capable of hosting a broad range of applications for both business and consumer use. Like a computer operating system, a mobile operating system is the software platform that determines the functions and features available on your device, such as thumbwheel, keyboards, wireless security, and synchronization, messaging and more.

Some of the more common and well-known Mobile operating systems are Google's Android and Apple's IOS because of their Popularity we are going to talk about these two operating systems which are commonly seen in market and then compare them with each other.

1.1. Smartphone's

A Smartphone is a mobile phone build on a mobile operating system with more advanced computing capability and connectivity than a phone. The first Smartphone's combined the functions of a Personal Digital Assistant (PDA) with a mobile phone. Some other features,

- Portable media players,
- Compact digital cameras,
- Pocket video cameras,
- GPS navigation,
- Web browsers,
- Touchscreen,
- Wi-Fi,
- Mobile Broadband.

1.2. Smartphone's OS

There are many Operating Systems for smart phones. The main mobile operating systems (OS) used by modern smart phones includes the following:

- Google's Android,
- Apple's iOS,
- Nokia's Symbian,
- RIM's BlackBerry OS,
- Microsoft's Windows Phone.

Such operating systems can be installed on many different phone models, and typically each device can receive multiple OS software updates over its lifetime.

Android from Google and IOS from Apple provides not only operating system but also provide a mobile development platform because both of them are facing tough competition against each other. Now we are going to talk about the main operating system respectively android and IOS which are commonly seen in market.

Figure 1: iPhone and Apple

1.3. Android

Android, Inc. was founded by Andy Rubin. In 2005, Google acquired it and then the team led by Rubin developed a mobile device platform powered by the Linux kernel. Finally, On the November 5, 2007 the Open Handset Alliance, a business alliance of several companies which include Google, HTC, Intel, LG and other 76 firms unveiled itself. On the same day, the Open Handset Alliance also unveiled their first product, Android, a mobile device platform which was built on the Linux kernel version 2.6 [http://developer.android.com/guide/developing/tools/emulat or.html].[1] And the first commercially available phone to run the Android operating system was the HTC Dream, released on 22 October 2008 [http://developer.android.com/resources/dashboard/platformv ersions; http://developer.android.com/guide/basics/what-isandroid.html].

Figure 2: Internal Architecture and Working

The diagram shows the components of the Android OS. One of its most well known features is the applications (apps). Applications are usually developed in the Java language using the Android Software Development Kit, but other development tools are available, including a Native Development Kit for applications or extensions in C or C++. Besides, by providing an open development platform, Android offers developers the ability to build extremely rich and innovative applications. Developers are free to take advantage of the device hardware, access location information, run background services, set alarms, add notifications to the status bar, and much, much more. So, In April 2011 Google said there had been about 100,000 Android apps installed. The Android OS is used on smartphones, netbooks and tablets, including the Dell Streak, Samsung Galaxy Tab, TV and other devices. And some research company estimated in Q2 2009 that Android had a 2.8% share of worldwide smartphone shipments. By Q4 2010 it had grown to 33% of the market, becoming the top-selling smartphone platform.
[http://code.google.com/p/openintents/wiki/SensorSimulator].

1.4. IOS

iOS is Apple`s mobile operating system. Originally developed for the iphone, iOS now can also support other Apple`s devices such as itouch, ipad and Apple TV. Although it is derived from Mac OS X, iOS has the technologies that are available only on itself, such as the Multi-Touch interface and accelerometer support, and these devices make iphone easier to use [http://en.wikipedia.org/wiki/History_of_Mac_OS_X].[6]
The other great feature of iOS is its numerous applications. According to the reference, iOS has more than 300,000 applications in Apple`s App Store, which have collectively been downloaded more than 10 billion times. This can be credited to the iOS software development kit (SDK), which contains the code, information, and tools people need to develop, test, run, debug, and tune applications for iOS. However, loading an application onto the devices is only possible after paying an iPhone Development fee [Buck, 2010]

II. SYSTEM ARCHITECTURE

2.1. Android Architecture

The Android architecture has several layers as showed in Figure 3.

2.1.1. Kernel

Linux is support for core system services such as security, memory management, process management, network stack, and driver model [http://thecoffeedesk.com/news/index.php/2009/05/17/iphone -architecture/]. The kernel also acts as an abstraction layer between the hardware and the rest of the software stack.
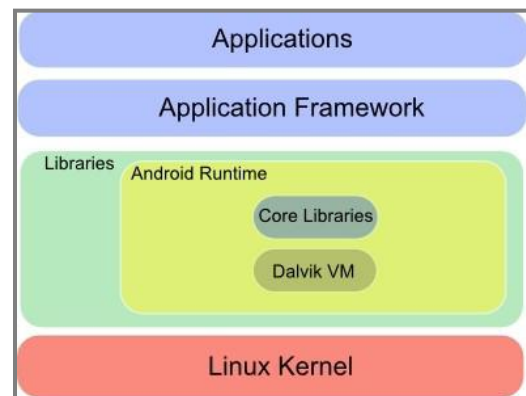

Figure 3: Android Architecture

2.1.2. Runtime

Runtime includes core libraries and Dalvik virtual machine. Core libraries have a set of core libraries that provides most of the functionality available in the core libraries of the Java programming language. Every Android application runs in its own process, with its own instance of the Dalvik virtual machine. The Dalvik VM executes files in the Dalvik Executable (.dex) format which is optimized for minimal

memory footprint. The VM is register-based, and runs classes compiled by a Java language compiler that have been transformed into the .dex format by the included "dx" tool. The Dalvik VM relies on the Linux kernel for underlying functionality such as threading and low-level memory management.

2.1.3. Libraries

Android has a set of C/C++ libraries used by various components of the Android system. These libraries are exposed to developers. The system C library is a BSD-derived implementation of the standard C system library. The media libraries are based on PacketVideo's openCORE which support playback and recording of many popular audio formats. The surface manager manages access to the display subsystem and seamlessly composites 2D and 3D graphic layers from multiple applications [Claudio Maia et al., 2010].

2.1.4. Application Framework

All Android applications are written with Java programming language, it ships with a set of core applications including email client, SMS program, calendar, maps, browser, contacts and others. Android offers developers the ability to build various applications with an open development. Developers have full access to the same framework APIs used by the core applications [Damianos Gavalas & Daphne Economou, 2011]. The application architecture is designed to simplify the reuse of components; any application can publish its capabilities and any other application may then make use of those capabilities. This same mechanism allows components to be replaced by the user. The applications including views that can be used to build an applications, including lists, grids, text boxes, buttons, and even an embeddable web browser. Content providers enable applications to access data from other applications or to share data with others. The resource manager providing access to non-code resources such as localized strings, graphics and layout files. The notification manager enable all applications to display custom alter in the status bar. The activity manager manages the lifecycle of applications and provides a common navigation back stack.
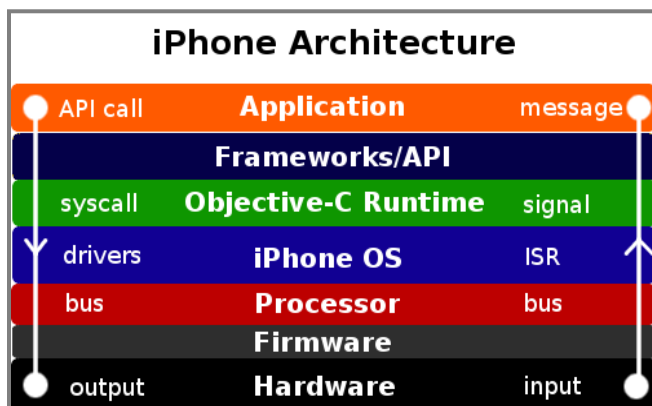
2.2. iPhone Architecture

Figure 4: iPhone Architecture

2.2.1. Hardware

In iPhone, Hardware refers to the physical chips soldered to the iPhone's circuitry. The actual processor falls under this layer, but the instruction set and in-memory descriptor tables are contained within the "processor" layer.

2.2.2. Firmware

Firmware refers the chip-specific code that is either contained with memory in/around the peripheral itself, or within the drive for said peripheral.

2.2.3. Processor

Processor is refers to the ARM instruction set and the interrupt descriptor table as set up by the iPhone OS during boot and driver initialization.

2.2.4. iPhone OS

iPhone OS is the kernel, drivers, and services that comprise of the iPhone Operating System. It sits between the user space and hardware.

2.2.5. Objective-C Runtimes

Objective-C runtime is comprised of both the Objective-C dynamically-linked runtime libraries, as well as the underlying C libraries.

2.2.6. Frameworks/API

Frameworks/API layer has API calls which are Apple-distributed headers with the iPhone SDK, with some dynamic linking occurring at runtime. These reside on top of the Objective-C runtime, as many of these are written in Objective-C.

2.2.7. Application

The application stored in iPhone has to be purchased through the application store. This application was compiled to native code by the Apple-distributed iPhone compiler, and linked with the Objective-C runtime and C library by the linker. The application also runs entirely within the user space environment set up by the iPhone OS.

III. FEATURES WITH RESPECT TO VERSION

3.1. Android OS

The Android OS by Google is the most widely used platform for smartphones and tablets on the market. It was introduced as a collaborative effort from the Open Handset Alliance (OHA), a unit that comprises companies such as Google, HTC, Sony, Dell, Samsung, LG, T-Mobile, Motorola, and many others. This is one of the reasons smartphones from these companies are released with the Android OS. As a result, the consumer has a wide variety of smartphones to choose from. Compared to the iOS from Apple, Android devices are far less expensive.

Jelly Beam [http://www.android.com/about/jelly-bean/], or Android 4.1, replaced the ice cream sandwich OS (4.0)

[http://www.android.com/about/sandwich/]. It allows users more ability to swipe their finger over the screen to perform actions. It also performs faster than the earlier release. Jelly Bean also makes it easier to share photos on social media sites.

Features of Android

Android does not include as many major updates, but rather smaller increments adding fewer updates each time. Most of the updates come in the form of ".X" updates that are actually additions rather than changes to the whole system.

3.1.1. Android 1 (Cupcake and Donut)

- Notification window: Drop down notification from apps across the phone
- Widgets: Home screen functions that do not require the user to open an app
- Gmail integration: Gmail is heavily present in Android
- Android market: Google's own version of the app store
- CDMA support*: Android could be used on Verizon and other CDMA providers
- Onscreen keyboard*: Keyboard used on the touchscreen
- Upload support to YouTube*: Videos could be captured and uploaded to YouTube
- Third party app development kit and support*: Other companies and individuals can make apps for the Android operating system

3.1.2. Android 2.0 (Eclair, Froyo, and Gingerbread)

- Multiple account functionality: More than one Google account can be used on Android
- Google maps: Google maps app can be used to navigate
- Quick contact: Contacts can quickly be contacted in a number of ways using the app
- Speech to text: The user can talk to the phone to type a text message
- Five home screens*: 5 different screens to hold quick select apps
- Enhanced gallery*: Gallery includes features for viewing including moving the image and flipping the phone to affect said image
- PIN lock capability*: Users can input a four digit number rather than a slide pattern
- New looks*: Looks of widgets and the background of the OS updated
- Front face camera support*: User has more control over front face camera

3.1.3. Android 3.X (Honeycomb)

- Action bar: Addition for app users to show popular options

- No need for physical buttons: System bar at the bottom of the phone can be used to go home, back, forward, etc.
- Android 4.0 (Ice Cream Sandwich)
- Data usage analysis: Used to show how much data has been used based on user's filters
- Android Beam: Two phones can connect simply by touching to share files.

3.1.4. Android 4.3 (Jelly Bean)

- Devices running Android 4.3 will now support low-energy Bluetooth Smart accessories like heart rate monitors, pedometers, thermometers and many others
- Android 4.3 now adds the autocomplete feature in the dial-pad suggesting contact names or phone numbers when users start keying-in something
- The Notification bar has been a popular feature on Android and with Android 4.3, you can control and interact with the status bar notifications.

3.2. Apple IOS

Apple's mobile operating system, iOS, contains a number of different features developed over its many versions and iterations since 2007. Many such features were, when first developed and introduced by Apple, lauded as innovative, even groundbreaking advances. The following sections detail the features introduced with the various iOS versions.

3.2.1. iPhone OS (iOS 1)

- Touch screen: Apple includes a screen that responds to finger presses and swipes
- Pinch-to-Zoom: User can pinch the screen to zoom the view in or out
- Apple Safari web browser: A mobile version of Apple's Web browser
- ITunes compatibility: USB connection to iTunes-enabled computer
- Touch screen keyboard: A touch screen keyboard replaces physical buttons, allowing a much larger screen without sacrificing device compactness
- Hidden file system: Unlike with a computer, the user cannot directly access the files present on the device
- Home button: A button present on the front of the device allows user to return there from any app at any time
- Home screen web snippets*: A quick view of the web is present on the home screen
- Multi touch keyboard*: Keyboard can accept more than a single button press at a time
- Re-arrange home screen icons*
- Wi-Fi iTunes purchases*: The user can make purchases from the device

3.2.2. iPhone OS 2 (iOS 2)

- App store: The user can purchase apps from Apple

- Support for 3rd party apps: Users and companies can develop apps
- iOS Developer Kit: Code used to develop apps for third party support is available
- Contact search: Can search contacts by name
- Microsoft Exchange support: Push email and other features have support
- ITunes Genius support*: Playlists created by iTunes based on past music
- Podcast downloads*: Audio files downloadable from 3rd parties (audiobooks, web shows, etc.)
- Google Street View*: Can view streets and maps from iPhone

3.2.3. iPhone OS 3 (iOS 3)

- Copy/Paste capability: Text selectable to copy and paste
- Spotlight search: Can search a web page with keywords
- USB/Bluetooth tethering: Other mobile devices can access internet through iPhone
- Landscape keyboard: iPhone can be turned horizontally to make a two-fingered keyboard
- Find my iPhone: iPhone can be located and shutdown or wiped clean
- Voice control: iPhone can respond to voice commands such as call or send message (pre-Siri)
- Voice control over Bluetooth*: User can use Bluetooth device to input voice commands
- Downloadable ringtones*: New ringtones available for the iPhone
- Remote lock*: Device can be shut off using mobile.me

3.2.4. iphone OS 4 (iOS 4)

- Multitasking: iPhone cannot run background apps, but can receive certain notifications from apps
- VideoChat: Can communicate through videos using iPhone
- Retina Display: iPhone display enhanced
- Threaded email: Email similar to text message threads in their display
- Game center*: An organization app used to place all games in one place
- TV show rentals*: iPhone can now display TV shows
- ITunes Ping*: Social network specifically tailored to music
- Verizon availability*: iPhone now available to Verizon users
- 3G tethering*: iPhone becomes hotspot for Wi-Fi enabled devices

3.2.5. iphone OS 5(iOS 5)

- Siri: Enhanced and interactive voice control

- PC-free: Device can be activated without a computer
- Notification center: A drop down notification center for organizing app actions
- iTunes Wi-Fi Sync: iPhone can share data back and forth with iTunes
- iCloud: A network the user can setup to connect all their Apple devices
- iMessage: Apple's texting app

Table 1: Technical Specifications

Attributes	Android	IOS
Developer	Google	Apple
OS Family	Linux	OS X, Unix
Initial Release	Sep-23 2008	July-29 2007
Programmed in	C, C++, java	C, C++, objective-C
Available on	Phones And Tablets (LG, Samsung, HTC and Other)	iPod Touch, iPhone, iPad, Apple TV
Voice command	Google now	Siri
Source model	Open source	Closed, with open source components.
Latest stable Release	Android 4.3 Jelly Bean (August 1, 2013)	7.0.2 (September 26, 2013)
Upcoming Release	Android 4.4 Kitkat (October, 2013)	iOS 7.0 (Most likely at WWDC)

IV. MARKET ANALYSIS

Android market share 75% of smartphones, 3.7% of tablets in North America (as of Jan'13) and 44.4% of tablets in Japan (as of Jan'13). In the United States in Q1 2013 - 52.3% phones, 47.7% tablets.

IOS market share 14.9% of Smartphone's, 87% of tablets in North America (as of Jan'13) and 40.1% of tablets in Japan (as of Jan'13) [http://www.SmartphoneANDROIDVsIOS/AndroidvsiOSDifferenceandComparisonDiffen.htm].

Android and iOS, the number one and number two ranked Smartphone operating systems (OS) worldwide, combined for 91.1% of all Smartphone shipments during the fourth quarter of 2012 (4Q12).According to the International Data Corporation (IDC) Worldwide Quarterly Mobile Phone Tracker, Android Smartphone vendors and Apple shipped a total of 207.6 million units worldwide during 4Q12, up 70.2% from the 122.0 million units shipped during 4Q11. For calendar year 2012, Android and iOS combined for 87.6% of the 722.4 million Smartphone's shipped worldwide, up from 68.1% of the 494.5 million units shipped during calendar year 2011.The two horse race between Android and iOS has collectively accounted for more than 50% share of the smartphone OS market over the past two years [http://www.idc.com/getdoc.jsp?containerId=prUS23503312]

Android continued its overall upward trajectory, reaching triple-digit growth for the year. Samsung was the biggest contributor to Android's success, amassing 42.0% of all Android smartphone shipments during the year. Following

Samsung was a long list of vendors with single digit market share, and an even longer list of vendors with market share less than one percent. The intra-Android competition has not stifled companies from keeping Android as the cornerstone of their respective Smartphone strategies, but has upped the ante to innovate proprietary experiences.

iOS posted yet another quarter and year of double-digit growth with strong demand for the iPhone. But what also stands out is how iOS's year-over-year growth has slowed compared to the overall market. The smaller volumes during 2Q12 and to a smaller extent 3Q12 underscore the possibility for a mid-year iPhone release in order to maintain market-beating growth. Speculation about the release of possible larger-screen and inexpensive models during the middle of 2013 continues to follow Apple, which would help sustain growth. But until any model is formally announced, speculation remains simply that [http://www.idc.com/getdoc.jsp?containerId=prUS23946013]

Table 2: Top Five Smartphone Operating System, shipments, and Market Share, 4Q12 (Units in millions)

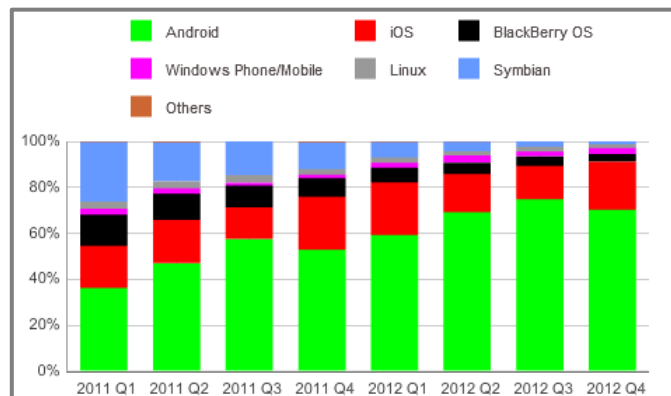| Operating System	4Q12 Shipments	4Q12 Market Share	4Q11 Unit Shipments	4Q11 Market Share	Year Over Year Change
Android	159.8	70.1%	85.0	52.9%	88.0%
IOS	47.8	21.00%	37.0	23.0%	29.2%
BlackBerry	7.4	3.2%	13.0	8.1%	-43.1%
Windows Phone	6.0	2.6%	2.4	1.5%	150.0%
Linux	3.8	1.7%	3.9	2.4%	-2.6%
Others	3.0	1.3%	19.5	12.1%	-84.6%
Total	227.8	100.0%	160.8	100.0%	41.7%

Figure 5: Worldwide Smartphone Market, OS share, 2012 Q4

Table 3: Top Five Smartphone Operating Systems, Shipments, and Market Share, 2012 (Units In Millions)

Operating System	2012 Unit Shipments	2010 Market Share	2011 Unit Shipments	2011 Market Share	Year Over Year Change
Android	497.1	68.8%	243.5	49.2%	104.1%
IOS	135.9	18.8%	93.1	18.8%	46.6%
Blackberry	32.5	4.5%	51.1	10.3%	-36.4%
Symbian	23.9	3.3%	81.5	16.5%	-70.7%
Windows Phone	17.9	2.5%	9.0	1.8%	98.9%
Others	15.1	2.1%	16.3	3.3%	-7.4%
Total	722.4	100.0%	494.5	100.0%	46.1%

V. ANDROID AGAINST IOS

Today mobile market provides us with so many options that it makes difficult for us to choose the best but as the saying goes "that what is wanted more is the best" and the same goes with our favorite Android. This Google's OS came into market in the year 2008 and before completing two years it has shown a remarkable growth in the market. This is all because of some reasons that I will try to elaborate in the following discussion. These are the points that are the most important that creates such a difference in my opinion. It is changing the scenario in the world wide market as it is being adopted by major players in smartphone market like HTC, Samsung, Motorola, and Samsung and not to forget Google's Nexus One. Android, because of its highlighting features is competing against mobile platforms from Apple, Microsoft, Nokia, Palm, Research in Motion and Symbian.

The android is growing faster than the iPhone. Its platform is showing a rapid growth from the last two years and the openness of the platform can account for this rapid growth. The comparison of android and iPhone can be done from different perspective but the final result is supposed to be same foe each viewpoint. Here we discuss some of the main features that make the difference between android and iPhone.

5.1. Development Environment

5.1.1. Language

Google's android provide a customized java virtual machine , and java byte code interpreter that facilitate android to offer free services and make android to be a java platform thus introduce a new development platform that influence developers to create there application using java programming whereas, iPhone has totally different approach for development environment. It introduces a small scale version of its desktop Mac OS X Cocoa. iPhone only supports Objective-C language. Android's popularity is due to its open platform and availability of excellent developer's tools. Java and the Eclipse IDE are major attractive aspects of Android to make it's the best choice of developers. iPhone is based on objective-C that is difficult to use and its development platform is not properly defined. The development environment of the iPhone is more tedious than android's. Almost all the standard Java IO, network libraries are easily available.

5.1.2. Performance

Performance is one factor among many that defines whether or not a platform will succeed. Performance comparisons depend on many factors, here I am discussing the performance of Android's JVM vs. the iPhone's Objective C. Android is a Java based platform and uses a Java Virtual Machine (Dalvik) to execute apps Java was considered to be a slow and cumbersome platform. Java has been optimized and now its performance is extremely fast. Dalvik has been

optimized even more for mobile devices, so now the Android is one fast platform.

iPhone OS is written using Objective C, which is an object oriented version of C that uses messages It's like having every phone call go through an operator who relays on the message to the other person rather than just calling the other person directly. There is a message passing system called objc_msgSend(), is a critical piece of software for anything written for OS X on the Mac or the iPhone.

5.1.3. Open Vs. Close (Platform Approach)

Apple offers a closed, proprietary system with peerless marketing, an excellent user interface and strong ties between hardware and software; Google prefers open-source approach to develop new applications. The iPhone doesn't offer background processing for third-party applications as comparison to Android. It is much more open. One can build any kind of application take benefit of any features. This is one of the main features of android that shines [http://www.darkreading.com/privacy/google-android-vs-apple-ios-the-mobile-a/240157894].

5.1.4. Syncing

iphone users have to plug into the computers to do all sorts of syncing but in android this can be easily done through Google account.

5.1.5. Application Publication Charges

As apple provide a proprietary system the applications can't be sold without Apple's approval, there cannot be multitasking and also there is freedom to the user to duplicate the features of the core apps. Both platforms take 30 per cent of application revenues, although Android is free to sign up to, while Apple charges developers $99 per year. To publish their application on the apple store the developer need to pay an annual fee of US$99 on the other hand android developer has to pay only $25 fee to one time registration and also they can publish the same application in other application market there is no restriction for that.

5.1.6. Content

On the net the content and the information regarding iPhone is not much as compared to Google's android We can easily get all the content, source code and information related to android platform as and when required.

Android SDK is installed with the full information, helping guide and APIreferences. It takes a few seconds to found information regarding our queries. IPhone also provides lots of resources that help developers to perform their task but it takes much time to do that.

5.1.7. Browsing

In terms of internet browsing, which platform is better? The answer is given by the researcher Neilsen. According to data collected by him and compiled by eMarketer, owners of Android phones are the most likely to use their device's Internet functionality

[http://www.diffen.com/difference/Android_vs_iOS]. Ninety-two percent of Androiders say they take utilize their phone's Web connection, compared to 88 percent of iPhone owners. Both devices are well above the curve for smartphone owners in general, however, where the overall Net-using percentage is only 71.

5.1.8. Security

There are some privileges on iPhone to restrict the addition of new software for the users. Each application runs on a single UNIX kernel. If there is some problem from running application then whole system can be affected.

Whereas in android each application runs independently. There are pre-defined permissions and authorizations for each feature. So from security point of view android is much better then iPhone for users.

5.1.9. Google Benefit

One another benefit of android is to make use of the facilities that Google offers such as Google maps, Google voice, Google documents and many more.

Table 4: Differences between Android and IOS

Attributes	Android	IOS
Developer	Google	Apple
OS Family	Linux	OS X, Unix
Widgets	Yes	No, except in NotificationCenter
Programmed in	C, C++, java	C, C++, objective-C
Messaging	Google Hangouts	iMessage
Internet browsing	Google Chrome (or Android Browser on older versions)	Mobile Safari
Source model	Open source	Closed, with open source components.
Video chat	Google Hangouts	Facetime
App store	Google Play – 1,000,000+ Apps. Other app stores like Amazon and Getjar also distribute Android apps.	Apple app store – 850,000+ Apps
Device manufacturer	Google, LG, Samsung, HTC, Sony, ASUS, and many more	Apple Inc

Table 5: Similarities between Android and IOS

Attributes	Android	IOS
Dependent on a PC or a Mac	No	No
Interface	Touch screen	Touch screen
Working state	Current	Current

VI.   CONCLUSION

After a long introduction of the basic concept of Android and OIS it is very hard to predict that which is ahead in mobile market, both are looking towards the future providing us to more and more advances in our mobiles. So while choosing a Smartphone does not follow the trend but to understand the differences between Android and IOS about their advantages and disadvantages which is supposed to be important when purchasing a Smartphone.

We don't care about who the winner is but about which company's software products and services are of our favor.

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