Indira Gandhi National Open University
School of Computer and Information Sciences

Commonwealth of Learning

INTRODUCTION TO MOBILE ARCHITECTURE

Mobile Operating Systems

2

Introduction to Mobile Architecture

School of Computer and Information Sciences
Indira Gandhi National Open University

Commonwealth *of* Learning

Block

2

MOBILE OPERATING SYSTEMS

INTRODUCTION TO MOBILE ARCHITECTURE

This course has been developed as part of the collaborative OER Course Development for ICT Skills initiative of the Commonwealth of Learning (COL). COL is an intergovernmental organisation created by Commonwealth Heads of Government to promote the development and sharing of open learning and distance education knowledge, resources and technologies.

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Published by:

Indira Gandhi National Open University, Maidan Garhi, New Delhi-110068, India.

The course has been developed with the support of the Commonwealth of Learning, Canada.

Acknowledgements

Indira Gandhi National Open University wishes to thank those below for their contribution to development of this Course Material:

Staff of School of Computer and Information Sciences, Administration, Finance & Accounts Division and Electronic Media Production Centre, IGNOU, New Delhi, India and all External Experts. Special thanks to Dr.Sanjaya Mishra, Education Specialist(eLearning), Commonwealth of Learning, Canada for his support and guidance through out.

BLOCK INTRODUCTION

This is the second block of the Course. This block introduces the learner to Operating Systems that were running Mobile devices.

Operating System plays a major role on the entire functionality of a device irrespective of the fact that it is a PC, Laptop , Tablet or a Mobile phone. There are numerous operating systems for each category of devices. In the case of Mobile devices also, there are large number of operating systems. In this block, we mainly discuss three popular Mobile operating systems, namely, Android, iOS and Windows Mobile. Initially, we discuss operating systems in general and then discuss specific Mobile operating systems.

The units in this block will demonstrate the running of some apps on some of the Mobile operating systems as well as configuring the concerned devices for some of the most important functionalities.

This block consists of four units and is organized as follows:

Unit 4 introduces Mobile Operating Systems (MOS). It covers basic functions of an Operating System followed by specifics of MOS. It also briefly discusses about the MOS that are currently in market and those that are popular but discontinued by the concerned developers.

Unit 5 introduces the basics of Android. The unit specifically discusses interface of Android devices, applications supported by them, the way the memory is managed and support for advanced features such as Virtual Reality.

Unit 6 introduces iOS which runs iPhone and iPAD. The accessibility features in addition to its flagship app SIRI are discussed in addition to other features of iOS.

Unit 7 introduces Windows Mobile operating system. The unit covers various versions of Windows operating system that was used to run on Windows based mobile devices including the latest Windows 10 Mobile operating system.

UNIT 4 INTRODUCTION TO MOBILE OPERATING SYSTEMS

Structure

4.0 INTRODUCTION

An Operating System may be defined as Resource Manager. An Operating system (OS) handles all hardware & software resources of the Computer. It works as a communication medium between various components of Computer as shown in Figure 4.1

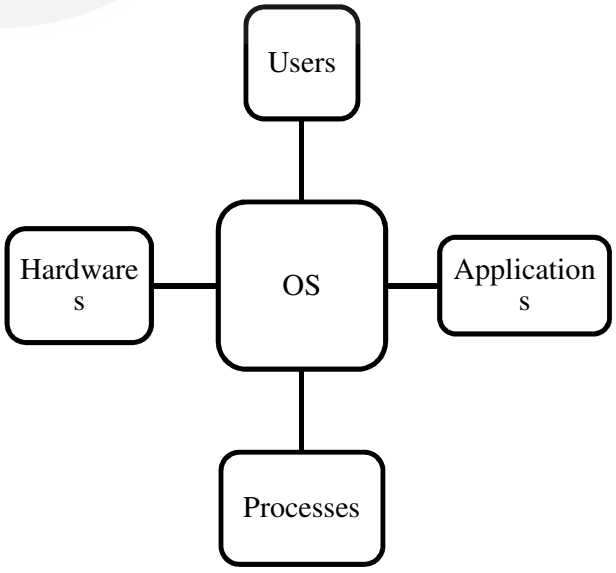

Figure 4.1 : Operating System and other elements

An Operating System not only manages but also allocates resources. The following are some of the basic functions of an Operating System:

- Peripheral Device Management;
- Data File Management;
- Memory Management; and
- Process Management.

4.1 OBJECTIVES

After going through this unit, you should be able to know

- meaning of Mobile OS;
- basic functions of a Mobile OS;
- architecture of a Mobile OS;
- about various Mobile Operating Systems; and
- existing and discontinued Mobile Operating Systems.

4.2 BASIC FUNCTIONS OF AN OPERATING SYSTEM

The following are some of the basic functions of an Operating System:

4.2.1 Peripheral Device Management

An OS handles communication between various devices with the help of its associative drivers. It keeps tracks of every connected device in the system. The unit which keeps track of devices is known as the Input-Output Controller or I/O controller which identifies which assigns processes to devices for specific duration. It allocates and de-allocates processes to devices in an effective way.

4.2.2 Data File Management

For smooth navigation and use of data files; a file system is generally organized into directories/folders which will consist of files and sub directories. Operating System maintains a log of information with respect to every file and folder such as location of the file, users of the file, date of creation, access rights etc. This information will enable OS to allocate/de-allocate resources efficiently.

4.2.3 Memory Management

Memory management involves management of Primary Memory which is a collection of data or bytes where each datum or byte has its own memory address or location. Primary memory provides a quick repository which can be accessed straightaway by the Central Processing Unit (CPU). Operating System keeps tracks of primary memory. That is, which portion of the memory is in use and by whom. Also, it keeps track of portions that are not in use.

4.2.4 Process Management

An OS also manages the allocation of the processor to various processes. The assignment is for a fixed period. This is known as Process scheduling.

Operating System keeps track of processor and status of each process in the memory. The unit which is responsible for executing this activity is known as traffic controller which allocates the processor to a process and also de-allocates processor when no longer required.

4.3 MOBILE OPERATING SYSTEMS

Mobile operating system is the system software which operates upon mobile devices. It is the software that provides the base upon which applications or programs can be run effectively on mobile phones, smart phones, tablets and hand held devices. Apart from the basic functions of an operating system, the mobile OS also handles cellular & Wi-Fi connectivity as well as access to device itself.

Now a days, mobile phones are used frequently to check emails, play games, watch news and make video calls etc. This development has brought latest functions to mobile phones that were previously only available on our Computers. There are hundreds of thousands of apps available each with its own purpose. You may download a news app that tells you the current news or updates in your city or around the globe or a game app. Indeed, we can find an app for any function that we are looking for.

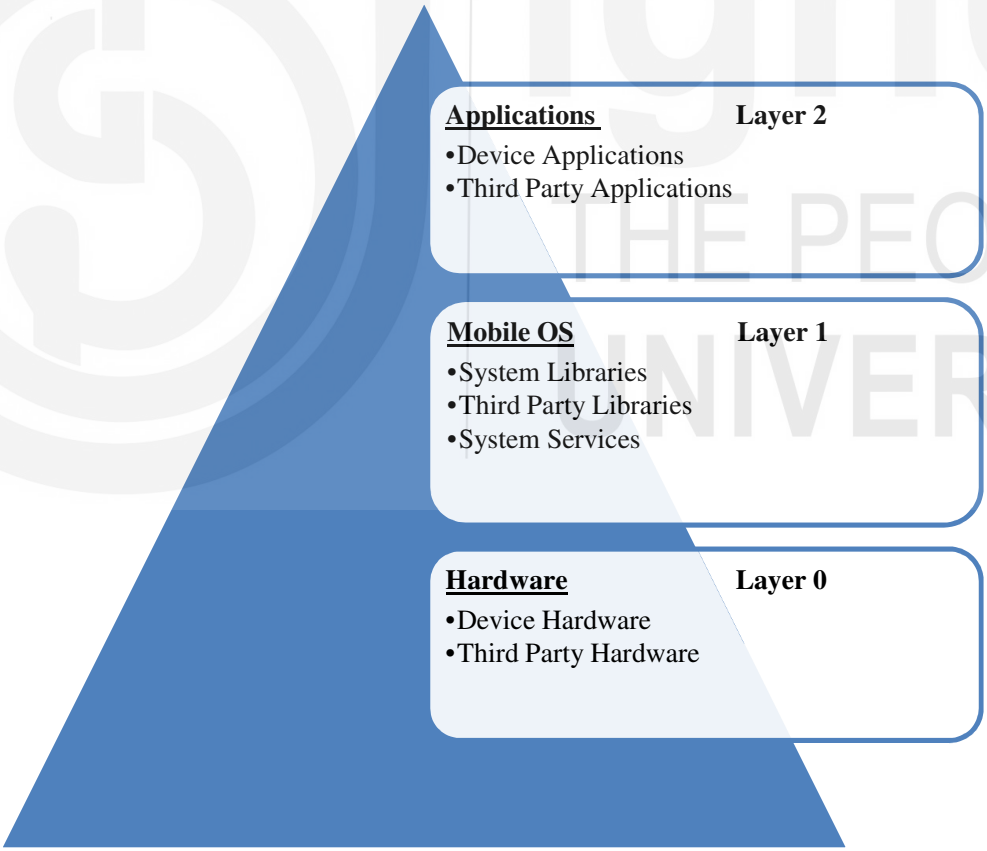

Figure 4.2 : Layers of a Mobile OS

The following are different layers of a Mobile Operating System (Figure 4.2):

4.3.1 Layer 0

It includes device hardware and third party hardware.

Device Hardware

Device Hardware refers to the identification of all physical components which are essential to develop a complete product in terms of its usability. The hardware components of the mobile include circuits, IC's, screen, and speakers which are needed to make a complete mobile phone. The hardware is basically designed while keeping the software requirements in mind, software or application will run on designated hardware only like Apple iOS can be configured on apple manufactured devices.

Third Party Hardware

It includes all physical components of the mobile devices which are manufactured by companies besides the original mobile manufacturer like using Samsung earphone in Apple iPhone. In other words, the hardware or physical component of the system which is not supported by the original manufacturer is known as third party hardware. For example, you buy anASUSlaptop and then upgrade it by installing third party hardware, like an Intel video card and a hard drive ofwestern digital technologies. Since the hardware is not pre-installed with the laptop and are bought from companies other than ASUS, they are called third party hardware.

4.3.2 Layer 1

It includes system libraries, third party libraries and system services.

System Libraries

These are In-built software resources which are basically developed for smooth functioning of system applications. It includes configuration, message templates, help data etc. In other words, System Libraries are the programs which are developed for providing the base, with the help of which application program can be run smoothly on the device. For example, playing a game on mobile phone required a graphics library for rendering different scenes, similarly for smooth functioning of system, system libraries are needed.

Third Party Libraries

These are those software resources which are required for running third party applications like flash player is required for running SWF (Small Web Format) file on the web browser. Similar to third party hardware, third party libraries are offered by the companies besides the original manufacturer of the application. For Example, you might require plug-in for running windows applications in Macintosh environment. We use Microsoft office in android operating system with the help Microsoft libraries designed for android so we can say third party libraries are used to support third applications.

System Services

These are the services which are actually required for running a mobile OS like notification manager, message organizer, contacts, dialing services etc. No mobile can work without system services; they have to be initiated or started first before using any phone. For example, you cannot write on a paper without a pen similarly all system services should be loaded first; boot manager is required for starting the operating system. Wifi service is needed for establishing a wireless connection etc.

4.3.3 Layer 2

It includes device applications and third party applications.

Device Applications

These are the pre-installed applications which come up along with the purchase of your smart phone;these are pre-loaded in the smartphones. For example, if you buy an apple iPhone, then you can find Apple iTunes, Apple Store, iWork etcare pre-installed in your phonesimilarly android phones come up with Google play store, google drive, YouTube, Gmail etc.

Third Party Applications

These are the extra applications which are not bundled along-with device applications. Basically, these applications are used to extend the features of your device. They not pre-installed applications, a user has to download and install it from the app store or play store. Some of the most commonly used third applicationsare MX Player, WhatsApp, Twitter etc.

4.4 Architecture of Android

Figure 4.3 depicts architecture of Android mobile operating system.

The architecture of Android includes the following four layers:

- Application
- Application Framework
- Libraries or Android Runtime
- Linux Kernel

Applications

This is the top most layer of the android operating system that categorized the applications or apps in to two parts, the first one manages the native or device applications and the second one manages the third part applications.

Application Framework

This layer provide the environment or base upon which different application can be run smoothly, like activity manager keeps tracks of the activities which are being carried by different applications, location manage uses the GPS to identify the location of the device, window manager maintains a cache or record of already opened applications etc.

Libraries or Android Runtime

This layer is used to identify the use of different resource libraries, which are required by different applications, like SQLite, which is database for storing data of mobile applications, Free type library is used to identify the font to be loaded, SSL maintains a secure connections if payment related app is functioning etc.

Linux Kernel

This layer handles different physical component of the device, by managing the processes, memory, power and drivers. It acts as an interface between the hardware and applications.

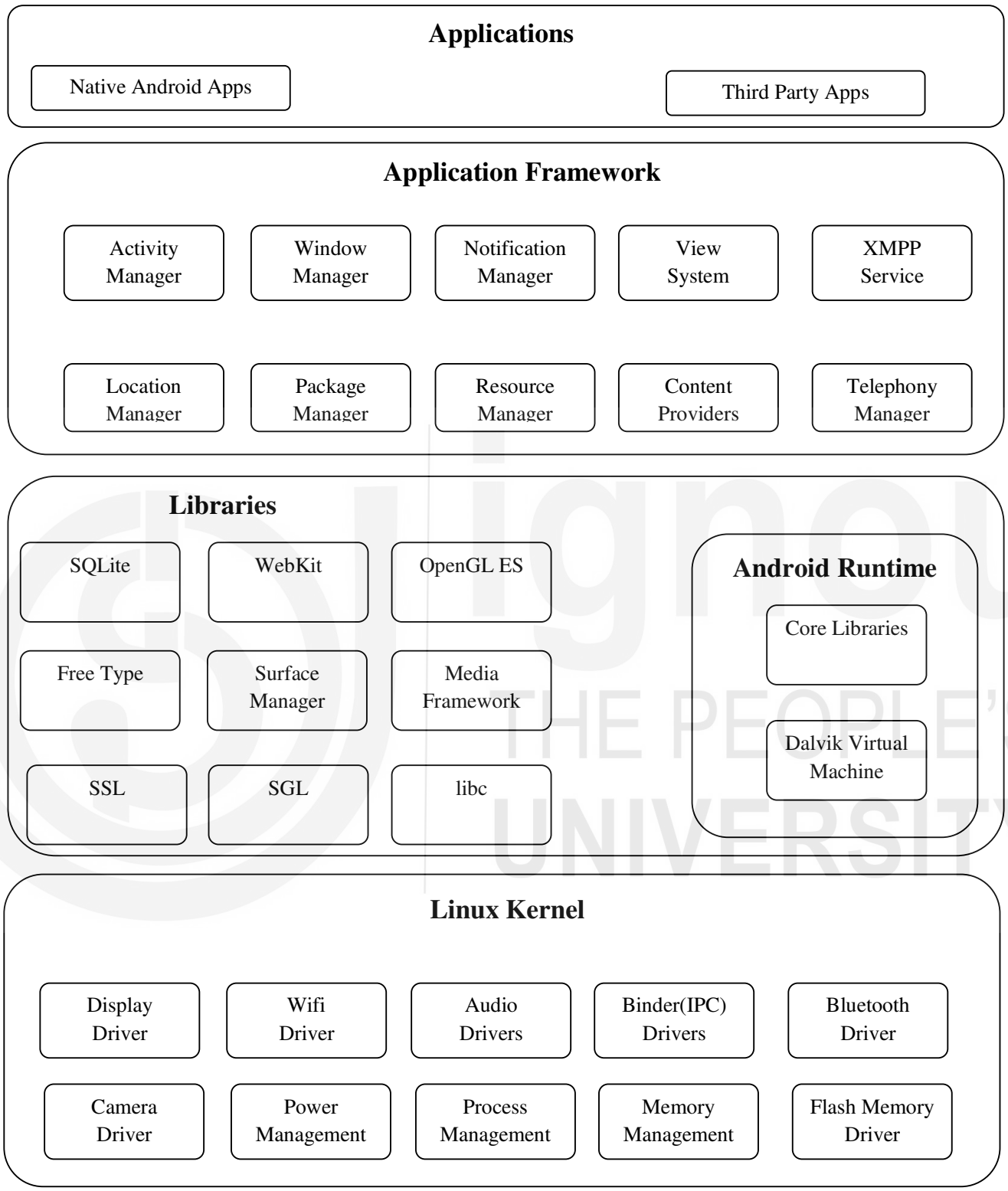

Figure 4.3 : Architecture of Android Mobile Operating System

4.5 KNOWING THE OPERATING SYSTEM OF A MOBILE PHONE

Mobile operating systems are tightly integrated with appearance, interface and function of a mobile phone that the name and version of its operating system software can be found only from concerned phone's *Settings* as shown in figure 4.4. There are some examples of mobile operating systems which includes Apple iOS, Google Android, and Microsoft's Windows Phone OS.

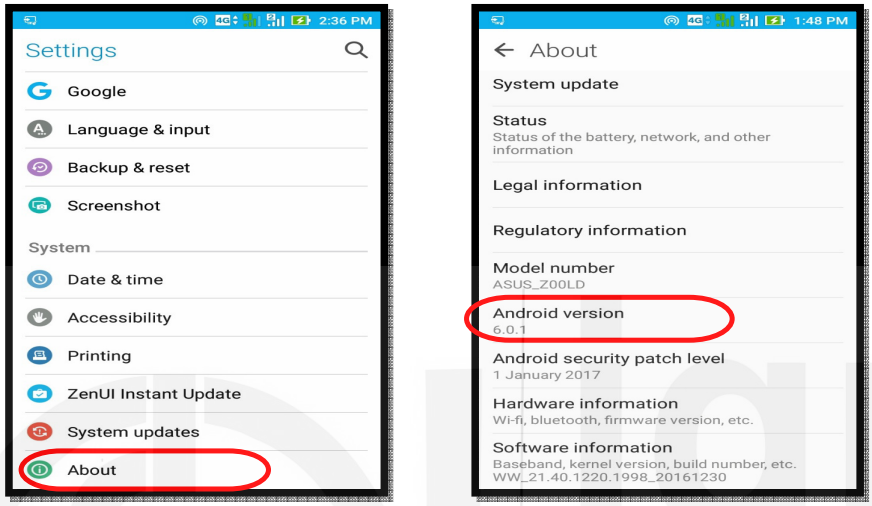

Figure 4.4 : Knowing the operating system of the mobile phone

Most of the mobile operating systems are bound to particular hardware that they come up with little flexibility and have some restrictions. For example, Apple's iOS permits users to install applications only from Apple's *Appstore*. In the case of Android, its *Play Store*.

Here's the list of commonly used mobile operating systems:

- Apple's iOS
- Google's Android
- Microsoft's Windows Phone OS
- Nokia's Symbian
- BlackBerry OS (Research in Motion)

Check Your Progress 1

1) An Operating System may be defined as …….

2) In …….. Device Management, An OS handles communication between various devices with the help of its associative drivers.

3) …….. layer of a Mobile OS includes device applications and third party applications

4) ActivityManager and WindowManager are part of …….. layer of Android architecture

5) …….. menu includes information about the operating system and its version in Mobile phone

4.6 DISCONTINUED MOBILE OPERATING SYSTEMS

The following are the discontinued Mobile Operating Systems. Though they are discontinued, some of them are still used. Discontinuation means that there will be no further upgrades or releases of new versions. Table 4.1 describes them briefly:

- Firefox OS
- Bada
- Symbian
- MeeGo
- webOS
- BlackBerry OS

Table 4.1 : Discontinued Mobile Operating Systems

Firefox OS	Firefox OS was introduced by the Mozilla Foundation for tablet PCs, smartphones, smart TVs and other handheld devices.It was an open source operating system that supports all standard web based technologies (HTML, CSS and JavaScript). It was publically launched in February 2012 and by the end of December 2014 it was offered from 14 operators in 28 countries. In September 2016, Mozilla formally declared that it would stop further development of Firefox OS smartphones.
Bada	Bada is a discontinued proprietary mobile Operating System of Samsung Electronics which wasintroduced in 2010. Samsung Wave was the first smartphone to use Bada OS. Bada supports mobile features like 3D graphics, multipoint-touch and of course, application downloads and installation. It was publically launched in February 2010 in Barcelona. In February 2013, Samsung publically announced that it will stop developing Bada.
Symbian	Symbian mobile operating system was initiallyfocused at mobile phones that provide a high-level functionality for exchanging information and managing personal information. This mobile OS acts as a middleware with transmission of wireless signalsusing integrated mailbox and the integration of Java and personal information managementfeature. It was the biggest collaboration between software and mobile manufacturing companies like Psion Software, Ericsson, Motorola and Nokia. The Symbian foundation shattered in late 2010 and only Nokia managed to control the development of the OS.

	The last Symbian smart phone from Nokia was Nokia 808 Pure View.
MeeGo	It is an open source discontinued mobile operating system hosted by the Linux foundation and was mainly targeted at mobile phones and information gadgets in the electronics market. In February 2010, Nokia and Intel announced the launch of MeeGo T01. In September 2011, it was discontinued in favor of Tizen (a new Mobile OS).
webOS	Palm Inc, a US based company was the originator of the webOS mobile operating system. It was the successor to Palm Operating System but later HP acquired Palm and now known as webOS in HP repository. HP deploys webOS in a variety of its devices including smartphones and HP Touchpad. webOS runs on the Linux kernel.
BlackBerry OS	Research In Motion introduced Black Berry OS for its deploymentin company's most popular Black Berry phone which was popular with corporate group users as it provides compatibility with Microsoft Exchange, Lotus Domino, Novell Group Wise email and other business software.Now it comes under the category of discontinued mobile operating systems. It was discontinued after the release of BlackBerry 10.

4.7 EXISTING MOBILE OPERATING SYSTEMS

The following are some of the existing Mobile Operating Systems. Table 4.2 describes them briefly:

- iOS
- Android
- Windows 10 Mobile
- Sailfish OS
- Tizen
- Ubuntu Touch

Table 4.2 : Existing Mobile Operating Systems

iOS	iOS mobile operating system was initially introduced by the Apple Inc for its deployment in iPhone devices. Now it is compatible with variety of Apple devices such as iPhone, iPad, iPad 2, iPod Touch etc. You can see iOS mobile operating system on Apple's own manufactured devices becauseapple does not grant license for its deployment on third-party hardware. iOSmobile operating system is extendedusing Mac OS X operating system of Apple Inc.

Android	Android is the most commonly known mobile operating system which was introduced by the Google under the category of Google's open and free software repository.The free software repositoryconsists of an operating system, middleware and also commonly used applications on mobile devices. The development of android version is inspired from the word "dessert" every version is coming up in alphabetical order with further updates and enhancements. The existing android version names are • Cupcake • Donut • Eclair • Gingerbread • Honeycomb • Ice Cream Sandwich • Jelly Bean • KitKat • Lollipop • Marshmallow • Nougat
Windows 10 Mobile	Windows 10 Mobile is the newest version of the windows operating system where Microsoft is trying to unify their desktop computer, tablet and mobile operating system in to a single OS. Windows 10 Mobile will carry many of the same features as it desktop version. In November 2015, Microsoft launched windows 10 mobile OS with Lumia 950, Lumia XL and Lumia 550.
Sailfish OS	Sailfish OS is the product of Jolla ltd which is based on Linux kernel. It is coming up with Jolla smartphones and tablets. Also targeting controlling and smart building equipment's. It is an extended version of MeeGo OS which was developed by Nokia and Intel.
Tizen	Tizen mobile operating system is an open and flexible operating system whose aim is to serve different industry requirements including mobile operators, device manufacturers, and software developers. It is mainly focusing on UI/UX development in order to meet the requirements of specific user segments.Now Samsung is the only Tizen member who is incorporating and further developing the operating system. In January 2015, Samsung released the Tizen-based Samsung Z1 mobile phone in India.
Ubuntu Touch	This Mobile OS is developed by Canonical Ltd as a mobile version of Ubuntu operating system. It is aimed at touch screen devices like smartphones, tablet computers and other handheld devices. In October 2011, it was announced for tablets, smartphones smart TVs and smart devices like smart watches, head units in car, smart wrist bands etc. It is coming up with Samsung Galaxy S4 Google Edition and Nexus 4 phones.

4.8 TYPES OF MOBILE OPERATING SYSTEMS

As with Software, there are open source and closed source mobile operating systems.

The following are some of the open source mobile Operating Systems:

- Tizen
- Plasma Mobile
- Firefox OS
- Sailfish OS
- Ubuntu Touch

The following are some of the closed source mobile operating systems:

- iOS
- BlackBerry OS
- Symbian
- Bada
- Palm OS

Figure 4.5 depicts the usage trend of various Mobile / Tablet operating systems during January , 2015 to December, 2016.

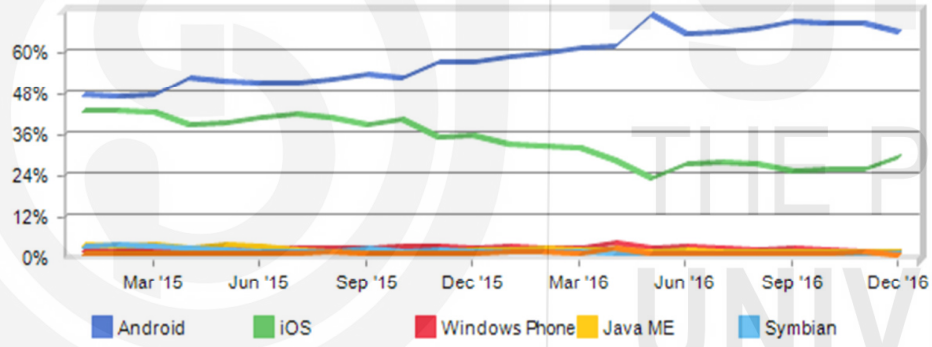

Figure 4.5 : Usage trend of various Mobile/Tablet operating systems

Courtesy: https://www.netmarketshare.com

The Mobile OS is an Amazing platform for developers for developing mobile apps innovatively and publish in market instantly. Now a days, mobile OS is also diverging in areas like tablets, smart TVs, Cameras, Smart watch etc. The most common OS's for mobile devices are Apple's iOS and Google's Android which still show growth. Mobile OS's like Research in Motion's (RIM's) BlackBerry OS and Microsoft's Windows Phone are down the ranks. As far as uses of mobile phones are concerned, India has become the second highest country after china to have maximum number of mobile users.

4.9 SUMMARY

From last few decades, smart phones have changed our lifestyle and now, tablets have entered into the market as well. These smartphones are carrying a notable impact on our lives and are in fact re-constructing the way we get information and communicate with others. This is not because of the device

hardware but the specialized software that these devices run and most crucial, their operating systems. Similar like conventional operating systems (like Windows, Linux, BSD etc.) or other versions of the same operating system (like Windows XP, Windows Vista, Windows 7 etc.), most of the smartphones can also run varied versions of the operating system they were made for and in some cases, they might even be capable to run operating systems they weren't made for. In general however, a smart phone with Google Android will only run a version of Google Android where as an Apple iPhone will only run an iOS version.Manysmartphone manufacturers use their own proprietary mobile operating system for their phones and tablets. A known example is Apple, with iOS being the operating system developed for Apple iPod, Apple Touch, iPhone and iPad devices. Similarly, RIM(Research in Motion) who use their proprietary BlackBerry OS for all BlackBerry phones and tablets, and HP, use their proprietary Palm Web OS for their Palm smartphones and tablets. A features of such operating systems is that they all have a muchuniformed look and feel across all devices that they run on, the way Mac OS X looks and act the same way on a MacBook Pro as it does on an iMac or a MacBook Air.

In this unit, we studied the basic architecture of a Mobile operating system, and architecture of most widely used Android. Also, discussed were some of the discontinued Mobile operating systems that were popular in the past, still some of being used, but with no further upgrades or releases of versions by respective companies that developed them. We also discussed some Mobile operating systems that were currently used in the market. After studying the unit, it's also possible to find the operating system along with version information of your mobile phone. The unit was concluded with sharing the usage trends of some of the mobile operating systems.

4.10 SOLUTIONS/ANSWERS

1) Resource Manager
2) Peripheral
3) Top (Layer 2)
4) Application Framework
5) Settings

4.11 FURTHER READINGS

- Mobile Operating Systems and Programming: Mobile Communications by Dr. ArashHabibiLashkari, Publisher: VDM Verlag Dr. Müller (July 7, 2011) ISBN-10: 3639369173, ISBN-13: 978-3639369175
- Mobile Phone Operating Systems: Symbian OS, Android, Mobile Operating System, Webos, S60, Cyanogenmod, Symbian Platform, Blackberry OS by Books LLC, Publisher: General Books LLC, 2010, ISBN:1157464408, 9781157464402
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- https://developer.android.com
- http://www.apple.com
- http://www.windowscentral.com
- https://www.netmarketshare.com

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UNIT 5 BASICS OF ANDROID

Structure

5.0 INTRODUCTION

An Android is one of the most widely used mobile operating system that supports variety of Smartphone's and tablet computers. Initially, Android was developed by the Android Inc. which Google bought in 2005. In 2007, Google released the first beta version of the Android Software Development Kit (SDK), whereas the first public version, Android 1.0, was announced in September 2008. Android source code is available under free and open source licenses. For mobile devices, Android provides a unified approach to application development that means mobile developers develop apps only for Android, and their applications should be able to run on different devices powered by Android. It is a standalone software base that can be deployed easily on any type of hardware configurations.

Features of Android

Android is a robust operating system that challenges Apple 4GS and supports good number of features.. Table 5.1 lists some of the features of Android.

Features	Description
Interface	Quite simple and attractive user interface
Database	SQL Lite, a lightweight RDBMS(Relational Database Management System)
Multi touch	Multi touch is available, two or more objects can be touched
Multi-Tasking	Two or more applications can be run at the same time
Multimedia Support	H.264, H.263, , AMR, MPEG-4 SP, AMR-WB, AAC, HE-AAC, AAC 5.1, MP3, WAV, MIDI, JPEG, PNG, BMP and GIF
Connectivity	Bluetooth, Wi-Fi, LTE, NFC, GSM/EDGE, IDEN, CDMA, EV-DO, UMTS, and WiMAX.
Adjustable Widgets	User can adjust widgets to show and hide contents, can resize them
Messaging Service	SMS(Short Messaging Service),MMS(Multimedia Messaging Service) and GCM(Google Cloud Messaging)
Internet Browser	Chrome, Firefox with support for HTML5 and CSS3

5.1 OBJECTIVES

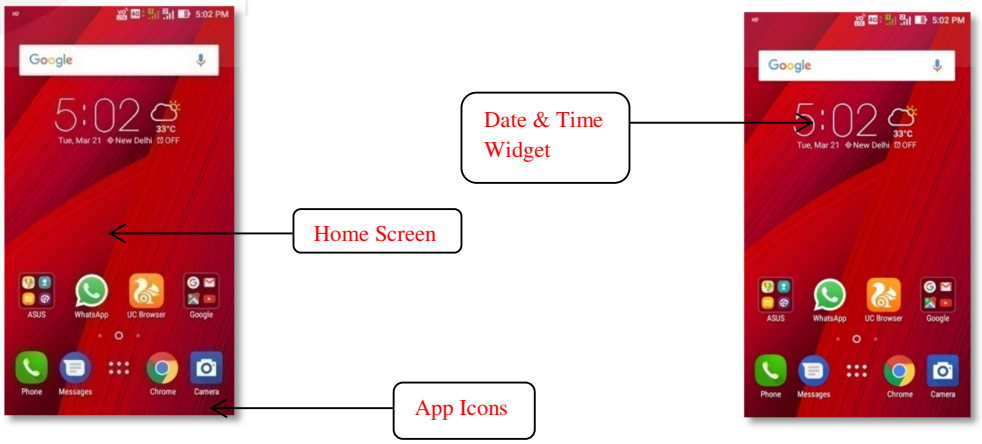
After going through this unit, you should be able to

- know the features of Android OS;
- understand interface &memory management of Android OS;
- develop a simple Android app; and
- understand the concept of virtual reality.

5.2 INTERFACE

The default interface of Android mobile OS is quite simple and easy, it is based upon human–computer interaction approach such as squeezing, tapping and swiping to control on-screen objects, using a virtual keyword. With the help of Bluetooth or USB, we can link-up keyboards, portable speakers; pen drives etc with our mobile phones. The reaction to any information is intended to be brisk and gives a liquid touch interface, regularly through the vibration feature of the gadget to give reply to the user. To react to extra user activities In-built equipment, for example, accelerometers, gyrators and proximity sensors are utilized. For instance altering the screen from portrait to landscape or empower the user to direct a vehicle in a racing game by pivoting the gadget, recreating control of a steering wheel. Home screen is the underlying route on any Android devices which is like the desktop found on PCs. Android home screens are made out of application symbols and widgets. App icons are used to start the relevant app whereas widgets are used to display the live auto-updating content such as a weather forecast, the user's email inbox, news widgets etc. On top of the mobile Home screen there is a status bar that shows information about the Android phone and its network. Status bar can be pulled down to uncover a warning region where applications show critical data or updates. You can drag any application on to the home screen and recent screen lets users to switch between recently used apps.

Figure 5.1 shows some the interfaces of Android OS.



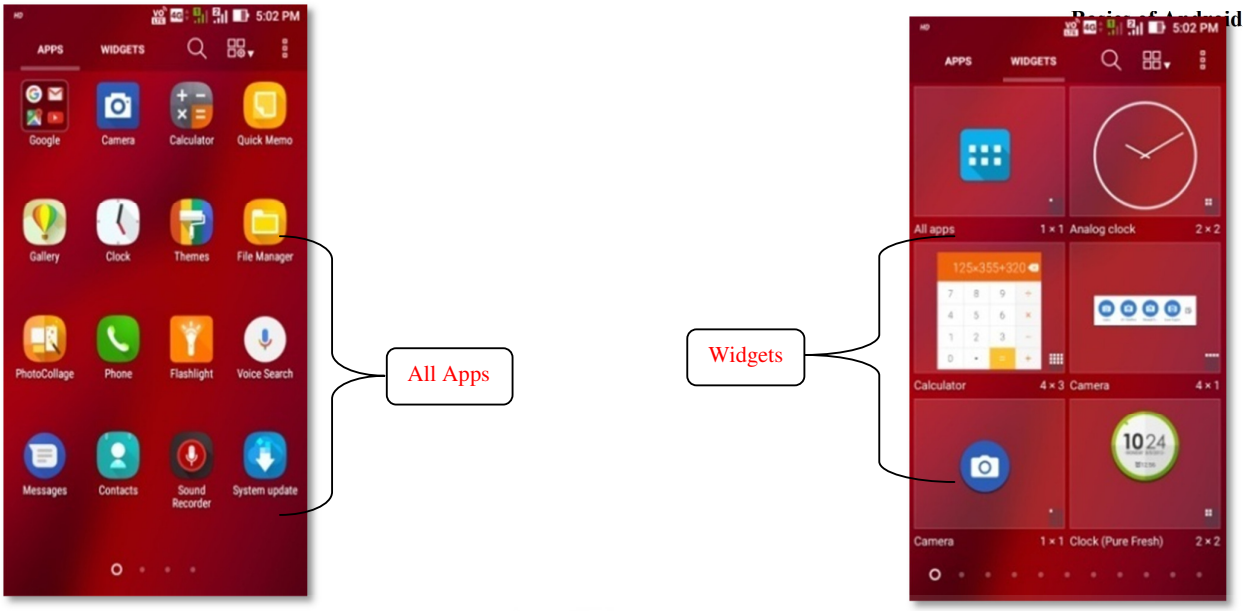


Figure 5.1 : Interfaces of Android OS

5.3 APPLICATIONS

Applications which are commonly known as ("apps") expand the functionality of the device and are written using the Android software development kit (SDK) and, often the Java programming language. The SDK bundled with a set of development tools like debugger, programming libraries, a handset emulator, documentation, instructional exercises and test code. Android has turned into a developing determination of third-party applications, which can be acquired by downloading and installing the APK (Android application package) file, or by downloading them with the help of an application store which assists users to install, update, and remove applications from their gadgets. Google Play Store is the most ordinarily known application store introduced on Android phones that consent to Google's similarity prerequisites and enables users to peruse, download and update applications which are made accessible by Google and other third-party app developers. Open nature of Android, allows various third-party application stores likewise accessible for Android, either to give an alternate for gadgets which are not pre-stacked with Google Play Store and applications that can't be offered on Google Play Store because of policy infringement or because of different reasons. Amazon Appstore, GetJar, and SlideMeare some of the commonly known third-party app stores.

Now let's learn to develop a "Hello World" app, First of all you have to download and install the Android Studio from https://developer.android.com/studio/index.html

Start your Android studio and then in the Welcome window, Click on *Start a new Android project* as shown in Figure 5.2.

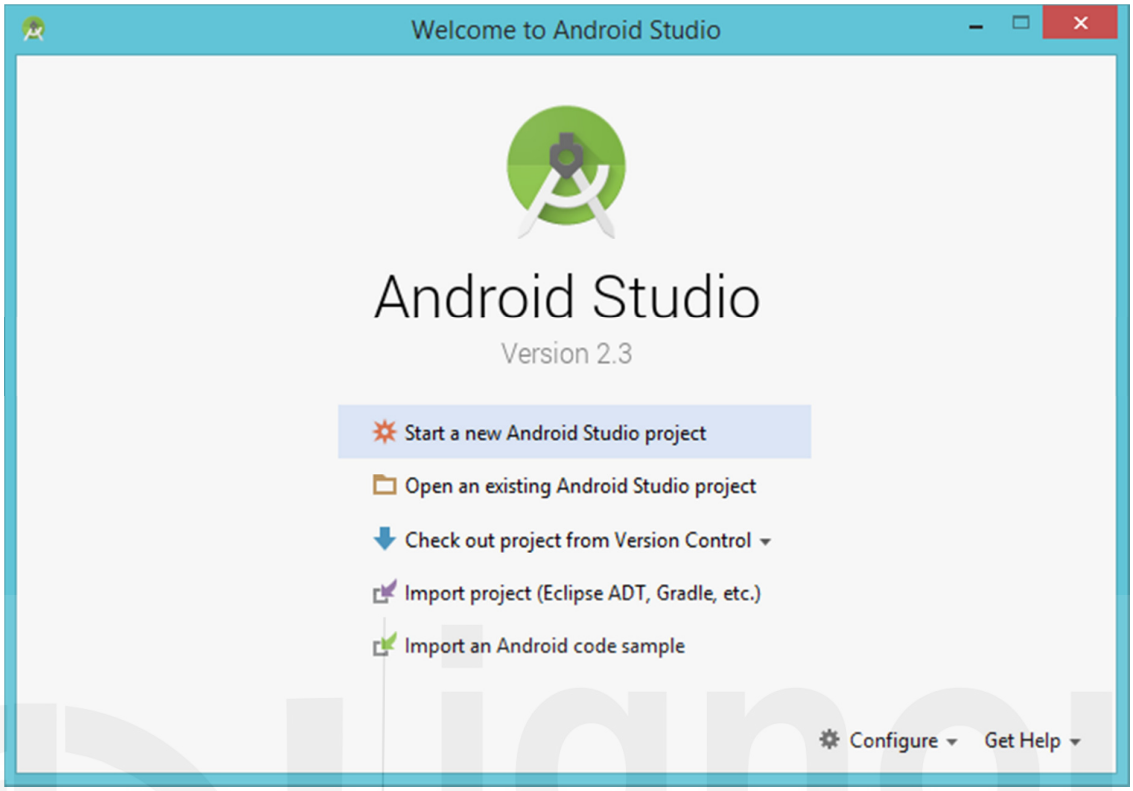


Figure 5.2 : Android Studio

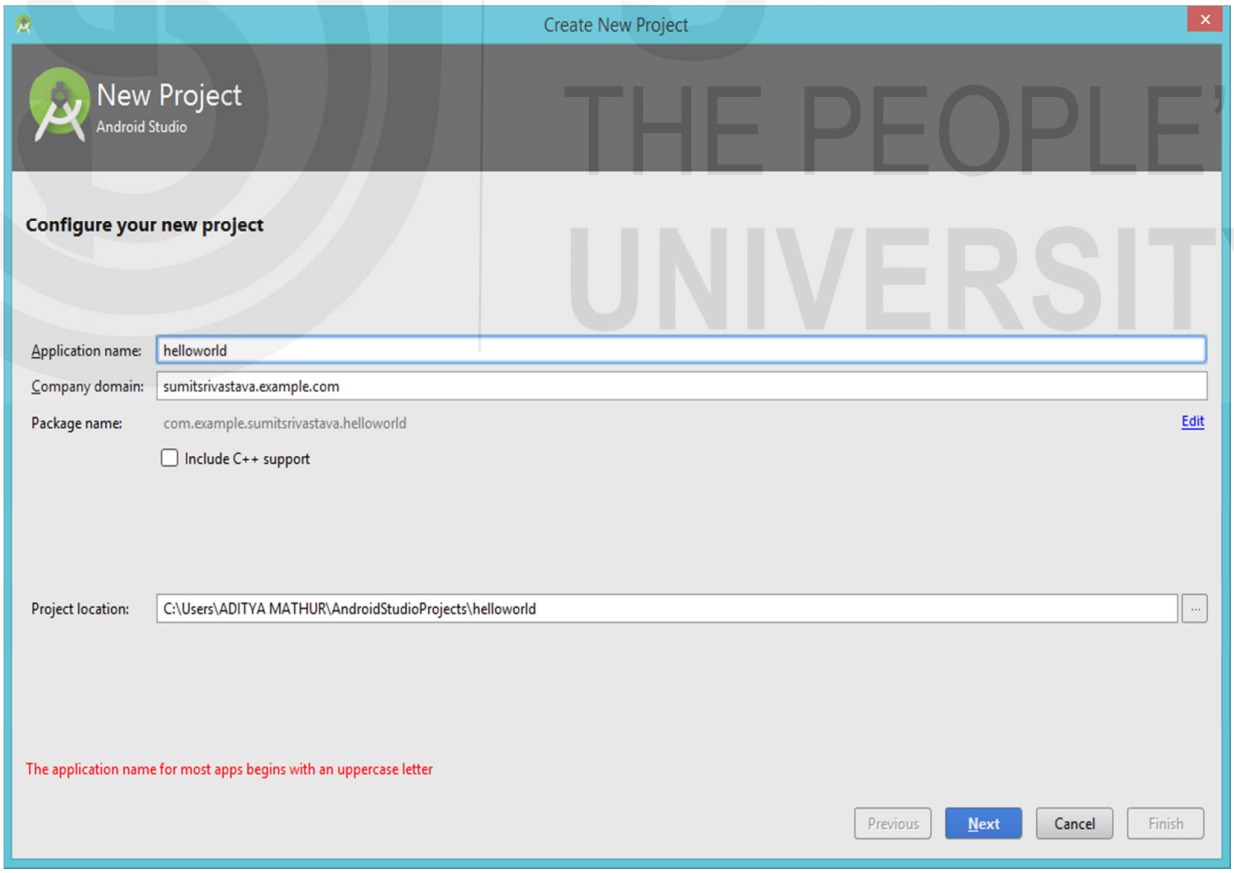


Figure 5.3 : Configuring new Project in Android Studio

In the New Project window, enter application name as *helloworld* as shown in Figure 5.3.

You can also change the location of your project, but, don't select any other option. Now, click *Next*.

In the next window titled *Target Android Devices*, go with default values and then click Next as shown in Figure 5.4.

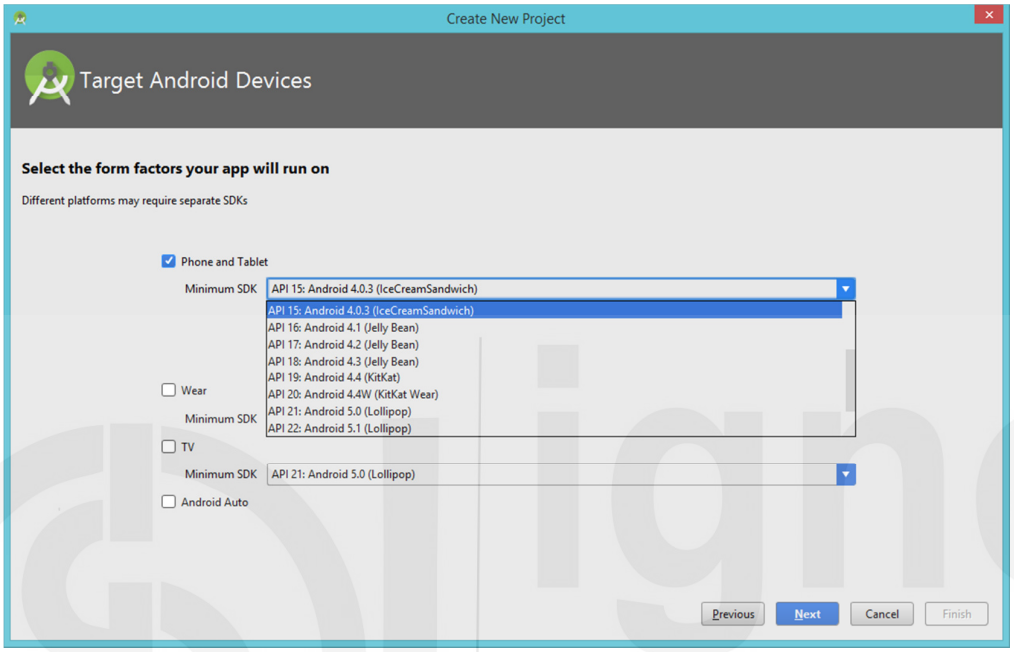


Figure 5.4 : Selecting the Target Android Devices

After clicking *Next* in *Target Android Devices*, requested components shall be installed as shown in Figure 5.5. Click *Next*.

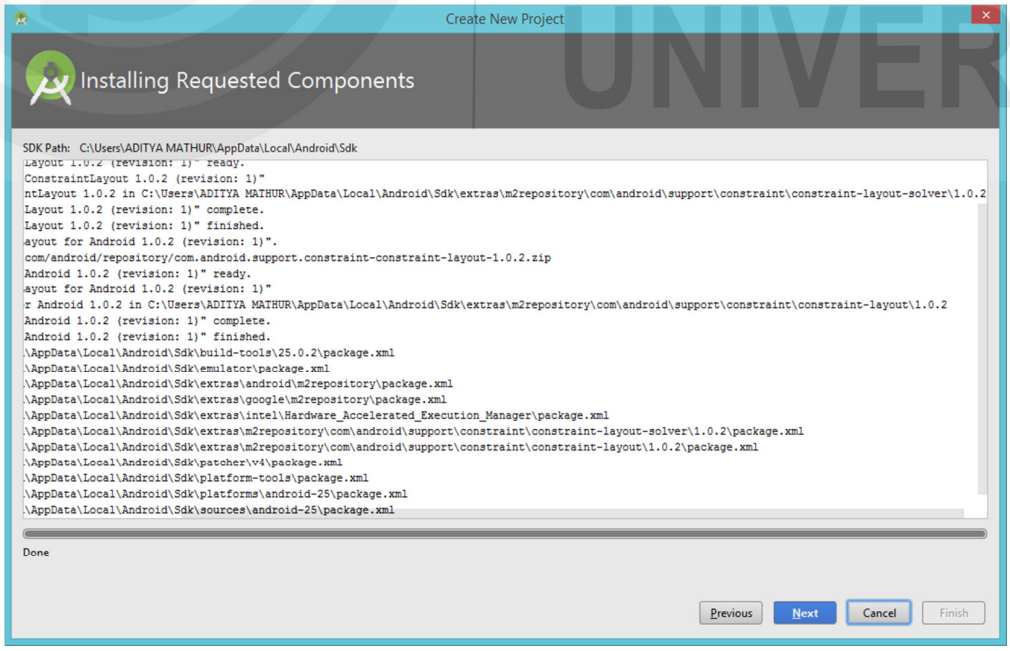


Figure 5.5 : Installation of Requested Components

In the next step i.e. *Add an Activity to Mobile*, click on *Empty Activity* thumbnail and then click *Next* as depicted in Figure 5.6.

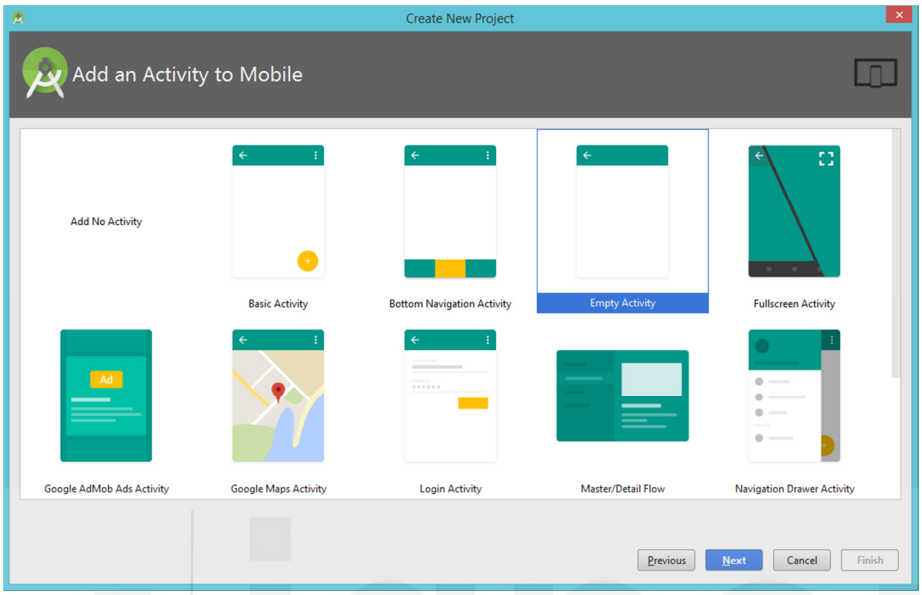


Figure 5.6: Adding an Activity to Mobile

In the next step, i.e. *Customize the Activity*, go with the default values or can give activity name and click *Finish* as shown in Figure 5.7.

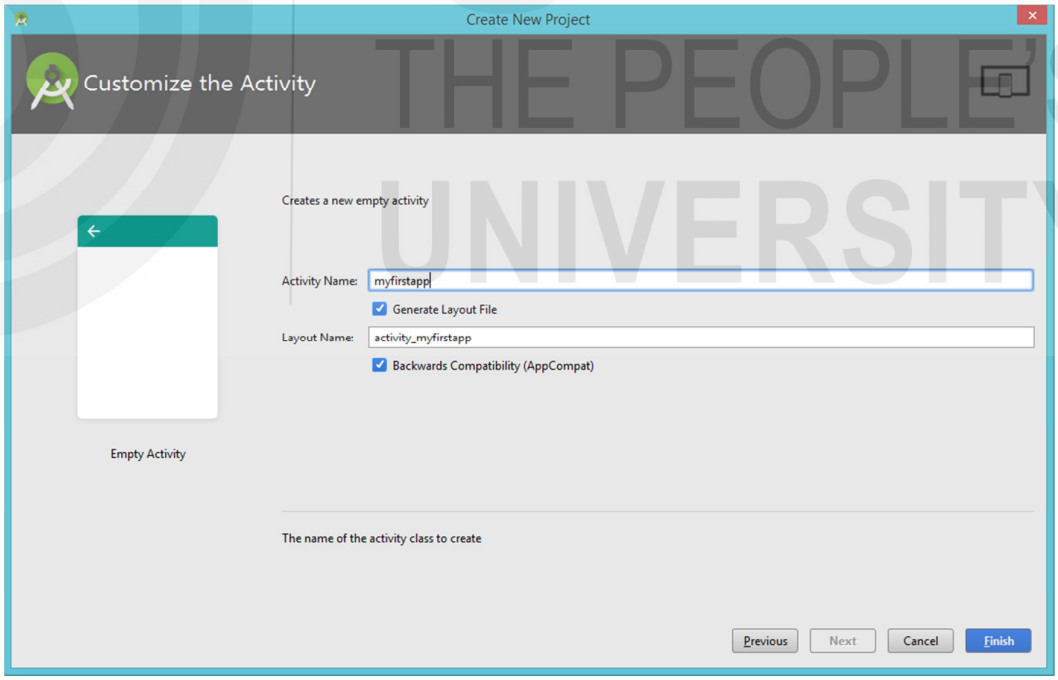


Figure 5.7: Customizing the activities in Android Studio

After processing, Android Studio will start the IDE (Integrated Development Environment) as shown in Figure 5.8 which builds the project information.

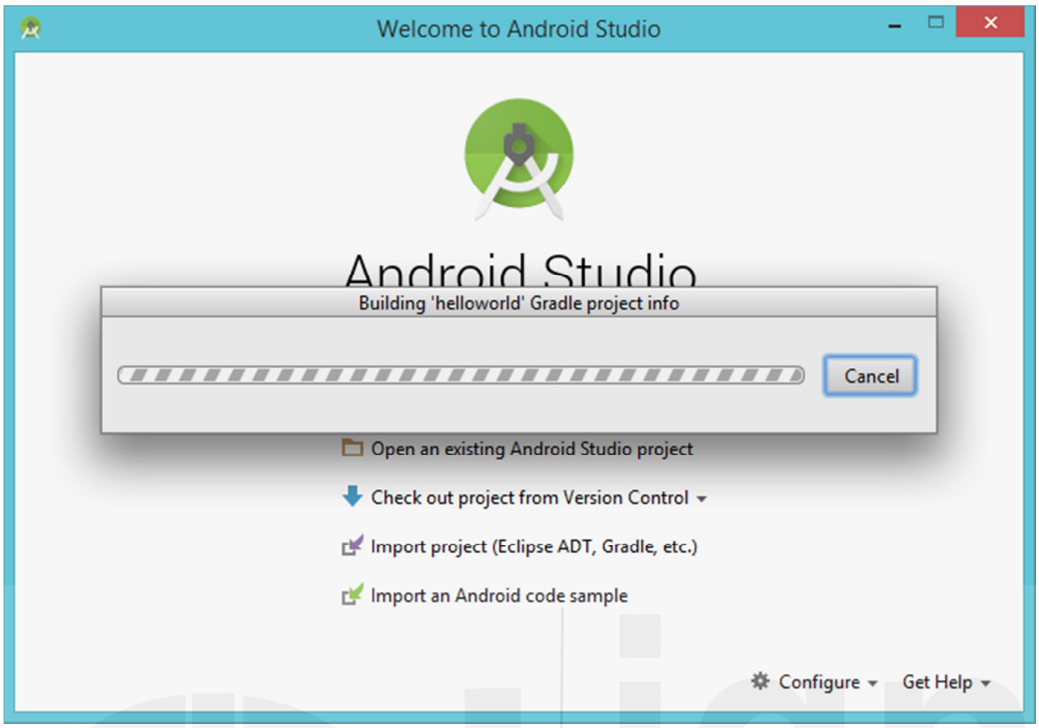


Figure 5.8: Building the project information

The code that was generated for the project is shown in Figure 5.9.

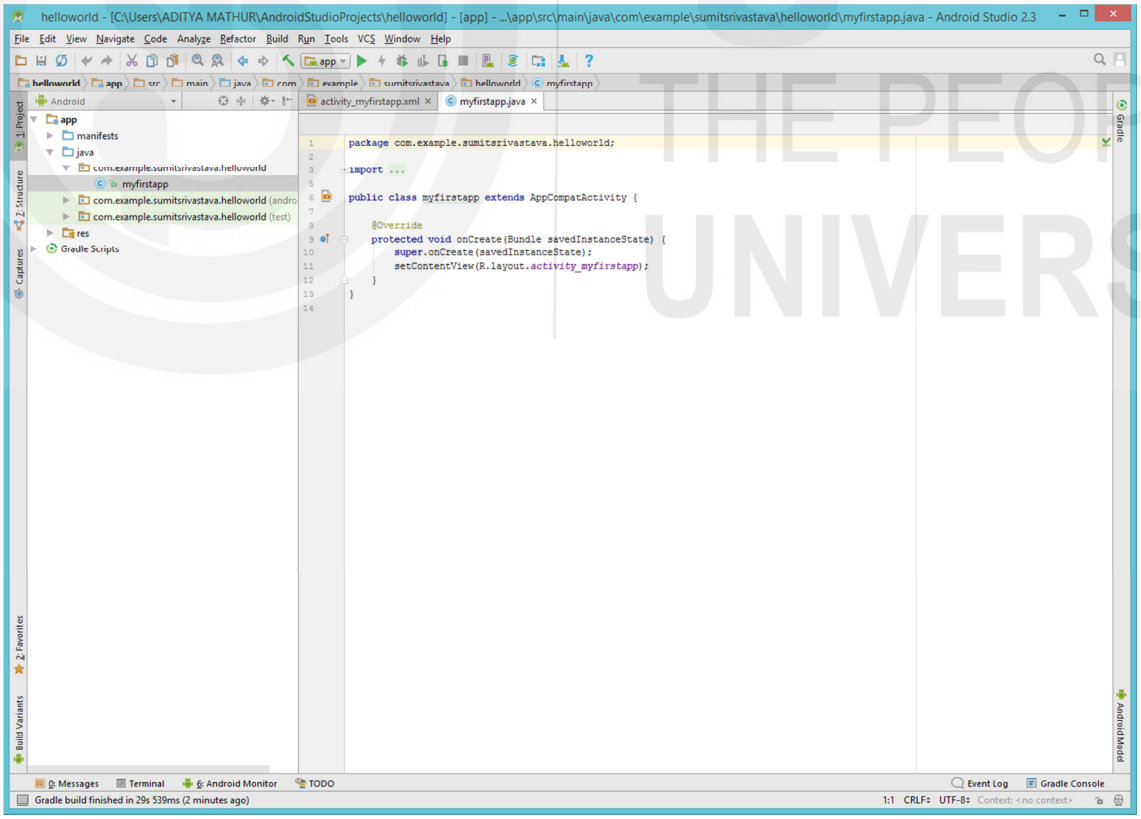


Figure 5.9: *helloworld* application

Now from the left navigation tree view, go to app > res > layout > activity_myfirstapp.xml as shown in Figure 5.10.

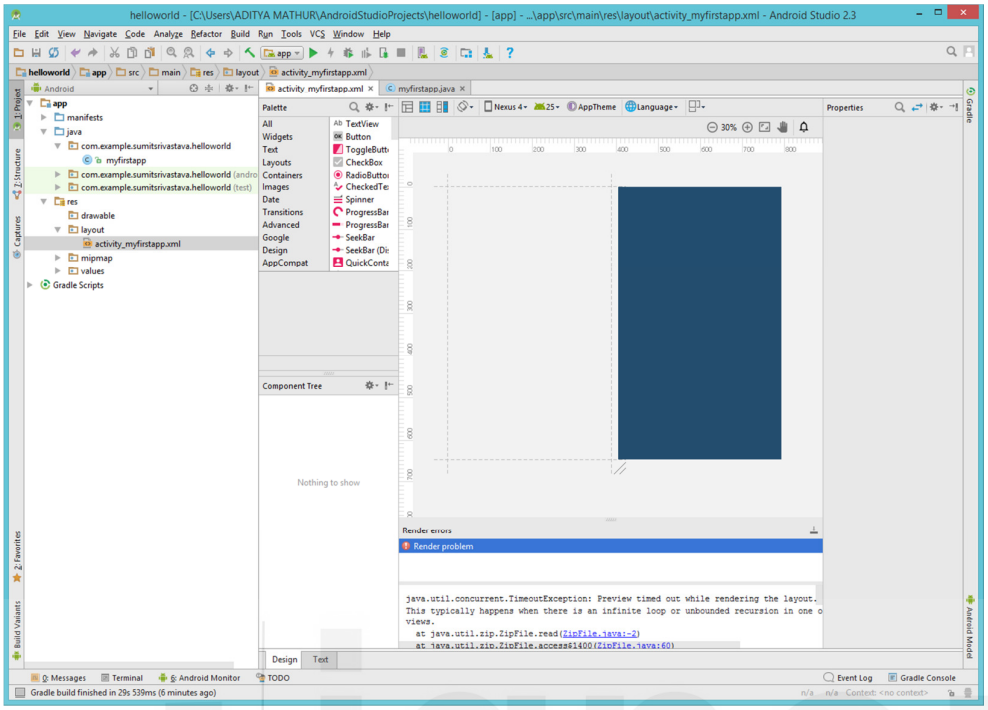


Figure 5.10: Palette in Android Studio

Now from *Palette* , drag the *TextView* element onto the layout as shown in Figure 5.11.

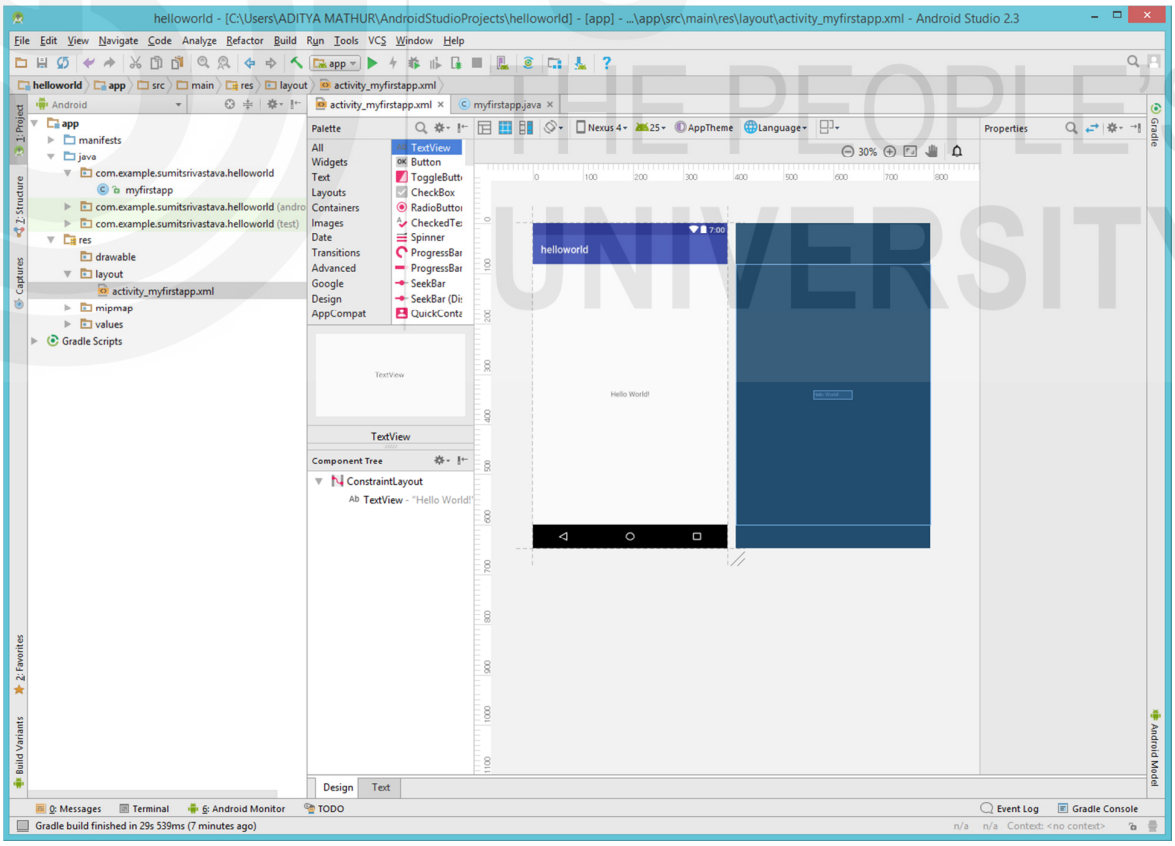


Figure 5.11: TextView in Palette

The following are the steps to setup your device:

- Associate your phone to your PC with a USB link. In case you're dealing with Windows, you have to introduce the USB drivers.
- Now, you have to enable USB debugging mode; Tap to Settings > Developer options.

In Android 4.2 and newer versions, by default developer option is hidden. To make it visible, go to *Settings>About phone> Tap Build number 7 times*. Now go back to the previous screen to find Developer options.

The following are steps to start app:

- Tap the app module given in the Project window and after that click Run > Run (or select Run from the toolbar).
- From the Select Deployment Target Screen, pick your device, and afterwards click OK.
- Now app will get installed on your device and afterwards it gets started automatically

That's *helloworld* app working on your device! (Figure 5.12).

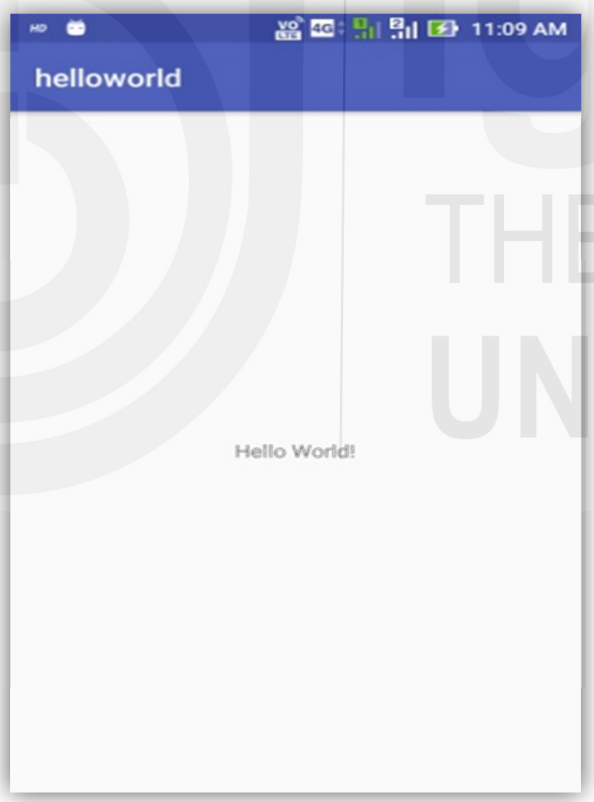


Figure 5.12: helloworld app runs

Table 5.2 lists some important files that are essential to run the app.

Table 5.2: Important files to run an app in Android

Files	Description
app > java > com.example.hello world> MainActivity.java	This is the primary point for your app. After build, when you run your app, the system initializes an instance of the current Activity which loads its layout.
app > res > layout > activity_ main.xml	This XML (Extensible Mark-Up Language) document characterizes the design for the UI movement's which contains a TextView component with the content "Hello World"
app > manifests > AndroidManifest.xml	This file depicts the essential elements of the application and furthermore characterizes each of its segments.
Gradle Scripts > build.gradle	You see two files i.e. one file for the project and one file for the "app" module. Every module has its own build.gradle file, but here you will find only one build.gradle file as but this project has just one module. Most of the time, you'll work with the module's build.gradle file to configure the development of your app.

5.4 MEMORY MANAGEMENT

Memory management includes managing RAM (random access memory) by moving processes back and forth between primary memory and Hard-disk at the time of execution of the program. It keeps an eye on each and every place of the memory, regardless of either it is granted to process or it is free to use. It verifies the amount of memory is to be granted to processes and also decides which process will obtain memory at what time. It keeps trail whenever some memory gets released or un-allocated and accordingly it updates the status.

Android Memory

Android is derived from a Linux based OS with 2.6.x kernel which is capable enough to handle most tasks in very well-mannered as it is deployed on native open source C libraries that have powered Linux machines for years. Basic operations of OS like process management, I/O management, memory management, and so on, are managed by the native stripped-down Linux kernel.

Using memory for each application

Memory for each application in android is managed by its own run time and virtual machine which is little unusual. Android run time also manages the process lifetimes and ensures application responsiveness by stopping and killing processes as necessary to free resources for higher-priority applications.

Every app runs in a separate process within its own Dalvik instance by giving responsibility for memory and process management to the Android run time.

Android run time stops and kills processes which are necessary to manage resources. Dalvik and the Android run time sit on top of a Linux kernel to handle low-level hardware interaction, while a set of APIs provides access to all of the under- lying services, features, and hardware.

The Dalvik Virtual Machine

It is defined as one of the crucial element of Android. Rather using a traditional JVM (Java Virtual Machine) like Java ME (Java Mobile Edition), Android utilizes its own customized VM(Virtual Machine) designed to manage multiple instances on a single device. Following are some function of the Dalvik VM:-

- It uses the Linux kernel to manage low-level functionalities like threading, process, security and memory management.
- As middle tier, it is used for managing hardware and system service access of android devices.
- It provides an abstraction layer to developers that ensure they never have to worry about a particular hardware implementation.
- It executes executable files (a compressed format) to ensure minimal use of memory.

Application Priorities and Process States

The sequence in which processes are killed to reclaim resources is basically determined by priorities given to hosted applications. The priority of an application is equal to its highest-priority component; the process that has a lower priority will be killed first. Priorities are also affected by inter-process dependencies; an app that has a dependency on another app will have at least as high a priority as the application it supports. All apps will remain running and in memory until the android needs its resources for other applications. Figure 5.13 gives details of states of the application states.

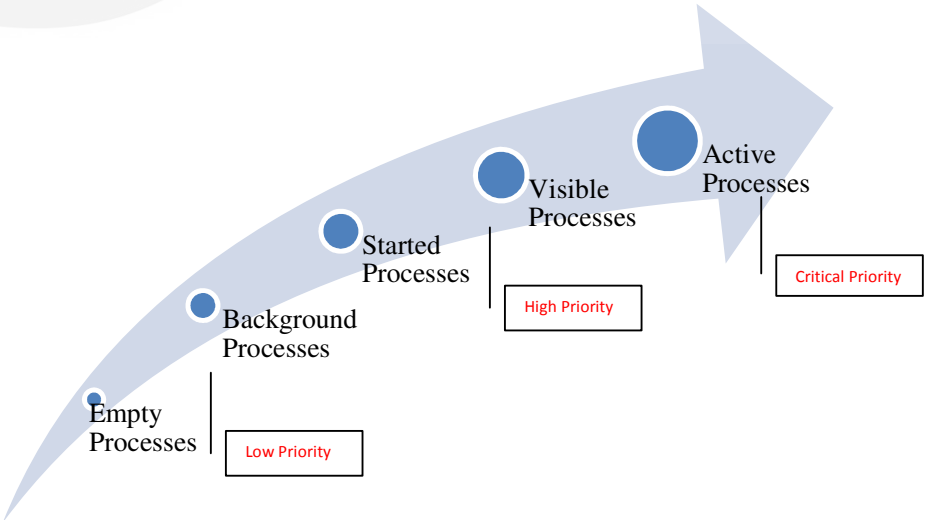


Figure 5.13: Details of Application States

Table 5.3 describes various states of processes:

Table 5.3: States of processes

Processes	Description
Active processes	Processes are active if they are in the foreground and responding to user events. Services which are executing an OnStart, OnCreate, or OnDestroy event handler.
Visible Processes	Processes are visible if they aren't in the foreground or responding to user events. When an activity is only partially obscured like a non-full-screen or transparent Activity. Usually there are very few visible processes, and they'll only be killed in extreme conditions to support active processes to continue.
Started Processes	These are the services that should be continued without a visible interface as services don't interact directly with the user, they get a slightly lower priority than visible processes. They are still kept in the category of foreground processes and won't be killed unless resources are required for active or visible processes.
Background Processes	Hosting processes which aren't visible and that don't have any services that have been started are considered background processes. Usually there will be a large number of background processes that will be killed using a last-seen-first-killed pattern to reclaim resources for foreground processes.
Empty Processes	For improving system performance, Android usually holds apps in memory after they have attained the end of their lifetimes. It maintains this cache to improve the start-up time of applications. These processes are regularly killed as needed.

Android also oversees opened applications which are running in the background. Iit closes the applications when the system needs memory. However, most of the android users are not fully satisfied with how it does its things because sometimes it keeps too many processes running which reduces the system performance. We can use task manager which does its job very well. I think, now, you might be clear with the concept of memory in Android.

5.5 VIRTUAL REALITY

A Computer technology that uses software programs for generating the realistic images, sounds and other sensations are known as virtual realities. In other word, an imaginary environment which simulates user physical presence is termed as virtual reality. It has been characterized as a reasonable and immersive simulation of a 3D domain, setup utilizing intuitive programming

and equipment. The made virtual condition can be experienced or controlled by the action of the body or as an "immersive, intelligent affair created by a PC".A user having virtual reality gadget is normally ready to "glance around" the imitated world, move about in it and connect with the environment things that are portrayed on a screen or in goggles. In today's world, virtual realities are depicted either on a computer monitor, a projector screen, or with a virtual reality headset which is also known as head-mounted display or HMD. Now, advanced haptic (capacity "to grasp something") systems include tactile information i.e. sense of touch, usually known as force response in video gaming, medical and military training applications. Couple of virtual reality frameworks utilized as a part of computer games can transmit vibrations and different sensations to the user with the assistance of an amusement controller. Virtual nearness of users can likewise be accomplished through telexistence, telepresence or the utilization of a virtual artifact (VA).The artificial condition can be indistinguishable to the present world for making a genuine life experience. Recently, Google developed a virtual reality (VR) platform which is known by the name "Daydream" for *Android Nougat*, the 7th version of the Android mobile operating system. In May 2016, Google uncovered Daydream, a VR platform that works on at Smartphone and furthermore gives VR abilities through a virtual reality headset and controller composed by Google itself.

5.6 SUMMARY

Android is a robust Operating System that supports a large number of apps in Smart Phones. These apps make life easier and advanced for the users. Hardware that supports Android is mainly based on ARM architecture platform which is shown in Figure 5.14.

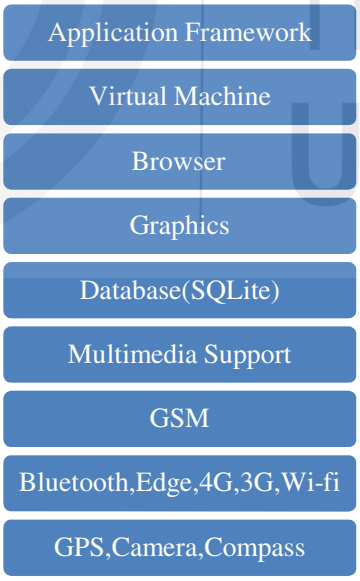


Figure 5.14: ARM architecture

Android mobile OS comes up with a pre-installed app store which is commonly known as Google Play Store. It allows Android mobile users to select, and download applications developed by third party developers and use them. There are around 2.8 million apps available on the market for users. Android apps are developed using Java. Android mobile OS is available as open source software for developers to develop apps. Android applications are

made out of at least one application segments like activities, services, content suppliers, and broadcast receivers. Each segment has its own part to determine the general conduct of the application, and each one can be enacted individually (even by different applications). All components in the application must be declared by the manifest file including declaration of all application requirements, like minimum version of android and any hardware configurations.

Check Your Progress 1

1) Explain Android OS and its features?

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2) Define memory management in android OS?

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3) Briefly explain about android interfaces& applications?

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4) What is virtual reality?

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5) Develop an android app to display your bio-data?

……..

……..

5.7 FURTHER READINGS

- Hello, Android: Introducing Google's Mobile Development Platform Paperback – 3 Mar 2011 by Ed Burnette, ISBN-10: 9350232928, ISBN-13: 978-9350232927
- Android Essentials by Chris Haseman, ISBN: 1430217367, 9781430217367
- Android Recipes: A Problem-Solution Approach by Dave Smith (Engineer), Jeff Friesen, Publisher: Apress L. P., 2011, ISBN: 1430234156, 9781430234159
- https://developer.android.com/studio/index.html
- https://en.wikipedia.org/wiki/Android_Studio
- https://android-developers.googleblog.com/2017/10/android-studio-30.html

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UNIT 6 BASICS OF iOS

Structure

6.0 INTRODUCTION

iOS is a mobile operating system developed by Apple. It was previously known as iPhone OS. This operating system runs on various devices such as iPhone, iPad, and iPod Touch etc. and it is available in 40 languages. It is second most popular operating system for handheld devices with 27% share globally. Most popular operating system is Android. iOS was originally developed for phones in 2007, further it is extended to support other devices such as the iPod Touch in September, 2007 and the iPad in January 2010. There are numerous versions of iOS which are released till date. The current version is iOS 10 which was released on September 13, 2016. It is supported on the iPhone 5 and above. It is also supported on iPad (4th generation), iPad Mini 2, iPad Pro and the 6th generation iPod Touch.This platform is written in C, C++, Objective-C, and Swift. It is very secure platform and it utilizes many security features both in hardware and software. Below are the security features of iOS:

- Secure boot
- Passcode
- Touch ID
- Non executable memory
- Encryption
- App Security
- Network Security
- Two-Factor Authentication

In iOS, there are four layers of abstraction as shown in Figure 6.1.

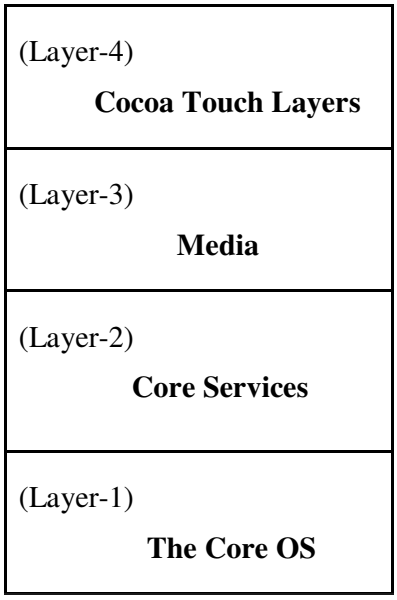

Figure 6.1: Layers of iOS

The user interface of iOS is somewhat different as compared to other Operating Systems of phones. It is based upon direct manipulation, using multi-touch gestures. Multi-touch gestures include swipe, pinch, tap, and reverse pinch. All of these have specific meaning and specific use within the context of iOS and multi-touch. There are various other control elements such as switches, buttons, sliders etc. Some applications in iOS use *accelerometers* to respond to shaking the device and three-dimensional rotating.

Table 6.1 lists some features of iOS

Features	Description
Home Screen	The Home Screen of iOS is given by **SpringBoard.** The Home Screen contains icons of different applications installed in the phone and it also contains a dock where a user can easily pin the most frequently used apps. There is a status bar at the top of the screen which displays current time, battery level of the phone, network strength of the connection, etc. Whenever the Home button is pressed, Home Screen will start to appear. If the device is protected with the passcode, then one has to enter that passcode first to unlock the device and after that only, the access to the Home Screen is granted. In iPhone OS 3, a new feature added named '**SpotLight**'. SpotLight allows users to search apps, contacts, media, messages, remainders, emails, etc. Later in iPhone 7, this feature of SpotLight is accessible by just pulling down anywhere on the home screen. In iOS 9, there are two ways by which we can use spotlight. In the latest version of iOS i.e., iOS 10, SpotLight is at the top of the "today" panel.
System font	System font of iOS is *Helvetica*. When iOS 3 is switched to iOS 4, its font changed to Retina Displays. With the release of iOS 7, users were provided with the ability to scale text or they can switch to Neue Bold. In iOS 9, the

	font was changed into San Francisco, which was originally developed for the Apple Watch.
Folders	The concept of Folders was first introduced with the release of iOS 4, in which two or more apps can be jiggled into one folder. Maximum number of apps that can be collected together in a folder is 12 on iphone 4S, 16 on iPhone 5, and 20 on iPad. The name of the folder is selected by the category of apps/files inside it, and user can also rename the name of the folder according to their ease. There can be nested folders also. Nested Folders means there can be a folder inside a folder.
Notification Center	Before the introduction of Notification Center, notifications were delivered in a modal window and cannot be viewed after being removed from the screen. With the release of iOS 5, Notification Center was introduced in which user can view the history of notifications. To view a notification, a user can simply tap on it and the corresponding app will be open in the phone.

6.1 OBJECTIVES

After going through this unit, you should be able to know

- basic features and functionalities of iOS;
- issues related to accessibility of iOS;
- the way iOS does multitasking; and
- about Siri and its usage.

6.2 ACCESSIBILITY

iOS enables users with vision and hearing disabilities to access its features. For example, visually impaired can communicate with their friends or relatives from overseas.

Table 6.2 gives some of the features of iOS for hearing impaired.

Features for Hearing impaired	
Features	**Description**
Facetime	This feature is a video conferencing system which is used on iOS as well as on Mac OS. With the help of this feature, users can do video call on two iOS devices like iPad, iPhone etc. There are many third party tools for video conference but FaceTime is the built in software of iOS and it is very well supported. It has the ability of lip reading and can converts to the text. For example - one user can use Facetime and on the other side second user can use braille display to read the text.

Closed Caption	It displays the text on screen while playing videos. There are many third party players for closed captioning but iOS has in-built player also that plays closed captioning. User has to turned it on and then video has to be closed captioned format that player understands.
Headphone Jack	Those users who need a higher volume level, can use headphone jack to add speakers. It is very useful because the built-in speakers are not loud enough.
Bluetooth Audio	User can also use Bluetooth Audio to listen in higher volume. Through Bluetooth speaker user can add amplification to the sound. Built-in speakers are not loud enough so user can increase the volume through Bluetooth speaker.
Messaging	Messaging is a great lifeline for those who have the hearing impairment. They can easily read the messages.
Visual Alerts	For different applications, user can save the different settings for visual alerts. Alert pop up right in the middle of the screen. Those who has hearing impairment, they could have problem in listening the notification sound, to solve this problem visual alerts is a great way to display the notifications.

The accessibility (Hearing) feature settings are shown in Figure 6.2.

Figure 6.2 : Accessibility (Hearing) feature settings in iOS

Table 6.3 lists features for visually impaired.

Features for Visually impaired	
Features	**Description**
Voice over	If a user is completely blind or partially blind then this technology is a boon for him. It reads the content of device and can navigate the user that where he is onscreen. For example- if user receives a message then it reads back, so that user can listen the message.
Siri	Siri is based on technology that is called Speech to Text. User has to touch the Siri button and speak something then Siri translates voice into the text and then executes the command accordingly. With the help of Siri, user can launch the applications, ask about the weather and get bring it back in voice form. This feature is very helpful for people with disabilities or without disabilities. Many people use Siri on daily basis.
Zoom	User has to turned on this feature, by default it sets to off. Once it is turned on, then any portion of the screen can be zoom in. If there is enough content on the screen then user can zoom it and can read easily. This is very useful for people who are partially blind.
Black on White	This feature has to be turned on as it sets to off by default. It is also called as invert colors. The normal screen is of the white background and black color text on it. In Black on White feature screen background will be of Black color and white color text on it. This is very helpful for those who need high contrast screens.
Speak Selection	User can highlight the text, then a button appears “Speak” and it reads back the selected content to the user. It speaks in the default device language.
Large Text	User can enlarge the text up to 56 points. It is helpful in reading the text easily. It is difficult to use it on small screen devices.
Braille Display	Braille Display is like a Braille Printer. iOS device sends the some text to the display and then it displays the first line of text. Braille displays can have 20 characters or 80 characters. It is a very good interface for braille proficient. This is very helpful for those who are deaf or blind. Braille displays connected to iOS devices via Bluetooth i.e. wirelessly.

The accessibility (Vision) feature settings are shown in figure 6.3.

Figure 6.3 : Accessibility (Vision) feature settings in iOS

6.3 MULTITASKING

Multitasking is a concept of performing multiple tasks (also known as processes) over a certain period of time by executing them concurrently. New tasks start and interrupt already started ones before they have reached completion, instead of executing the tasks sequentially so each started task needs to reach its end before a new one is started. As a result, a computer executes segments of multiple tasks in an interleaved manner, while the tasks share common processing resources such as central processing units (CPUs) and main memory. In iOS based devices, user can use more than one app at a time with the help of multitasking. With the release of iOS 4, the functionality of Multitasking was introduced in June 2010. This functionality was limited to fewer devices such as iPhone 4, iPhone 3GS, iPod Touch (3rd generation). Now, multitasking is supported on almost all latest devices like iPhone 3GS+, iPod Touch 3rd generation +, and all iPad models.

After the release of iOS 4, multitasking is supported in seven background APIs:

- Voice over IP
- Background audio
- Background location
- Local notifications
- Push notifications

- Task completion
- Fast app switching

After the release of iOS 5, three more APIs were added:

- Newsstand
- Bluetooth Accessory
- External Accessory

With the release of iOS 7, Apple introduced a new feature of enabling the apps to perform background updates. Most frequently used apps of the device are given high preference to update and it is preferred to use Wi-Fi network instead of cellular network to update the apps.

6.3.1 Switching Applications

In iOS, user can easily switch from one app to another. Following are steps to switch from one app to another.

- Double-Click on the Home Button to see recently used apps.
- Swipe Right or Left to find the app that you want to use.
- Tap the desired app.

Switching in iOS gets updated with every new version released. Like in iOS 4 to iOS 6, the application switcher is activated by double-clicking the Home Button. After this, a scrollable dock-like interface starts appearing in the bottom that let the contents of the screen moving upwards. User can choose any icon to switch to that particular application.In iOS 7, the application switcher gets activated by double-clicking the Home Button. There are some changes now as compared to previous versions. Now, the screenshots of open applications are displayed on the top of the icon and user can browse through the apps by horizontal scrolling, and user can close any application by dragging them up.With the release of iOS 9, there is a significant change in the visualisation of application switcher but the concept of showing screenshots is same as that of iOS 7. In iOS 9, the size of the application icon is relatively small, and it appears above the screenshot, and each application card overlaps the other.

6.3.2 Ending Tasks

User can easily end the tasks running in the phone. In iOS 4 to iOS 6, to quit/end the applications running, user have to hold the icons appearing in the application switcher, then tap on the red minus circle that appears at the corner of the app's icon. With the release of iOS 7 and further, the process of ending tasks become faster and easier. In iOs7, user don't have to hold the icons to close them, indeed they can swipe up the icons to close them. At Most three apps can be cleared at a time in iOS 7.

6.4 SIRI

Siri is Apple's personal assistant that takes input in voice, processes the function and returns back the output in voice format. User can ask the questions to Siri, or can ask Siri to do things. Siri is an essential part of iOS since iOS 5. On 14 October, 2011, it was first introduced as a feature of the

iPhone 4S. Now, it has been included on all iOS devices after October 2012. It is also integrated with Apple Watches which can be activated just by saying "Hey, Siri". It is also integrated into Apple's TV and in cars also.

6.4.1 Setting Up Siri

The following are steps to enable Siri in iOS devices:

i) Open the setting in the iOS device.

ii) Scroll down and click on Siri.

iii) Then, user can toggle the switch on or off and user will be asked to confirm to enable or disable Siri.

In *Settings*, Siri needs to be enabled (Figure 6.4).

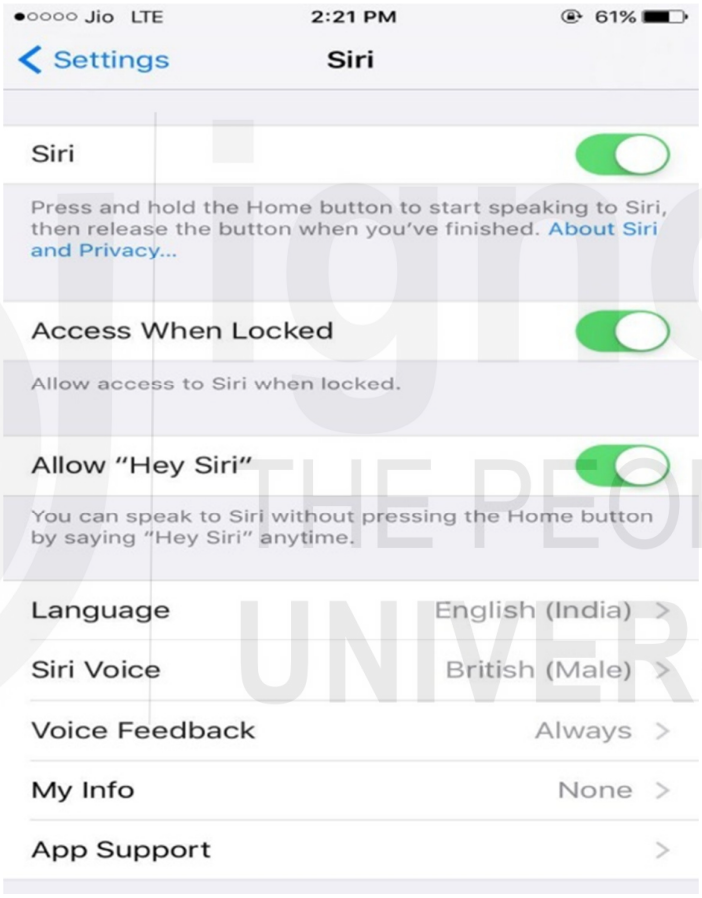

Figure 6.4 : Enabling Siri

6.4.2 Launching Siri

The following are steps to launch Siri:

i) First, press and hold the Home button on iOS Device, and say "Hey, Siri" to activate Siri.

ii) Ask Siri to do something or give some command.

iii) Then, Siri will perform the action (Figure 6.5)

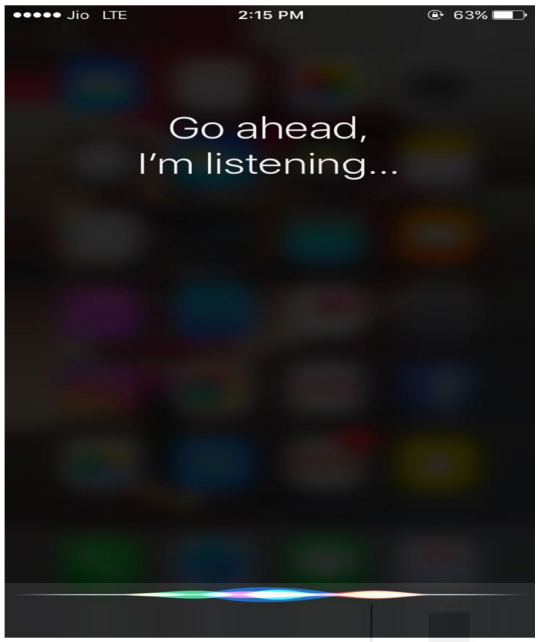

Figure 6.5: Siri in action

6.5 GAME CENTER

Game center is a social gaming network that supports online multiplayer. Players can share the games online. On July 10, 2008 Apple Inc. launched the App Store but it had no unified multiplayer and social system on that platform. Then, many third party apps like OpenFeintPlus AGON Online and Scoreloop came into the light and control over the online gaming environment.Apple announced Game Center on 08 April, 2010. It features turn based gaming, player profile photos, friend suggestions and achievement points. With iOS 6 it updates the game center and some features were added like game challenges, beat leaderboard scores etc.

Players can connect with friends, can send friend requests, playing games and organize multiplayer games. 500 friends can be connected to a single Game Center. Some games contains achievements, some have certain tasks to be completed and player earn some reward points also. In some games, players can see the leaderboards so that they can compare their score with their connected friends.

Table 6.4 lists some features of Game Center.

Features	Description
Achievements	Players can earn points as reward by meeting specific game-in challenges. It was basically developed to socialize and create competition between players.
Leaderboard	Some games have features the leaderboard through which players can compare their score with their connected friends.
Multiplayer	Few games host the matches between the players. Players can be their friends or can be anyone from around the world.

Users have to set their profile in Game Center. Following are the steps to setting up the profile:

Settings > Game Center > Sign In

Then, user should sign in with their Apple ID.

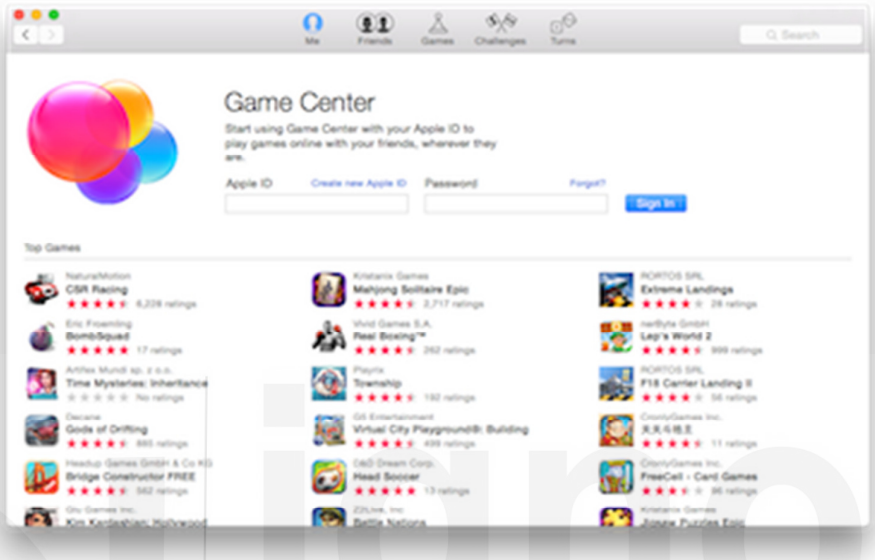

Figure 6.6 : Interface of Game Center

6.6 SUMMARY

iOS is an operating system specially developed for mobile devices. Apple Inc. first launched it in 2007 and then many releases were rolled out. iOS has many smart features, visually and hearing impaired person can use it in a very ease manner. Disabled people can operate the iOS devices by their voice only and it has the great feature of Braille Display through which blind person can operate the phone.

iOS is compatible with many devices like:

- iPad
- iPad Mini
- iPad Pro
- iPhone
- iPod

There is an online store, developed by Apple Inc. called *App Store*. In *App Store*, users can find the apps which are compatible with their iOS device.

Check Your Progress 1

1) Describe security features of iOS.

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2) Enlist various changes made in the home screen of iOS with different versions.

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3) Explain the features of iOS which enable a visually impaired person to use this platform.

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4) Explain the features of iOS which enable a hearing impaired person to use this platform.

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5) What is switching? Explain it in the context of iOS.

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6) List different features of Game Center.

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7) Mention various steps needed to set up Siri.

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6.7 FURTHER READINGS

- *Take Control of iPhone Basics, iOS 4 Edition by Karen G. Anderson, publisher: TidBITS(2011), ISBN: 1615422013, ISBN:9781615422012*
- Apple iOS and iPhone Basics: Expert Advice, Made Easy, by Chris Smith, James Wallace, Contributor: Mark Mayne, Publisher: Flame Tree Publishing (2015), ISBN: 1783613947, ISBN: 9781783613946.
- https://upload.wikimedia.org/wikipedia/en/4/44/Game-center-macapp.png
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- https://en.wikipedia.org/wiki/Game_Center

UNIT 7 BASICS OF WINDOWS MOBILE

Structure

7.0 INTRODUCTION

Microsoft developed *Windows Mobile* Operating System for Smart phones and Pocket PCs so that those windows users can access the windows features on their handheld devices. It was originally developed as Windows CE in 1996. However, Windows Mobile first appeared in 2000 as Pocket PC 2000. 'Pocket PC' came to be known as Windows Mobile in 2003 after which it started coming in different versions as that of Windows and was mostly used by business and enterprise consumers. It became the most popular smart phone in U.S. until 2007.But afterwards; it started losing its popularity. After the launch of other operating systems like iOS and Android, in February 2010, Microsoft announced Windows Phone to supplant Windows Mobile. After that, Windows Mobile has been deplored. The last version of Windows Mobile was released after the announcement of Windows Phone. That last version is 6.5.5. But, this version was not able to run in newly developed Windows Phone because Windows Phone was not compatible with Windows Mobile devices and software. Microsoft finally stopped developing the Windows Mobile and started developing Windows Phone only. Windows Phone basically aimed at the consumer market instead of enterprise market.

The following is the list of different versions of Windows Mobile and Windows Phone:

- Windows CE
- Pocket PC 2000
- Pocket PC 2002
- Windows Mobile 2003
- Windows Mobile 2003 SE
- Windows Mobile 5
- Windows Mobile 6
- Windows Mobile 6.1

- Windows Mobile 6.5
- Windows Phone 7
- Windows Phone 8
- Windows Phone 8.1
- Windows 10

7.1 OBJECTIVES

After going through this unit, you should be able to know

- features of Windows Phone;
- about the development for Windows Phone;
- about evolution of Windows Phone; and
- about various releases of Windows phone.

7.2 DEVELOPMENT

Windows Phone is successor of Windows Mobile and Zune (It was the digital media product of Microsoft). Windows Phone shows a new user interface which is developed in *Metro Design Language (MDL)*. Metro is the geometry-focused design language created by Microsoft especially for user interfaces. Windows Phone is specially designed for Consumers instead of enterprise market. It was first come in the market in October 2010 with its first version as Windows Phone 7. Now, the latest version of windows OS in phone is Windows 10 which was released in the end of year 2015.

7.2.1 Evolution of Windows Phone

In 2004, a major update have begun in windows mobile which was named as 'Photon', but the development of this update was very slow and ultimately, the project got stopped. In 2008, Microsoft re-constructed the windows mobile team and started working for the development of a new mobile operating system. In 2009, fresh operating system was released as Windows Phone but due to unexpected shortfalls or delays, Microsoft released Windows Mobile 6.5 as an interim version. Within small span of time, Windows Phone was developed. But, new operating system was not congruent with Windows Mobile apps. According to a Product Manager of Microsoft, they were lacking with the time and resources, if they would have sufficient time and resources they might be able to solve the issues of compatibility. He said, they were attempting to make the Windows Phone available for both end users and enterprise network and also trying to go ahead with capacitive touch screens rather using stylus based screen. On February 15, 2010, Mobile World Congress in Barcelona, Spain announced Windows Phone 7 which was officially released on November8, 2010in the consumer market of United States. In 2011, Microsoft announced Windows Phone 7.5 *Mango* that has the power of Internet Explorer 9; which provides the similar web standards and graphical interface as the desktop versions. In 2012, Microsoft released a minor update which was known by the name *Tango.* This minor update fixed the existing bugs and reduced the hardware requirements; which supported the devices with lesser configuration to run windows mobile operating system. In February 2011, a partnership was signed between Microsoft CEO Steve

Ballmer and Nokia CEO Stephen Elop at a press event in London. In this partnership, it was decided that the windows mobile operating system would be the primary operating system for the Smart phones which are being developed by the Nokia. This partnership replaced the Nokia Symbian OS with windows mobile OS. Both Nokia and Microsoft were aimed at setting up a new mobile platform to compete with Android and iOS. In October 2012, Microsoft introduced Windows Phone 8 as a new generation of the mobile operating system. It was replaced by the previous Windows CE–architecture; which was derived from Windows NT Kernel with various modules shared with Windows 8.In April, 2014, Windows Phone 8.1 was being released. There were some new features added via a notification center , separate volume controls, Internet Explorer 11.Similar to Apple iOS , Siri and Google Now in Android**,** Microsoft introduced anew called CORTANA in its Windows 8.1 Mobile Phone. In January 2015, Microsoft announced Windows 10 Mobile phone where Bing search feature was replaced by the CORTANA, a voice assistant. The Operating System of this mobile is for smart phones and tablets running on ARM Architecture (Figure 7.1).

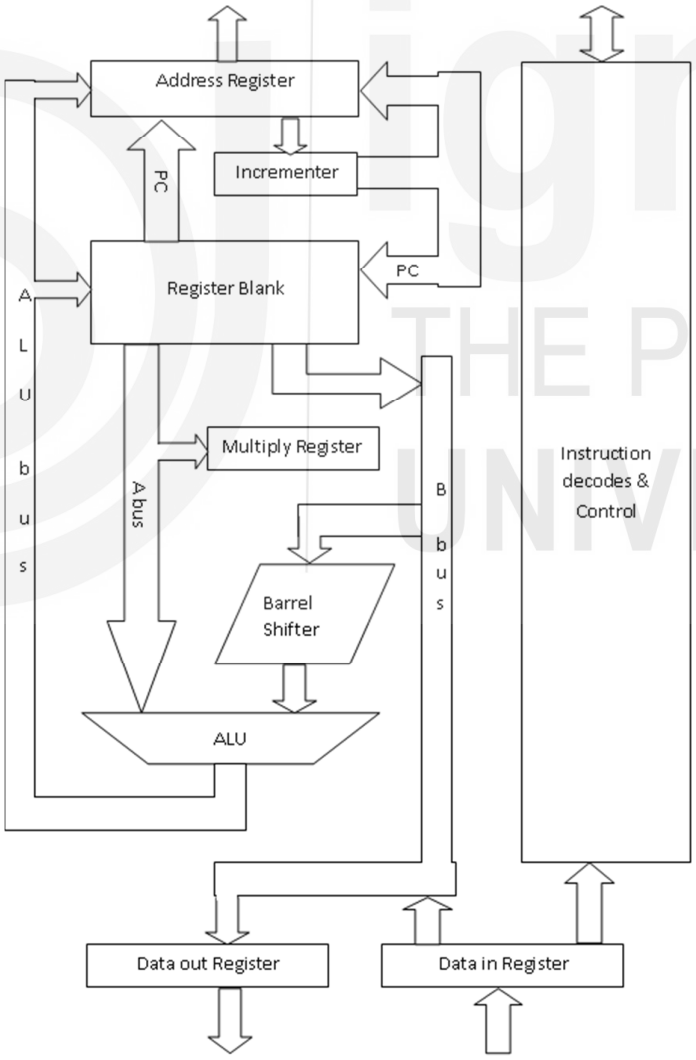

Figure 7.1 : ARM Architecture

7.3 FEATURES OF WINDOWS MOBILE

In this section, let's discuss features of Windows Mobile.

User Interface

Windows Phone shows a new user interface which is developed in MDL. The home screen of windows mobile phone depicts the "Live Tiles" i.e. the thumbnail or image links to applications functions & features; third party applications such as Web pages, contacts etc are also linked up with these tiles on the home screen. Tiles can be added, rearranged or removed by the end users. Tiles get updated automatically and change its status dynamically. For example- the text message tile would show the list of unread messages. User can also resize live tiles to either a small, medium, or large appearance. There is a feature in windows mobile phone called 'Hubs', which is used to integrate the local as well as online content with the help of windows phone's integration technique. It is used to connect windows phone with commonly known social networking websites such as Facebook, WhatsApp Twitter etc. For example- the people hub is used to fetch contacts from various sources like Facebook , Gmail and windows live. Similarly picture hub is used to show photographs captured using device camera and the user photo album from Facebook. Users can also perform different types of activities on social networking websites using Hubs.

The user interface of Windows Phone is shown in Figure 7.2.

Figure 7.2: User Interface of Windows Phone

Multitasking

Multitasking refers to an idea of executing multiple tasks or activities concurrently or at the same time. In Windows Mobile Phone, multitasking feature can be accessed by long pressing the "back" arrow. A card-based task switcher is used in windows mobile phone 7, whereas later versions make use of true background multitasking feature.

Contacts

End users can save their contacts in Windows Phone with their Mobile Phone, Email, and Contact Image etc. It also synced with other sites like Facebook, Windows Live Contacts, Twitter, LinkedIn, Google, and Outlook etc. This is also called as "People Hub". User can manage their contacts by divide them into different groups.

Text Input

Windows phone has on-screen virtual keyboard which also contains the facility to insert emoticons. It has in built spell checker and word prediction which can speed up the typing of user. While user types something, it shows the list of similar words from which user can select the particular word and it will insert automatically. It has the swipe typing feature also which avail the user to type any word without lifting the finger.

Web Browser

Internet Explorer is the default web browser in Windows Phone (Figure 7.3). It enables the user to maintain the list of frequently accessed web pages on the Start screen. It can load upto 6 tabs simultaneously. It also supports multi-touch gestures, zoom in and zoom out of animations etc. User can save the pictures which are available on web page and can share web pages via email. It supports searching the word or phrase in a web page.

Figure 7.3: Microsoft Internet Explorer

Media Player

Media player is used for playing multimedia files like videos, movies and music. It displays standard media control icons such as play (▶), pause (⏸), fastforward, backforward, and stop (■) buttons. Every Operating System has one built-in media player. Like, windows come with windows media player, Android OS comes with Google Play Music by default.

Office Suite

Microsoft office is the default office suit in Windows Phone which supports synchronization between the desktop version of Microsoft Office and Windows

Phone (Figure 7.4).User can create or edit the documents, reports, presentation etc with the help of Word, Excel and Power point respectively on the go.

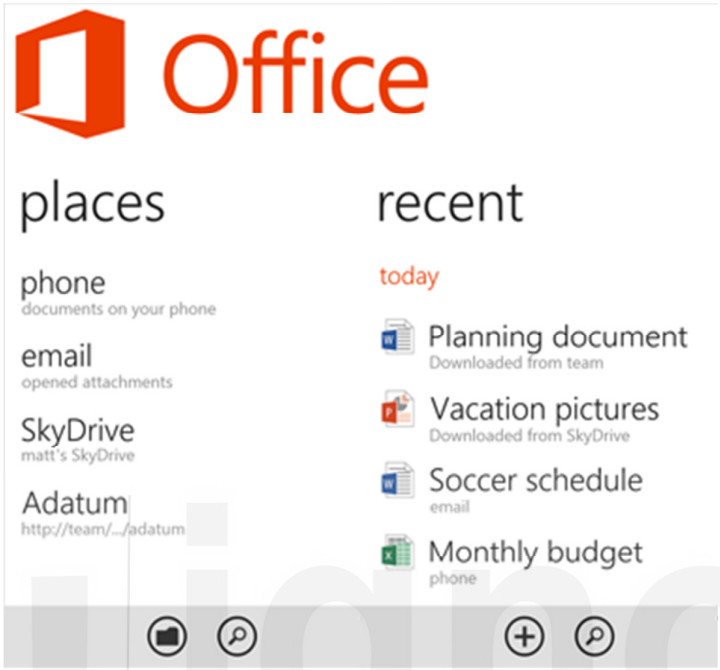

Figure 7.4: Microsoft Office Suite in Windows Phone

Shared Internet Connection

It is Windows administration that empowers one internet enabled mobile phone to impart its internet connection with other mobile phones. Internet connection can be shared using Windows Phone.

The following is the process to share Internet connection in Windows Phone:

Keeping in mind the end goal to utilize your Windows phone as a versatile Wi-Fi hotspot and offer your internet connection, you'll require an active internet data plan in your phone.

Figure 7.5 shows the screen on tapping *Settings.*

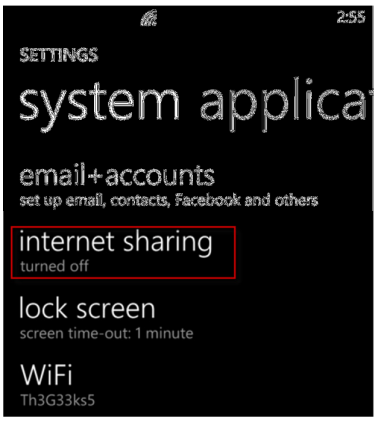

Figure 7.5: After tapping *Settings*

Then, tap Internet sharing (Figure 7.6).

Figure 7.6: After tapping Internet sharing

Move the slider from Off to On. This will automatically turn on your device's Wi-Fi (Figure 7.7).

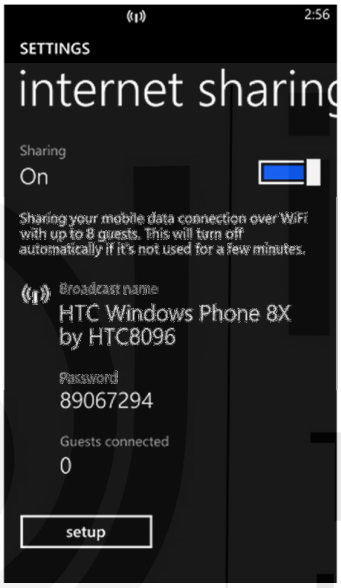

Figure 7.7 : Wi-Fi switched ON

Now Tap setup to configure Internet Sharing Setup.

Figure 7.8 : Save and Exit

You can modify the default broadcast name and specify the password. Tap the right checkmark for saving your changes, and tap X to get exit (Figure 7.8).

7.3.1 Virtual Private Networking

In Windows Phone, Virtual Private Network can be established over PPTP protocol. The User Interface of Windows Phone continues to change with different versions. The display screen of the phone was later known as the "Home Screen", and shows the current date, time, relevant information, and emails etc.

The following are the steps to configure VPN profile of Windows Phone 8.1:

i) Tap Settings. Choose VPN. Move slider to turn on the VPN status. Choose+add (Figure 7.9).

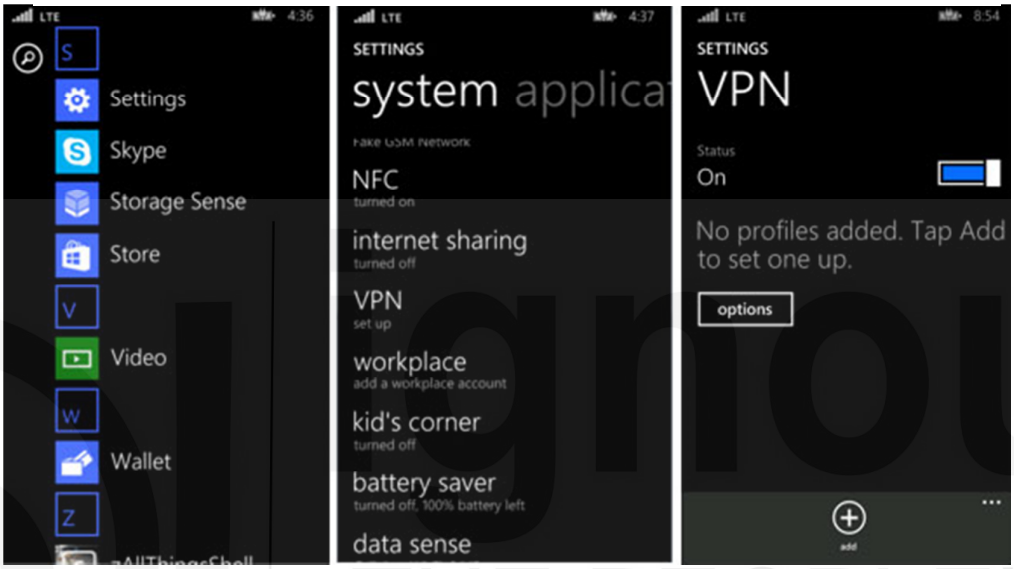

Figure 7.9: Turning ON VPN from *Settings*

ii) Now, type the server name or IP address. Choose IKEv2. For SSL-VPN, click the link shown there and download a third-party plug-in.

iii) For setting up a password for your VPN, choose user name+password. Provide the required details. To provide more details, choose Advanced. Now Tap Save (Figure 7.10).

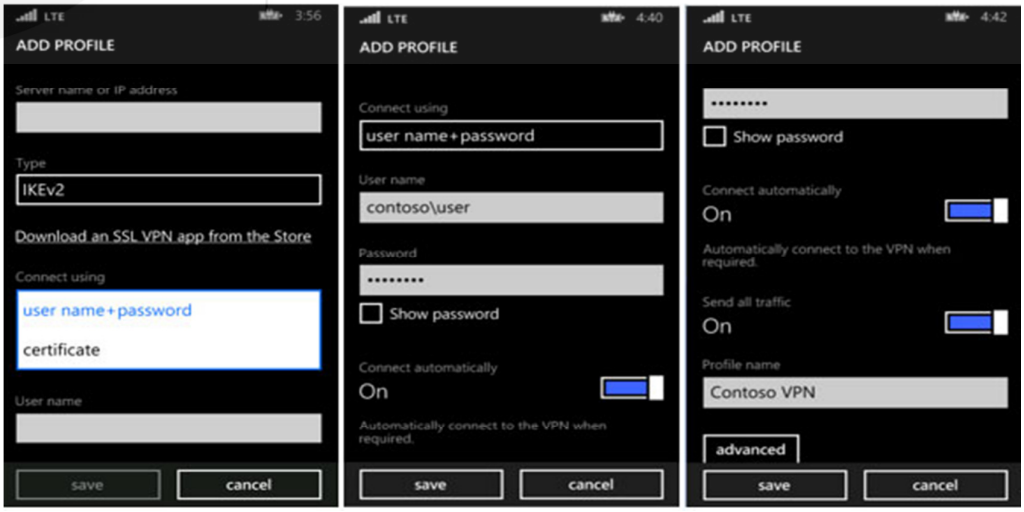

Figure 7.10: Setting User Name and Password

iv) For adding certificate security in your VPN, choose certificate. Select the desired certificate. Toggle the required settings. Provide the required details. To see the chosen certificate, select details (Figure 7.11).

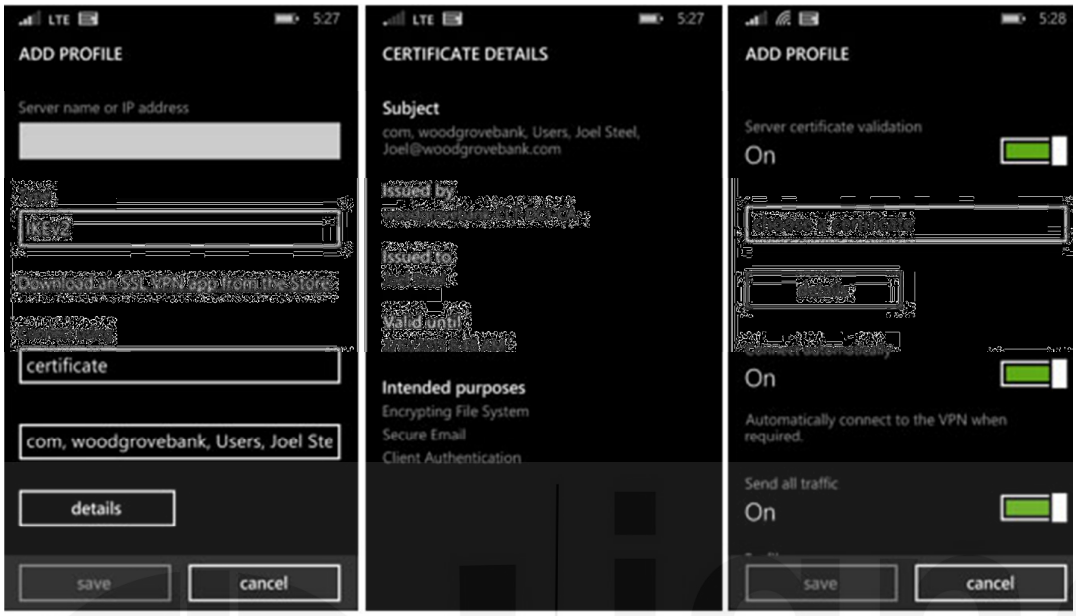

Figure 7.11 : Adding Certificate Security to VPN

v) While configuring certificate-based VPN, the certificate that is chosen under Connect is basically required for setting up the VPN connection.

vi) If you select server certificate validation, then option to select another certificate will be provided to you that will be used for VPN authentication process once the connection gets established.

vii) To provide more details, Choose Advanced, Choose Save. Now VPN profile will be get created automatically. To make further changes or see details on the profile, tap and hold the profile. To toggle to a manual profile, choose Switch to Manual (Figure 7.12).

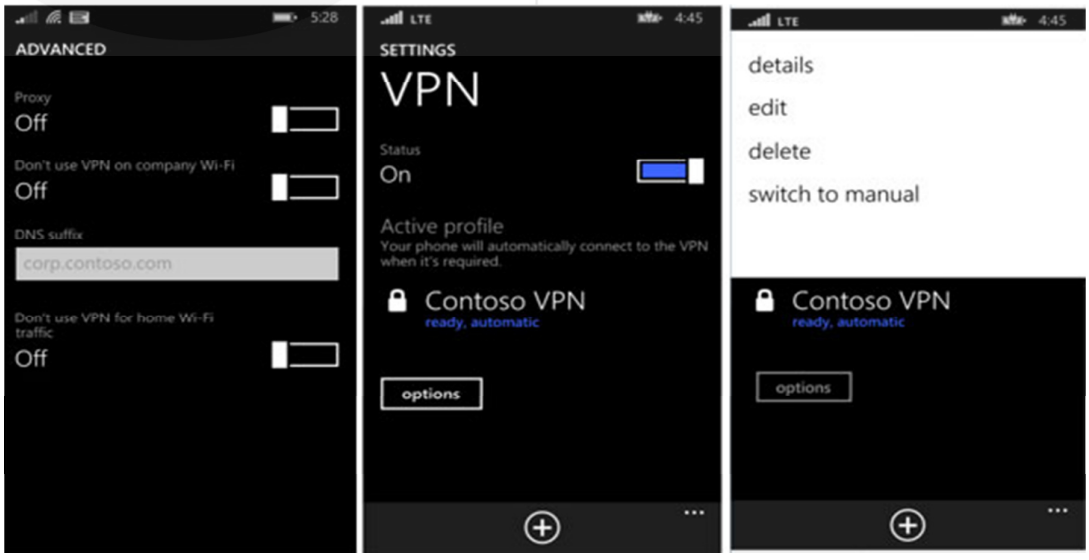

Figure 7.12 : VPN Ready

7.4 RELEASES

Microsoft released different versions of Windows Phone. In this section, we shall discuss about released versions.

7.4.1 Windows Phone 7

On October 21, 2010, Microsoft released the first mobile client operating system as Windows Phone 7. Afterwards, few more updates have been done as shown in table 7.1.

Table 7.1: Versions of Windows Phone 7

Version	Changes
7.0.7004	It was the first version of windows phone 7 OS.
7.0.7008	Update process was improved for future update.
7.0.7390	New features were added viz. Copy and Paste, CDMA support, Fast application start-up etc.
7.0.7392	Issues of Fraudulent certificates were resolved.
7.0.7403	This version was required for updating to *MANGO*.

The comprehensive interface and Metro UI of the windows mobile operating system was highly appreciated for its design and fresh clean look. Now, let's have a look on Market Share of Microsoft Windows Phone.

Windows Phone 7 (2010-2012)

Gartner (It is an American research and advisory firm providing information technology related insight for IT and other business leaders located across the world.) gives the report about devices running Microsoft OS sold to customers worldwide.

- In first quarter of 2011, 1.6 million devices were sold out.
- In second quarter of 2011, 1.7 million devices were sold out for a market share of 1.6%.
- In third quarter of 2011, Microsoft market share was slightly dropped to 1.5%.
- In fourth quarter of 2011, Microsoft market share was increased by 1.9% till first quarter of 2012.
- In second quarter of 2012, Microsoft market share got dropped back to 1.3%.

Windows Phone 7.5

A major update was announced by Steve Ballmer to Windows Phone 7 at the 2011 Mobile World Congress and this version was known by the name "Mango**".** This version overcomes various shortcomings of the previous versions like adding up the newer version of web browser i.e. internet explorer 9 which provides the similar web standards and graphics as the desktop versions. In 2012,a minor update was released which was known by the name **"**Tango**"** that fixed the bugs of the previous versions, and also minimized the hardware requirements to let devices to run windows phone using256 MB of

RAM and800 MHz CPUs. Some of the comprehensive features were also disabled on these phones.

Windows Phone 7.8

Due to several changes in the kernel requirements and the hardware specifications, previously released Windows Phone hardware was incapable of being upgraded to Windows Phone 8. Although, it was announced that Windows Phone 7 devices would receive a free upgrade to Windows Phone 7.8.

The new features which were updated in Windows Phone 7.8:

- The start screen was updated in which users can resize live tiles
- New themes were added.
- An update to the lock screen was also introduced.
- New logo was introduced for applications such as Games, Store, and Office etc.
- Issues of volume control were resolved.

7.4.2 Windows Phone 8

Windows phone 8 was released in different phases. The phases were known as GDR (General Distribution Release) (Table 7.2).

Table 7.2 : Releases of Windows Phone 8

Release	Description
GDR 1	In General Distribution Release 1, **Portico** was released out as the minor update on December 2012. In this update, some improvements and bug fixes were done. Messaging techniques were enhanced. Bluetooth connectivity becomes more efficient and some new settings for Wi-Fi connections were also added.
GDR 2	Microsoft released a minor update as General Distribution Release 2 in July 2013.As we learned in the previous section that a partnership was signed between Nokia and Microsoft, with effect of this Nokia released its own update along with GDR 2. Nokia updated the firmware of the users, namely Lumia Amber, which was available for Lumia phones only. In GDR 2, some bugs were fixed and there were some improvements in camera.
GDR 3	General Distribution Release 3 was released in October 2013. Following features were updated in this release. • Changes were made in kernel, file system, drivers, network stack and graphic support. • Internet Explorer 10 was rolled out. • NFC (Near Field Communication) support was added. • Nokia Map technology was added. • Support of new protocols was added that allow people to sync Google contacts and calendar information with another devices.

	• 1080 Pixels screen resolution support. • Accessibility improvements for visually impaired. • Better Storage management. • SkyDrive was integrated which can sync user data such as music.

Windows Phone 8 (2012-2015)

Gartner gives report after the release of Windows Phone 8about devices running Microsoft OS sold to customers worldwide. In Q4 2012, Microsoft market share was increased to 3% which is 124% increase over the same time period in 2011.In Q3 2013, Windows Phone holds a worldwide market share of 3.6%, which is 123% from the same period in 2012.In Q2 2014, Windows Phone market share was dropped back to 2.5%.

Windows Phone 8.1

Windows phone 8.1 was also released in different phases. These phases were known as GDR (General Distribution Release) (Table 7.3).

Table 7.3 : Releases of Windows Phone 8.1

Release	Description
GDR 1	In this update, new language and region support was added for Cortana (Voice Assistant). An option of organising apps into folders was also enabled. Multiple messages in SMS could be sent simultaneously. GDR 1 also includes new VPN (Virtual Private Network) and Bluetooth features for enterprise users. Several changes were made to the Internet Explorer.
GDR 2	GDR 2 was released in February 2015 with increased security features for OEM's (Original Equipment Manufacturer). Other changes made were: • Extra languages added. • Anti-Theft mode introduced. • Gesture keyboard was introduced. • New feature for unlocking the phone by Double-tapping the screen was introduced. • Dual SIM feature was introduced. • Support for Qualcomm snapdragon 200/400/400 LTE.

7.4.3 Windows 10 Mobile

Windows 10 Mobile is a mobile operating system developed by Microsoft. It is an iteration of the Windows Phone product line and a successor to Windows Phone 8.1 and is an edition of Windows 10, Microsoft's operating system for personal computers, as part of Microsoft's plans to unify Windows' application platform across multiple device classes.

Windows 10 Mobile aims to provide greater consistency with its counterpart for personal computers, including more extensive synchronization of content, a new universal application platform that allows one app to run on multiple Windows 10 devices such as PCs, mobile devices and Xbox, as well as the capability, on supported hardware, to connect devices to an external display and use a "PC-like" interface with mouse and keyboard input support. Microsoft has built tools for developers to easily port some iOS apps with minimal modifications. Windows Phone 8.1 smart phones are eligible for upgrade to Windows 10 Mobile, pursuant to manufacturer and carrier support. Some features may vary depending on hardware compatibility.

Windows 10 Mobile is designed for use on smart phones and phablets running on ARM processor architectures. Windows 10 Mobile entered public beta for selected Lumia brand smart phones on February 12, 2015. The first Lumia smart phones powered by Windows 10 Mobile were released on November 20, 2015 while eligible Windows Phone devices began receiving updates to Windows 10 Mobile on March 17, 2016, pursuant to manufacturer and carrier support.

In October 2017, it was revealed that Microsoft had discontinued active development of Windows 10 Mobile due to its low market share and the lack of third-party development for the platform, and that the operating system will only receive patches and maintenance releases going forward.

7.5 SUMMARY

In this era of technology, there are various brands and companies which are continuously emerging in this competitive world in terms of new techniques, Smartphone, PCs, laptops. Windows phone is one of them, it is being evolved from past 20 years and still it is upgrading itself. It released its first edition in 1996 as Windows CE and after that number of releases and versions took place and ultimately, Windows 10 Mobile is the latest version of Windows Phone. Numerous application developers are taking interest in Windows Phone. As of 2013, 21% of mobile developers are using Windows Phone platform, and many more stating that they are interested in adopting this platform. But, there are some another platforms also that are in high competition with Windows Phone. Windows Phone has some shortcomings in terms of applications, which it should overcome to compete with other platforms like Android and iOS. Five years ago, Windows mobile begun off life as a promising contrasting option to Android and iOS. Microsoft situated its scope of Windows phone 7 handsets as the genuine third portable biological system, yet it's a great opportunity to let it be known has fizzled. In the event that an absence of gadgets from phone creators and even Microsoft itself wasn't sufficient proof, the last nail in the pine box hit today. Microsoft just sold 4.5 million Lumia gadgets in the current quarter, contrasted with 10.5 million in the meantime a year ago. That is a monstrous 57 percent drop. Indeed, even a 57 percent expansion wouldn't be sufficient to spare Windows phone at this moment. Microsoft and Nokia have sold an aggregate of 110 million Windows phones contrasted with 4.5 billion iOS and Android phones in a similar period. IDC as of late detailed that 400 million phones were sold in the current quarter, which means only 1.1 percent of them were Lumia Windows's phones. Microsoft does not have any convincing Lumia handsets, and the Lumia 950 and Lumia 950 XL were both baffling lead gadgets with incomplete Windows 10 Versatile programming. With Lumia deals on the decay and Microsoft's arrangement to not create a lot

of handsets, it's reasonable we're seeing the finish of Windows phone. Gossipy titbits recommend Microsoft is building up a Surface mobile; however it needs to make it to the market first. Windows phone has for some time been in decay and its application circumstance is just deteriorating. With an absence of equipment, absence of offers, and fewer than 2 percent piece of the overall industry, it's an ideal opportunity to call it: Windows phone is dead. Genuine Windows on phones may turn into a thing with Continuum in the long run, however Windows mobile as we probably am aware it is finished.

Check Your Progress 1

1) List the features of Windows Mobile.

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2) Define ARM architecture. Explain how this architecture proved as a boon for Windows Phone?

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3) Describe the release of version 8 of Windows Phone.

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4) What are hubs? Explain the importance of hubs.

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5) What are the various changes made during the transition of Windows Mobile to Windows Phone?

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7.6 FURTHER READINGS

- Migrating to Windows Phone by Jesse Liberty and Jeff Blankenburg Publisher: Paul ManningISBN-13(pbk): 978-1-4302-3816-4, ISBN-13(electronic): 978-1-4302-3817-1
- Dive in Windows Phone 8 Development by Jennifer Hawkins, Publisher: CreateSpace Independent Publishing Platform(2016), ISBN-1540658104, ISBN-9781540658104.
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- https://en.wikipedia.org/wiki/Windows_Phone
- https://en.wikipedia.org/wiki/Windows_10_Mobile