

# Comprehensive and Technical Overview of Android and IOS OS

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Received: 08 Jan 2015

Revised: 26 Jan 2015

Accepted: 26 Jan 2015

Published: 31 January 2015

**Abstract**— Google’s Android and Apple ios are operating system used primarily in mobile technology, such as tablets and smart phone’s. In these past years, the entire world has witnessed the rise of these two platforms. The iOS platform developed by Apple is the world’s most advanced mobile operating system (OS), continually redefining what people can do with a mobile device. Google’s Android platform developed by Google is an optimized platform for mobile devices with a perfect combination of an application programs, middleware and operating system (OS). This research paper will be extremely helpful to have a comparative overview between these two OS’s and also sheds light on the technical specification, market analysis, development environment aspect of these two largely operating systems. And the Comparison is done on the basis of their performances, their platform and the growth in mobile world. The Salient new key Features introduced in Android and IOS are also described.

**Keywords**— Smartphone’s; Android; IOS; iPhone; Mobile operating system; Comparison; Architecture.

## I Introduction

A Smartphone is a cellular telephone with an integrated computer and other features not originally associated with telephones, such as an operating system, Web browsing and the ability to run software applications. The first Smartphone was IBM’s Simon, which was presented as a concept device (rather than a consumer device) at the 1992 COMDEX computer industry trade show

- A) Some vendor or analyst-suggested requirements for designation as a Smartphone
- A recognized mobile operating system, such as Nokia’s Symbian, Google’s Android, Apple’s iOS or the BlackBerry OS
  - The ability to sync more than one email account to the device
  - Embedded memory
  - Touch screen
  - Wi-Fi, A mobile browser, Internet connectivity
  - Hardware and/or software-based QWERTY keyboard
  - Wireless synchronization with other devices, such as laptop or desktop computers
  - The ability to download applications and run them independently
  - Support for third-party applications
  - The ability to run multiple applications simultaneously[1]

## II – OS Technologies and Architecture

### A) Android Technologies

Android is an open-source software stack created for a wide array of devices with different form factors. The primary purposes of Android are to create an open software platform available for carriers, OEMs, and developers to make their innovative ideas a reality and to introduce a successful, real-world product that improves the mobile experience for users. We also wanted to make sure there was no central point of failure, where one industry player could restrict or control the innovations of any other. The result is a full, production-quality consumer product with source code open for customization and porting.

Android was originated by a group of companies known as the Open Handset Alliance, led by Google. Today, many companies both original members of the OHA and others have invested heavily in Android. These companies have allocated significant engineering resources to improve Android and bring Android devices to market.

The companies that have invested in Android have done so on its merits because we believe an open platform is necessary. Android is intentionally and explicitly an open-source as opposed to a free software effort; a group of organizations with shared needs has pooled resources to collaborate on a single implementation of a shared product. The Android philosophy is pragmatic, first and foremost. The objective is a shared product that each contributor can tailor and customize. [2]

### B. Android Low-Level System Architecture

Before you begin porting Android to your hardware, it is important to have an understanding of how Android works at a high level. Because your drivers and HAL code interact with many layers of Android code, this understanding can help you find your way through the many layers of code that are available to you through the AOSP (Android Open

Source Project) source tree. The following Figure1 shows a system level view of how Android works:

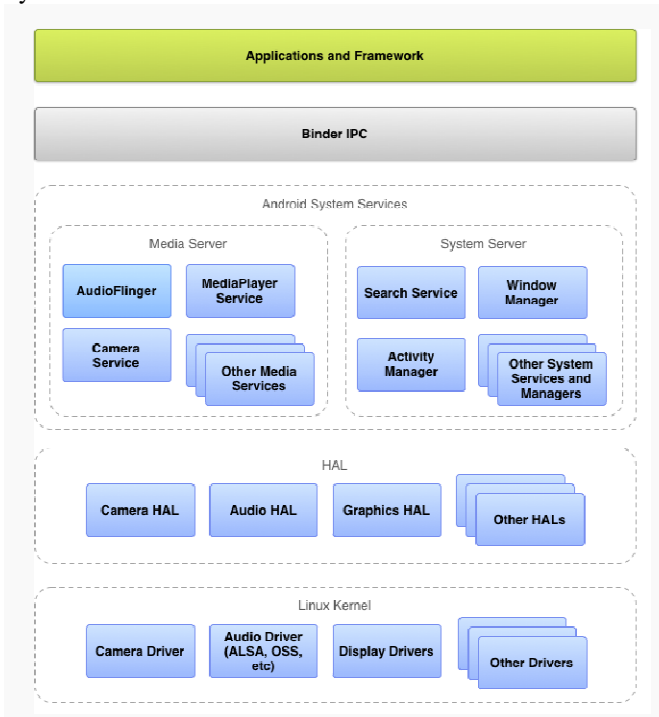


Figure1. Android System Architecture

#### i) Application framework

This is the level that most application developers concern themselves with. You should be aware of the APIs available to developers as many of them map 1:1 to the underlying HAL interfaces and can provide information as to how to implement your driver.

#### i) Binder IPC

The Binder Inter-Process Communication mechanism allows the application framework to cross process boundaries and call into the Android system services code. This basically allows high level framework APIs to interact with Android's system services. At the application framework level, all of this communication is hidden from the developer and things appear to "just work."

#### ii) System services

Most of the functionality exposed through the application framework APIs must communicate with some sort of system service to access the underlying hardware. Services are divided into modular components with focused functionality such as the Window Manager, Search Service, or Notification Manager. System services are grouped into two buckets: system and media. The system services include things such as the Window or Notification Manager. The media services include all the services involved in playing and recording media.

#### iii) Hardware abstraction layer (HAL)

The HAL serves as a standard interface that allows the Android system to call into the device driver layer while being agnostic about the lower-level implementations of your drivers and hardware. You must implement the corresponding HAL (and driver) for the particular piece of hardware that your product provides. Android does not mandate a standard interaction between your HAL implementation and your device drivers, so you have free reign to do what is best for your situation. However, you must abide by the contract defined in each hardware-specific HAL interface for the Android system to be able to correctly interact with your hardware. HAL implementations are typically built into shared library modules (.so files).

#### iv) Linux Kernel

For the most part, developing your device drivers is the same as developing a typical Linux device driver. Android uses a specialized version of the Linux kernel with a few special additions such as wake locks, a memory management system that is more aggressive in preserving memory, the Binder IPC driver, and other features that are important for a mobile embedded platform like Android. These additions have less to do with driver development than with the system's functionality. You can use any version of the kernel that you want as long as it supports the required features, such as the binder driver. However, we recommend using the latest version of the Android kernel. [3]

#### C. IOS Technologies

IOS is the operating system that runs on iPad, iPhone, and iPod touch devices. The operating system manages the device hardware and provides the technologies required to implement native apps. The operating system also ships with various system apps, such as Phone, Mail, and Safari that provide standard system services to the user.

The iOS Software Development Kit (SDK) contains the tools and interfaces needed to develop, install, run, and test native apps that appear on an iOS device's Home screen. Native apps are built using the iOS system frameworks and Objective-C language and run directly on iOS. Unlike web apps, native apps are installed physically on a device and are therefore always available to the user, even when the device is in Airplane mode. They reside next to other system apps, and both the app and any user data is synced to the user's computer through iTunes.

#### D. The IOS Architecture Is Layered

At the highest level, IOS acts as an intermediary between the underlying hardware and the apps you create. Apps do not talk to the underlying hardware directly. Instead, they communicate with the hardware through a set of well-defined system interfaces. These interfaces make it easy to write apps that work consistently on devices having different hardware capabilities.

The implementation of IOS technologies can be viewed as a set of layers, which are shown in Figure 2. Lower layers contain fundamental services and technologies. Higher-level

layers build upon the lower layers and provide more sophisticated services and technologies

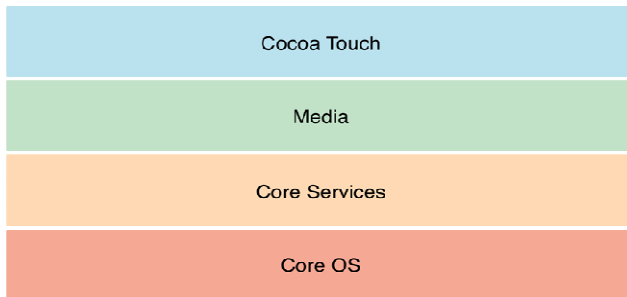


Figure2. Layers of iOS

As you write your code, it is recommended that you prefer the use of higher-level frameworks over lower-level frameworks whenever possible. The higher-level frameworks are there to provide object-oriented abstractions for lower-level constructs. These abstractions generally make it much easier to write code because they reduce the amount of code you have to write and encapsulate potentially complex features, such as sockets and threads. You may use lower-level frameworks and technologies, too, if they contain features not exposed by the higher-level frameworks.

Apple delivers most of its system interfaces in special packages called frameworks. A framework is a directory that contains a dynamic shared library and the resources (such as header files, images, and helper apps) needed to support that library. To use frameworks, you add them to your app project from Xcode. [4]

#### i) Cocoa Touch Layer

The Cocoa Touch layer contains key frameworks for building iOS apps. These frameworks define the appearance of your app. They also provide the basic app infrastructure and support for key technologies such as multitasking, touch-based input, push notifications, and many high-level system services. When designing your apps, you should investigate the technologies in this layer first to see if they meet your needs. [5]

#### ii) Media Layer

The Media layer contains the graphics, audio, and video technologies you use to implement multimedia experiences in your apps. The technologies in this layer make it easy for you to build apps that look and sound great. [6]

#### iii) Core Services Layer

The Core Services layer contains fundamental system services for apps. Key among these services are the Core Foundation and Foundation frameworks, which define the basic types that all apps use. This layer also contains individual technologies to support features such as location, iCloud, social media, and networking. [7]

#### iv) Core OS Layer

The Core OS layer contains the low-level features that most other technologies are built upon. Even if you do not use these technologies directly in your apps, they are most likely being used by other frameworks. And in situations where you need to explicitly deal with security or communicating with an external hardware accessory, you do so using the frameworks in this layer. [8]

### III - Features With Respect To Version

#### A. 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.

##### i) 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

##### ii) 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

### iii) 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.

### iv) Android 4.0 (Ice Cream Sandwich)

- Data usage analysis: Used to show how much data has been used based on users filters
- Android Beam: Two phones can connect simply by touching to share files [9]

### v) Android 4.3 (Jelly Bean)

- Restricted profiles for tablets
- Bluetooth Smart support
- Dial pad autocomplete
- Improved support for Hebrew and Arabic[10]

### vi) Android 4.4 (KitKat)

- A more polished design, improved performance, and new features.
- Google Now, just say “Ok Google” to launch voice search
- Faster multitasking
- A smarter caller ID[11]

### vii) Android 5.0 (Lollipop):

- A bold, colorful, and responsive UI design for consistent, intuitive experiences across all your devices
- New ways to control when and how you receive messages - only get interrupted when you want to be
- More time playing, less time charging
- Keep your stuff safe and sound [12]

### b. Features of 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.

#### i) iPhone OS (iOS 1)

- Touchscreen: 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

- Touchscreen keyboard: A touchscreen 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
- Multitouch 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

#### ii) 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

#### iii) 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

#### iv) iPhone 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
- v) *iphone 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[13]
- vi) *iphone iOS 6*
- Updates to Siri, FaceTime over cellular
  - Photo Stream over iCloud
  - Better sharing options throughout iOS
  - Remodelling of the App Stores
  - enhanced Safari with iCloud tabs
  - VIP mail on the native Mail app and more emoji
  - New calling features, allowing you to set a reminder to call back or reply with a text message. [14]
- vii) *iphone iOS7*
- *New design*
  - IOS camera app
  - Itunes Radio
  - Apple control centre
  - Notification bar
  - Smart multi-tasking
  - Air Drop. [15]
- viii) *iphone iOS 8*
- Elegant and intuitive interface.
  - Built-in features and apps that make your device – and you – more capable.
  - With the App Store, there's almost no limit to what your iOS device can do.
  - iCloud. Everything you need. Anywhere you need it.

- Easy to update.
- Safety and security come standard.
- Accessibility built in.
- Switch languages on the fly.[16]

#### IV Software upgrades

Although Google does update Android frequently, some users may find that they do not receive the updates on their phone, or even purchase phones with out-of-date software. Phone manufacturers decide whether and when to offer software upgrades. They may not offer an upgrade to the latest version of Android for all the phones and tablets in their product line. Even when an upgrade is offered, it is usually several months after the new version of Android has been released.

This is one area where iOS users have an advantage. iOS upgrades are generally available to all iOS devices. There could be exceptions for devices older than three years, or for certain features like Siri, which was available for iPhone 4S users but not for older versions of iPhone. Apple cites hardware capability as the reason some older devices may not receive all new features in an upgrade.

#### V Building and Publishing Apps for iOS vs. Android

Android apps are programmed using C, C++ and Java. It is an "open" platform; anyone can download the Android source code and Android SDK for free. Anyone can create and distribute Android apps for free; users are free to download apps from outside the official Google Play store. There is, however, a one-time \$25 registration fee for developers who want to publish their apps (whether free or paid apps) on the official Google Play store. Apps published on Google Play undergo a review by Google. The Android SDK is available for all platforms - Mac, PC and Linux.

iOS apps are programmed using Objective-C. Developers must pay \$99 every year for access to the iOS SDK and the right to publish in Apple's app store. The iOS SDK is only available for the Mac platform.

Some app development platforms - such as Titanium Appcelerator and PhoneGap - offer a way to code once (say in JavaScript and/or HTML) and have the platform convert it into "native" code for both Android and iOS platforms.

#### VI Choosing between IOS and Android

To summarize the key pros and cons of Android and iOS:

A. *iOS pros and cons*

- **Massive app ecosystem:** distinct advantage for tablet apps while on smartphones popular apps are usually available for both platforms
- **Deeper integration with Facebook and Twitter:** it is easier to post updates and share on social networks using iOS than Android because of how deeply integrated these platforms are with iOS.
- **iOS-only apps** like Passbook, FaceTime, and mobile payments app Square (available on iOS 3GS,4,4S,5 and up, not only for a limited Android phones)
- **Interface is locked down:** Limited customization options for the home screens; only rows of app icons are allowed. No third-party apps are pre-installed by the wireless carrier. Users can only install apps from the App Store
- **Software upgrades:** Apple offers software upgrades to all devices that have the hardware capable of handling the new software. This means devices stay current with software features for at least two to three years.
- **Better privacy controls:** iOS offers better control over the access apps have to users' private information such as contacts and location.

#### B. Android pros and cons

- **Massive hardware selection:** A large number of Android devices are available at various price points, with varying hardware capabilities, screen sizes and features.
- **Highly customizable user experience:** The home screen can be customized with not just app icons but widgets that allow the user to stay connected or informed. Other examples include SwiftKey, which modifies your Android smartphone's keyboard, and apps that emulate older gaming consoles. Google has fewer restrictions than Apple on what kinds of apps it allows in its Play store. Moreover, you can choose to install Android apps from places other than the Google Play store.[17]

	Android	IOS
Advantages	1. Open-source, ease in third-party apps	1. Sufficient documentation
	2. Multi-tasking	2. Sophisticated development
	3. Flexibility	3. Uniformed product

	4. Can solve security issues	4. Support multi-task after V4.0
	5. Can be virtualized	
Disadvantages	1. Versatile products	1. Too many restrictions, not flexible
	2. Insufficient documentation	2. Not ease to third-party apps
	3. If Apps are too long then it force closes those apps.	3. Security issues
	4. Can also slow down	4. Cannot be virtualized

Table 1-Both competitors is defined as follow in form of advantages and disadvantages. [18]

## VII. Market Analysis

From an operating system perspective, Android devices will continue to drive shipment volumes while iOS devices drive revenues. By 2018, Android will control 80% of global smartphones shipped and 61% of revenues, while iOS will control only 13% of volumes and 34% of revenues. With Android volumes so dominant, it is no longer a possibility for new operating systems like Tizen and Firefox to compete on price alone any underdog OS must bring a radically different appeal to gain any significant traction. [19]

#### A. APP DOWNLOADS ON IOS ARE 85% MORE EXPENSIVE COMPARED TO ANDROID

App developers today face a challenging mobile app economy. With over 2 million apps available between Google and Apple's app store, and over 110 billion app downloads, competition for has never been more fierce.

We took a close look at app download trends across the world to make sense of how acute the problem is. Research on the InMobi network for apps downloaded in Q2 2014, between 1st April and 30th June shows some interesting patterns is shown in Table 2.

#### B. App crazy nations

USA and China top the charts at 18% and 10% respectively in terms of share of app downloads. With its high smartphone penetration and a vibrant developer community, US leads the pack. China, despite being a late smartphone adopter is growing quickly fueled by its home-grown brands of mobile phones and the iPhone is shown in Figure 3

#### C. IOS vs Android

When split by operating system, an app download on iOS tends to be more expensive than on Android is shown in Figure 4. [20]

	2014*	2014* Market Share	2018*	2018* Market Share	2014- 2018 CAGR
<b>Shipment (M units)</b>					
Android	1,060	82.3%	1,498	80.0%	9.0%
iOS	178	13.8%	240	12.8%	7.8%
Other OS	49	3.8%	135	7.2%	51.8%
<b>Total</b>	<b>1,288</b>	<b>100.0%</b>	<b>1,873</b>	<b>100.0%</b>	<b>9.8%</b>
<b>Value (US\$M)</b>					
Android	255,102	66.6%	275,248	60.9%	1.9%
iOS	116,540	30.4%	152,626	33.8%	7.0%
Other OS	11,262	2.9%	23,895	5.3%	33.2%
<b>Total</b>	<b>382,904</b>	<b>100.0%</b>	<b>451,769</b>	<b>100.0%</b>	<b>4.2%</b>

Table2. Worldwide Smartphone Forecast by Shipments and Value, 2014 and 2018 (Shipments in millions of units and Value in US\$ Million)

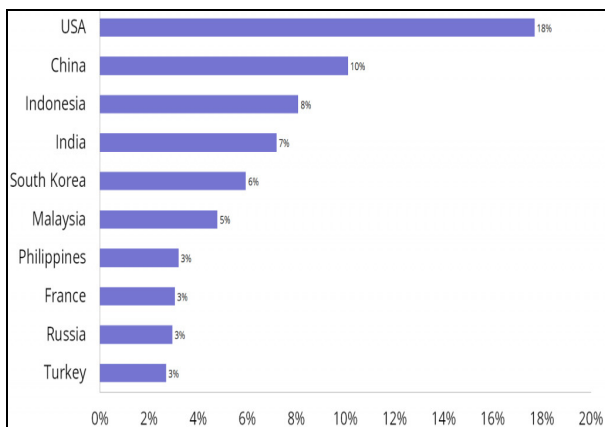


Figure3. App Crazy Nations

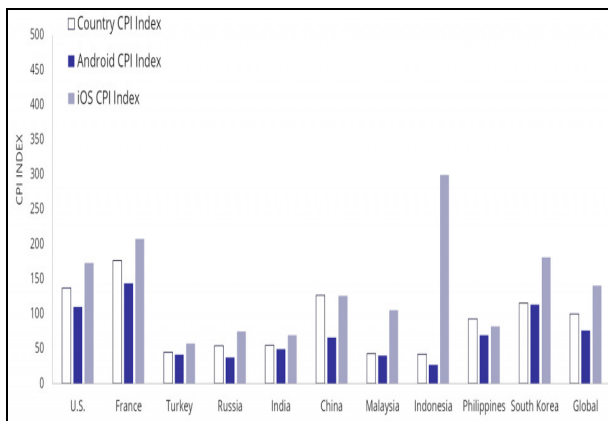


Figure4. IOS vs Android

VIII Comparison Development Environments



A. Language

- i) Android: Java
- ii) iPhone: Objective-C

B. IDE

i) Android

Android development leverages the excellent JDT tools; Everything Java is indexed, the IDE has a rich model of the source code, and refactoring is seamless; JDT’s incremental compiler provides immediate feedback with errors and warnings as you type.

ii) iPhone

Xcode IDE, Instruments, iPhone simulator, frameworks and samples, compilers, Shark analysis tool, and etc.

C. Programming Model

i) Android

With Android’s support for multiple processes and component reuse, the platform itself provides support for Intents and Activities (Intent is just a variant of a command); provide a way of declaring user preferences in XML; XML format is extensible allowing custom UI components to be integrated.

ii) iPhone

MVC design pattern, provide a way of declaring user preferences in XML; iPhone developers that wish to customize preferences will have to implement a UI from scratch.

D. UI Builder

i) Android

Android UI (User Interface) builder can’t display UIs how they’ll actually appear.

ii) iPhone

iPhone app developers are given a good UI builder; It’s flexible and can model some sophisticated UIs. [21]

The following table details some of the technical specifications and overview of major differences of the Android and Apple iOS devices [22]

Company	Google	Apple
Base OS	Linux	UNIX and OSX
Customizable	Yes	Limited, Needs Jailbreak for Extensive Customization
Latest Version	Android 5.0 Lollipop	iOS 8.0
Open Source	Yes	No

<b>Supported Devices</b>	Many devices, including Motorola, Samsung, HTC, LG, Nexus and Sony	Only devices developed by Apple, like the iPhone, iPad and the iPod Touch
<b>Voice Assist</b>	Yes, with Google Now	Yes, with Siri
<b>Apps</b>	1,000,000 + apps on the Google Play Store	1,000,000 + apps in the iTunes store
<b>Languages Supported</b>	32	34
<b>Messaging Medium</b>	Google Hangouts	iMessage
<b>Interface</b>	Touch Screen, Voice	Touch Screen, Voice
<b>Data Transfer</b>	PC, Android Beam	PC, AirDrop
<b>Default Net Browser</b>	Google Chrome	Safari
<b>Game Organizer</b>	Play Games	Game Center
<b>Official Website</b>	www.android.com	www.apple.com

Table 3-An overview of major differences

## IX Conclusion

The Google's Android and Iphone ios have evolved significantly since then, and above we have made equally thorough comparison between these two OS. We can't rank one OS higher than the other. Doing so wouldn't be fair enough as both Android 5.0(Lollipop) and ios 8.1 are reliable, polished and technically feature rich mobile operating system well worthy of the attention they have been getting all over the world. It is the different factor that make them awesome but at the end of the day picking mobile and its operating system (OS) depends on there's priorities. In short we can explain that these two biggest world markets OS are evolving and expanding as iOS to include its own versions of many features that have been on Android for some time. Meanwhile Android is getting a technical makeover and facelift it needs to match iOS in terms of speed and battery life.

It might sound that two operating system's are meeting at the end, but still apple controlling larger application that is used

to do certain tasks, while android let you to use any application you want practically anything. And the other differences are emerging, such as content sharing of apple while android lets you share device

We doubt that either operating system (OS) has changed significantly enough to sway dedicated mobile users from one to the other. However, the both operating system (OS) are improving and that's the important thing. As they continue to take the best ideas of each other's, as they appear to be at present then the competition will make both operating system's (OS) better off in the long run.

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