UNIT 1 CONCEPTS OF MOBILE COMPUTING

1.1 FUNDAMENTAL OF MOBILE COMPUTING

- Mobile Computing refers a technology that allows transmission of data, voice and video via a computer or any other wireless enabled device. It is free from having a connection with a fixed physical link. It facilitates the users to move from one physical location to another during communication.
- Mobile Computing is a technology that provides an environment that enables users to transmit data from one device to another device without the use of any physical link or cables.
- In this technology, data transmission is done wirelessly with the help of wireless devices such as mobiles, laptops etc.
- This is only because of Mobile Computing technology that you can access and transmit data from any remote locations without being present there physically. Mobile computing technology provides a vast coverage diameter for communication. It is one of the fastest and most reliable sectors of the computing technology field.

➢ Concept of Mobile Computing

The concept of Mobile Computing can be divided into three parts:

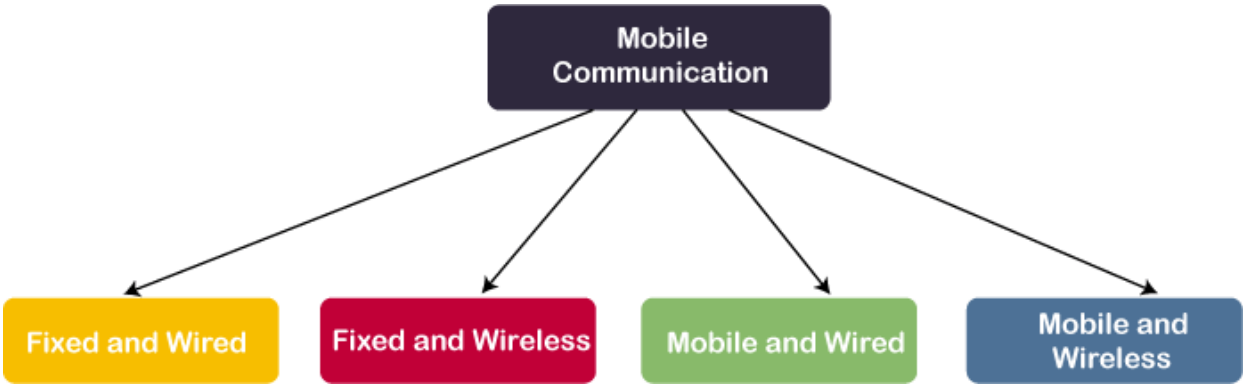
- Mobile Communication
- Mobile Hardware
- Mobile Software

1. Mobile Communication

- It specifies a framework that is responsible for the working of mobile computing technology.
- Mobile communication refers to an infrastructure that ensures reliable communication among wireless devices.
- The mobile communication framework consists of communication devices such as protocols, services, bandwidth etc. necessary to facilitate and support the services.

- **Mobile communication can be divided in the following four types:**

1. Fixed and Wired
2. Fixed and Wireless
3. Mobile and Wired
4. Mobile and Wireless



- **Fixed and Wired:** In Fixed and Wired configuration, the devices are fixed at a position, and they are connected through a physical link to communicate with other devices. **For Example**, Desktop Computer.
- **Fixed and Wireless:** In Fixed and Wireless configuration, the devices are fixed at a position, and they are connected through a wireless link to make communication with other devices. **For Example**, Communication Towers, Wi-Fi router
- **Mobile and Wired:** In Mobile and Wired configuration, some devices are wired, and some are mobile. They altogether make communication with other devices. **For Example**, Laptops.
- **Mobile and Wireless:** In Mobile and Wireless configuration, the devices can communicate with each other irrespective of their position. They can also connect to any network without the use of any wired device. **For Example**, Wi-Fi Dongle.

2. Mobile Hardware

- Mobile hardware consists of mobile devices or device components that can be used to receive or access the service of mobility. Examples of mobile hardware can be smart phones, laptops, portable PCs, tablet PCs, Personal Digital Assistants, etc.

- These devices are inbuilt with medium that can send and receive signals. It means they can send and receive signals at the same time.

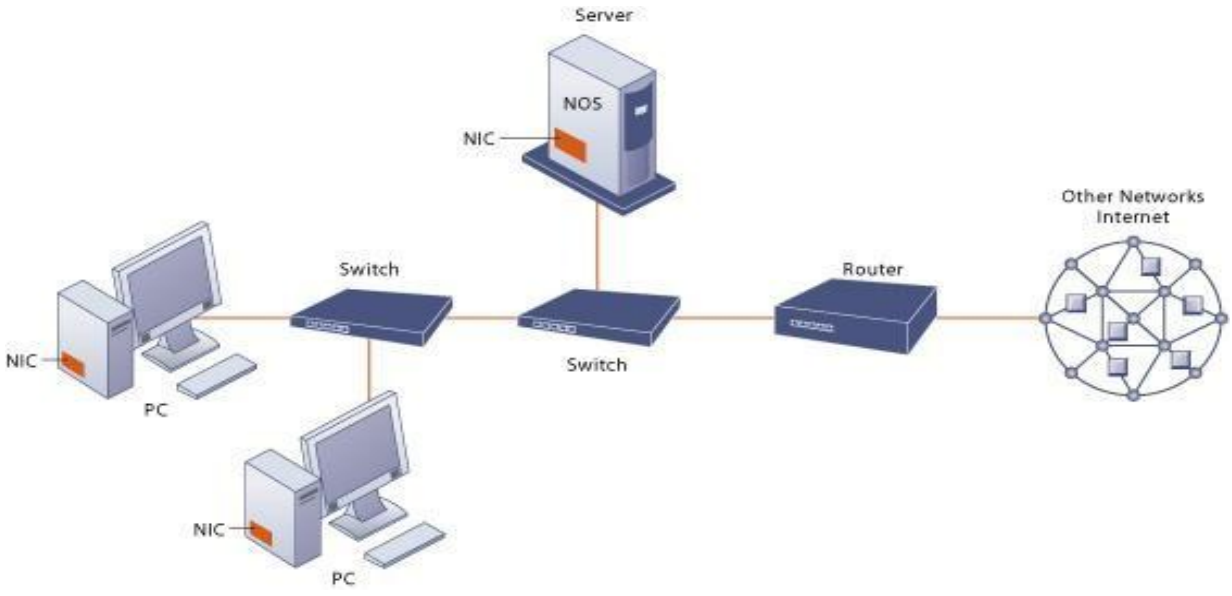
3. Mobile Software

- Mobile software is a program that runs on mobile hardware. This is designed to deal capably with the characteristics and requirements of mobile applications. Mobile Software is a heart of the mobile systems. This is an essential component (part) that operates the mobile device. This provides portability to mobile devices, which ensures wireless communication.

1.1.1 Concepts of fixed and wireless network

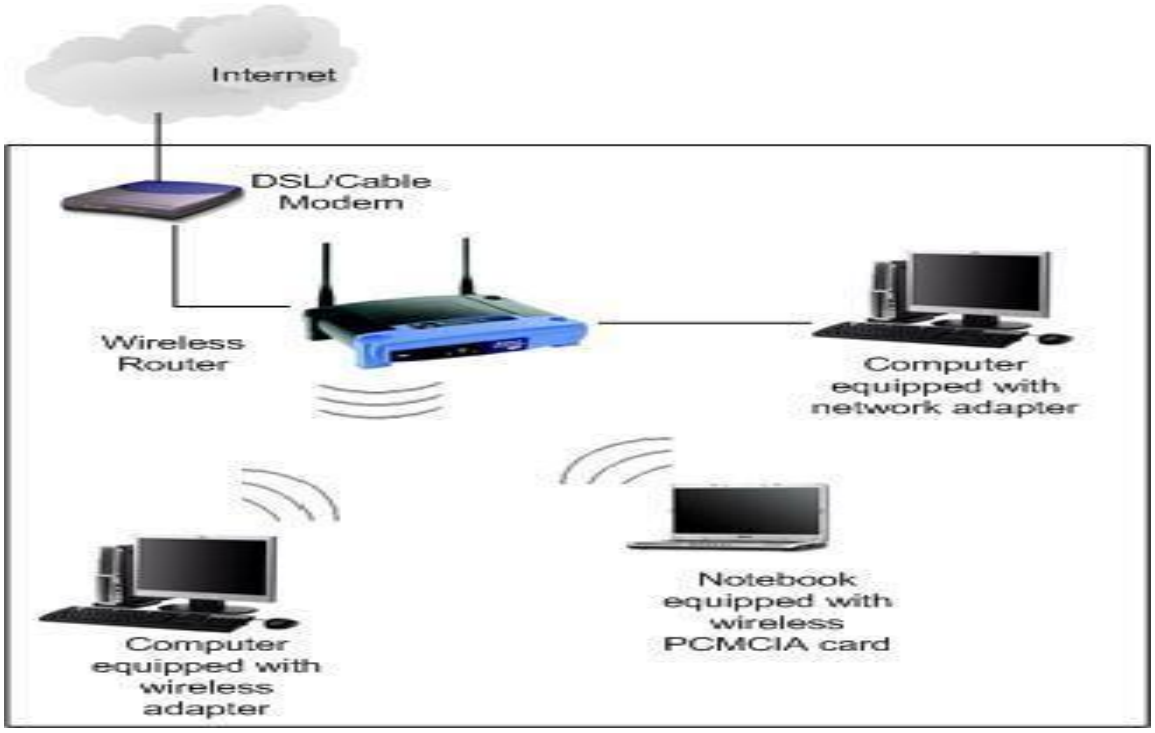
1. Fixed Network

- Fixed Network means network services comprising the public switched telephone network and/or networks based on Internet Protocols.
- It is a group of computers, printers, phones, and other equipment that are connected by wires, rather than by radio signals.
- A fixed-network can be seen as a connection to many customers, by means of a cable, through which a user can make phone calls or connect to the Internet.



2. Wireless Network

- A wireless network connects computers and devices without cables.
  A wireless network connects computers using Ethernet cables.
- A wireless network is a computer network that uses wireless data connections between Computer and mobile. Examples of wireless networks include cell phone networks, wireless local Area Network, wireless sensor networks, satellite communication networks etc.



➢ Difference Between Fixed and Wireless Network

Wireless Networks	Fixed Networks
There is no requirement of any physical Link in the wireless network.	In Fixed Networks, a physical Link is required in any condition.
The data loss rate is high in Wireless Networks.	In Fixed Networks, a perfect link is established between the devices, so the data loss rate is very low.
In Wireless Networks, the data transmission rate is low, so it provides less speed. Latency is high in Wireless Networks, which finally results in more delay.	
The Wireless Networks may be hacked that's why the security is always low in this type of network.	

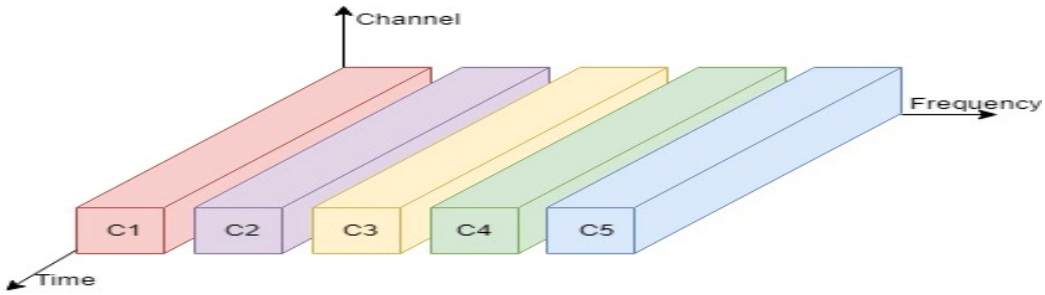
1.1.2 Introduction of Multiplexing and Modulation

- Multiplexing is a technique used in the area of electronics and signal processing. In mobile computing, telecommunications and computer networks, Multiplexing is a method that can be used to combine multiple analog or digital signals into one signal over a shared medium. The main aim of using this method is to share a limited resource.
- Example: You can see a real-life example of Multiplexing in the telecommunication field where several telephone calls may be carried using one wire. Multiplexing is also called as **muxing.**
- Multiplexing is a technique that allows multiple simultaneous analogs or digital signal transmission across a single data link.
- Multiplexing can be classified into the following four types:

- Frequency Division Multiplexing (FDM)
- Time Division Multiplexing (TDM)
- Code Division Multiplexing (CDM)
- Space Division Multiplexing (SDM)

1. Frequency Division Multiplexing (FDM)

- Frequency division multiplexing is an analog technology. It combines several smaller distinct frequency ranges signals into one medium and sends them over a single medium.
- FDM's most common applications are a traditional radio or television broadcasting, mobile or satellite stations, or cable television.
- **For example:** In cable TV, you can see that only one cable is reached to the customer's locality, but the service provider can send multiple television channels or signals simultaneously over that cable to all customers without any interference.



- **Advantages of FDM**

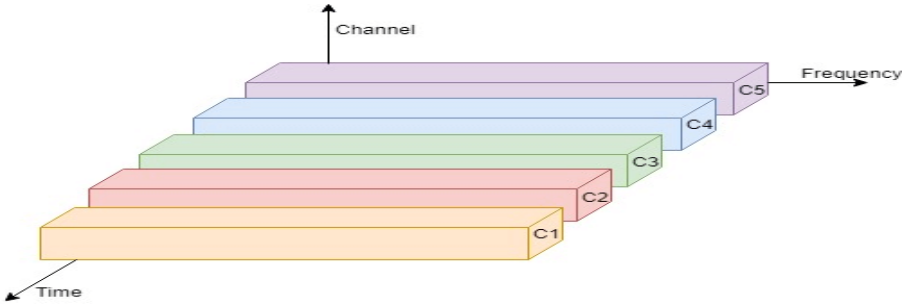
- The concept of frequency division multiplexing (FDM) applies to both analog signals and digital signals.
- It facilitates you to send multiple signals simultaneously within a single connection.

- **Disadvantages of FDM**

- It is less flexible.
- In FDM, the bandwidth wastage may be high.

2. Time Division Multiplexing (TDM)

- The Time Division Multiplexing or (TDM) is a digital or analog technology (in rare cases) that uses time, instead of space or frequency, to separate the different data streams. The Time frames of the same intervals are divided so that you can access the entire frequency at that time frame. It is mainly used in telephonic services.



Advantages of TDM

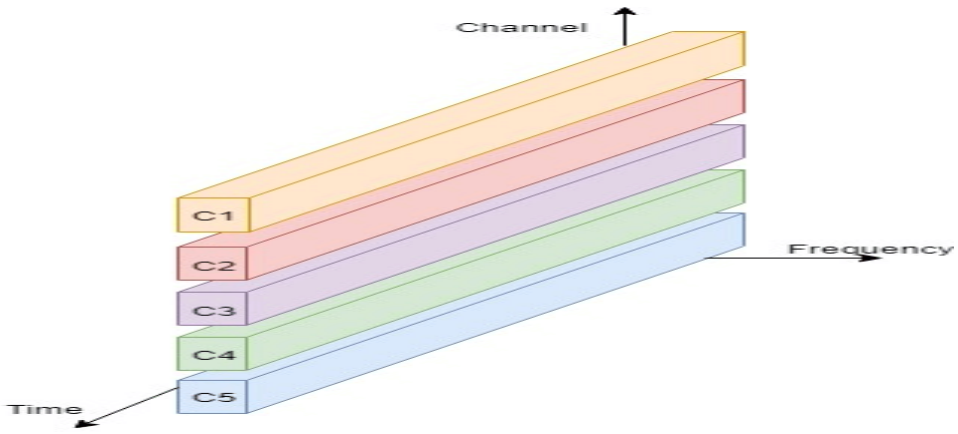
- It facilitates a single user at a time.
- It is less complicated and has a more flexible architecture.

Disadvantages of TDM

- It isn't easy to implement.

3. Code Division Multiplexing (CDM)

- The Code Division Multiplexing or (CDM) allots a unique code to every channel so that each of these channels can use the same spectrum simultaneously at the same time. It is mainly used in Cell Phone Spectrum Technology (2G, 3G etc.).



Advantages of CDM

- It is highly efficient.
- It faces fewer Inferences.Disadvantages of CDM
- The data transmission rate is low.
- It is complex.

4. Space Division Multiplexing (SDM)

- The Space Division Multiplexing or (SDM) is called a combination of Frequency Division Multiplexing (FDM) and Time Division Multiplexing (TDM).
- It passes messages or data-parallel with the use of specific frequency at a specific Time. It is used in GSM (Global Service for Mobile) Technology.

Advantages of SDM

- In SDM, the data transmission rate is high.
- It uses Time and Frequency bands at its maximum potential.

Disadvantages of SDM

- An inference may occur.
- It faces high inference losses.

Modulation

- Modulation is a process of mixing signals to produce a new form of signals. The newly produced signal has certain benefits over an un-modulated signal. Mixing of low-frequency signal with a high-frequency carrier signal is called Modulation.
- In other words, you can say that "Modulation is the **process of converting one form of signals into another form of signals**." For example, an Analog signal to Digital signals or Digital signals to Analog signals.Modulation is also called **signal modulation**.
- **Example:** Let's understand the concept of signal modulation by a simple example. Suppose an Analog transmission medium is available to transmit signals, but you have a digital signal that needs to be transmitted through this Analog medium. So, to complete this task, you have to convert the digital signal into an analog signal. This process of conversion of signals from one form to another form is called Modulation.

Advantages of Modulation

Following is the list of some advantages of implementing Modulation in the communication systems:

- By implementing Modulation, the antenna size gets reduced. Before modulation technology, the antenna used for transmission had to be very large. The range of communication gets limited as the wave cannot travel to a distance without getting modulated.
- The range of communication has increased.
- The quality is immensely improved.
- Receivers are allowed to adjust to the bandwidth.
- Multiplexing of signals occurs.

1.1.3 Fundamentals of spectrum, Bluetooth technology

1. Spectrum

- Spectrum relates to the radio frequencies allocated to the mobile industry and other sectors for communication over the airwaves. Additional frequencies, including both coverage and capacity bands,
  means mobile operators can connect more people and offer faster speeds.
- In Mobile computing Spread spectrum is a technique used for wireless communications in telecommunication and radio communication. In this technique, the frequency of the transmitted signal.
- In other words, "Spread Spectrum is a technique in which the transmitted signals of specific frequencies are varied slightly to obtain greater bandwidth as compared to initial bandwidth."
- Now, spread spectrum technology is widely used in radio signals transmission because it can easily reduce noise and other signal issues.

Types of Spread Spectrum

- Spread Spectrum can be categorized into two types:
- Frequency Hopping Spread Spectrum (FHSS)
- Direct Sequence Spread Spectrum(DSSS)

1. Frequency Hopping Spread Spectrum (FHSS)

- The Frequency Hopping Spread Spectrum or FHSS allows us to utilize bandwidth properly and maximum. In this technique, the whole available bandwidth is divided into many channels and spread between channels, arranged continuously.

2. Direct Sequence Spread Spectrum (DSSS)

- Direct Sequence Spread Spectrum (DSSS) is a spread-spectrum modulation technique primarily used to reduce overall signal interference in telecommunication. The Direct Sequence Spread Spectrum modulation makes the transmitted signal wider in bandwidth than the information bandwidth.

2. Bluetooth Technology in Mobile Computing

- Bluetooth technology is a high speed and low powered wireless technology designed to connect phones or other portable equipment for communication or file transmissions. This is based on mobile computing technology.
- Bluetooth is also known as IEEE 802.15 standard or specification that uses low power radio communications to link phones, computers and other network devices over a short distance without using any type of connecting wires.
- As Bluetooth is an open wireless technology standard so, it is used to send or receive data to connected devices present across a certain distance using a band of 2.4 to 2.485 GHz.
- In Bluetooth technology, the wireless signals transmit data and files over a short distance, typically up to 30 feet or 10 meters.
- Bluetooth technology was developed by a group of 5 companies known as Special Interest Group formed in 1998. The companies are Ericsson, Intel, Nokia, IBM, and Toshiba.
- The range of Bluetooth technology for data exchange was up to 10 meters in older versions of devices, but the latest version of Bluetooth technology i.e., Bluetooth 5.0, can exchange data in the range of about 40-400 meters.
- The average speed of data transmission in Bluetooth technology was around 1 Mbps in the very first version. The second version was 2.0+ EDR, which provided the data rate speed of 3Mbps. The third was 3.0+HS, which provided the speed of 24 Mbps. The latest version of this technology is 5.0.

Advantages of Bluetooth Technology

- Bluetooth Technology is based on Wireless technology. That's why it is cheap because it doesn't need any transmission wire that reduces the cost.
- The energy or power consumption is very low, about 0.3mW. It makes it possible for the least utilization of battery life.
- It is robust because it guarantees security at a bit level. The authentication is controlled using a 128bit key.
- You can use it for transferring the data and verbal communication as Bluetooth can support data channels of up to 3 similar voice channels.
- It doesn't require line of sight and one to one communication as used in other modes of wireless communications such as infrared.

Disadvantages of Bluetooth Technology

- In Bluetooth technology, the bandwidth is low.
- The data transmission range may also be an issue because it is also less.

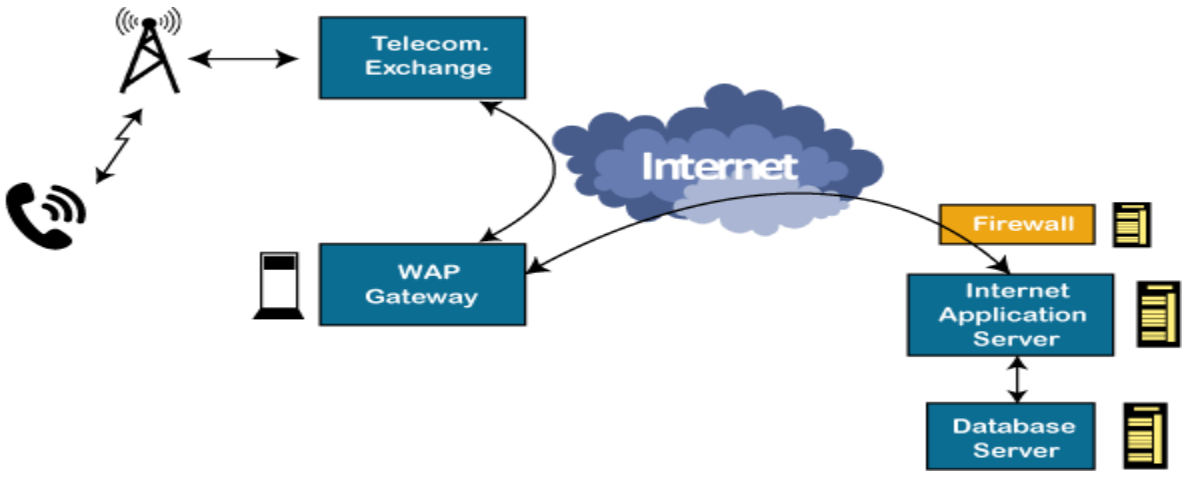
Applications of Bluetooth Technology

- Bluetooth technology is used in many communicational and entertainment devices. The following are some most used applications of the Bluetooth technology:
- Bluetooth technology is used in desktop/Laptop. It means the peripheral devices such as a mouse, keyboard, printer, speakers, etc. are connected to the desktop without a wire.
- It is used in the multimedia transfer, such as exchanging multimedia data like songs, videos, pictures etc. that can be transferred among devices using Bluetooth.
- This technology is also used in the following devices.
- Bluetooth Speakers.
- Bluetooth Headphones.
- Bluetooth Headsets for calling purposes.
- Bluetooth gaming consoles etc.

1.1.4 Concepts of Wireless Application Protocol (WAP)

- Wireless Application Protocol or WAP is a programming model or an application environment and set of communication protocols based on the concept of the World Wide Web (WWW), and its hierarchical design is very much similar to TCP/IP protocol stack design.
- Features of Wireless Application Protocol or WAP in Mobile Computing:

1. WAP is a De-Facto standard or a protocol designed for micro-browsers, and it enables the mobile devices to interact, exchange and transmit information over the Internet.
2. WAP is based upon the concept of the World Wide Web (WWW), and the backend functioning also remains similar to WWW, but it uses the markup language Wireless Markup Language (WML) to access the WAP services while WWW uses HTML as a markup language. WML is defined as XML 1.0 application.
3. In 1998, some giant IT companies such as Ericson, Motorola, Nokia and Unwired Planet founded the WAP Forum to standardize the various wireless technologies via protocols.
4. After developing the WAP model, it was accepted as a wireless protocol globally capable of working on multiple wireless technologies such as mobile, printers, pagers, etc.
5. In 2002, by the joint efforts of the various members of the WAP Forum, it was merged with various other forums of the industry and formed an alliance known as Open Mobile Alliance (OMA).
6. WAP was opted as a De-Facto standard because of its ability to create web applications for mobile devices.



Working of Wireless Application Protocol or WAP Model

The following steps define the working of Wireless Application Protocol or WAP Model:

- The WAP model consists of 3 levels known as Client, Gateway and Origin Server.
- When a user opens the browser in his/her mobile device and selects a website that he/she wants to view, the mobile device sends the URL encoded request via a network to a WAP gateway using WAP protocol.
- The request he/she sends via mobile to WAP gateway is called as encoding request.
- The sent encoding request is translated through WAP gateway and then forwarded in the form of a conventional HTTP URL request over the Internet.
- When the request reaches a specified Web server, the server processes the request just as it would handle any other request and sends the response back to the mobile device through WAP gateway.
- Now, the WML file's final response can be seen in the browser of the mobile users.

1.1.5 Mobile Agents

- In Mobile Computing, Mobile Agents are the composition of computer software and data that can separately move from one computer to another computer and continue its execution on the destination computer.
- In other words, you can say that An Mobile Agent is an autonomous program that is capable of moving from host to host in a network and interact with resources and other agents.
- In this process, the chance of data loss is limited because the state of the running program is saved and then transported to the new host. It allows the program to continue execution from where it left off before migration.
- The most important advantage of mobile agents is the possibility of moving complex processing functions to the location where you have huge amounts of data and that have to be processed.

- Mobile Agents are also called as transportable agents. They are classified into two types:

    1. **Mobile Agents with pre-defined path:** They have a static migration path.
    2. **Mobile Agents with undefined path i.e., Roamer:** They have dynamic migration paths. The mobile agents choose their path according to the present network condition.

Life Cycle of Mobile Agents

The life cycle of mobile agents ensures the following conditions:

- They can adapt to the environment. For example, either home or foreign environment.
- They are capable of switching among the positions of one node to another.
- They are autonomous and focused on the final output.

Advantages of Mobile Agents

- Mobile Agents are autonomous and self-driven in nature.
- They are maintenance-friendly or easily maintainable.
- They are able to operate without an active connection between client and server.
- They reduce the compilation time.
- They provide less delay in the network.
- They provide fewer loads on the network.
- They facilitate parallel processing.

Disadvantages of Mobile Agents

- The most significant disadvantage of mobile agents is their security. They are less secured

1.2.1 History, Concepts and Features of Android

History

- Android began in 2003 as a project of the American technology company Android Inc., to develop an operating system for digital cameras. In 2004 the project changed to become an operating system for smart phones. Android Inc., was bought by the American search engine company Google Inc., in 2005.
- The history and versions of android are interesting to know. The code names of android ranges from A to J currently, such as Aestro, Blender, Cupcake, Donut, Eclair, Froyo, Gingerbread, Hon eycomb, Ice Cream Sandwitch, Jelly Bean, KitKat and Lollipop. Let's understand the android history in a sequence.
- Initially, Andy Rubin founded Android Incorporation in Palo Alto, California, United States in October, 2003.
- In 17th August 2005, Google acquired android Incorporation. Since then, it is in the subsidiary of Google Incorporation.
- The key employees of Android Incorporation are Andy Rubin, Rich Miner, Chris White and Nick Sears.
- Originally intended for camera but shifted to smart phones later because of low market for camera only.
- Android is the nick name of Andy Rubin given by coworkers because of his love to robots.
- In 2007, Google announces the development of android OS.
- In 2008, HTC launched the first android mobile.

The Android operating system is most frequently used on different mobile platforms around the world. It is occupied approximately 75% of shares in the worldwide market by the end of 2020. A company like Open Handset Alliance has developed the first Android that depends on the customized version of the Linux kernel as well as other open-source software. At the initial stage of 2005, Google sponsored the project & it obtained the entire company. In September 2008, the first Android device was released in the market to dominate the mobile industries due to several features like user friendly, the support of the community is huge, customization, manufacturing of android devices in large companies. Consequently, the market examines the demand to develop Android-supported devices with smart developers. So, the

Android operating system became a complete set of operating systems for different devices like wearable, mobiles, notebooks, smart TVs, tablets, set-top boxes, etc.

Features of Android

1) Near Field Communication (NFC)

Most Android devices support NFC, which allows electronic devices to easily interact across short distances. The main aim here is to create a payment option that is simpler than carrying credit cards or cash, and while the market hasn't exploded as many experts had predicted, there may be an alternative in the works, in the form of Bluetooth Low Energy (BLE).

2) Alternate Keyboards

Android supports multiple keyboards and makes them easy to install; the SwiftKey, Skype, and 8pen apps all offer ways to quickly change up your keyboard style. Other mobile operating systems either don't permit extra keyboards at all, or the process to install and use them is tedious and time-consuming.

3) Infrared Transmission

The Android operating system supports a built-in infrared transmitter, allowing you to use your phone or tablet as a remote control.

4) No-Touch Control

Using Android apps such as Wave Control, users can control their phones touch-free, using only gestures. Have messy hands but need to turn off your screen or change a song? Simple. This could prove especially useful if you're driving, so you can keep both eyes on the road.

5) Automation

The Tasker app lets you not only control app permissions but also automate them. Do you only want your location services to be active during the day? Want to create a customized way to start your music—for example, with a voice command and at a certain volume? Tasker can help.

6) Wireless App Downloads

Accessing app stores on any mobile device can be frustrating, but iOS makes it a little more difficult—download an app on your computer, and it won't sync to your mobile device until you plug in and access iTunes. Using the Android Market or third-party options like AppBrain, meanwhile, let you download apps on your PC and then automatically sync them your Droid, no plugging required.

7) Storage and Battery Swap

Android phones also have unique hardware capabilities. Google's OS makes it possible to remove and upgrade your battery or to replace one that no longer holds a charge. In addition, Android phones come with SD card slots for expandable storage.

8) Custom Home Screens

While it's possible to hack certain phones to customize the home screen, Android comes with this capability from the get-go. Download a third-party launcher like Nova, Apex or Slide and you can add gestures, new shortcuts, or even performance enhancements for older-model devices.

9) Widgets

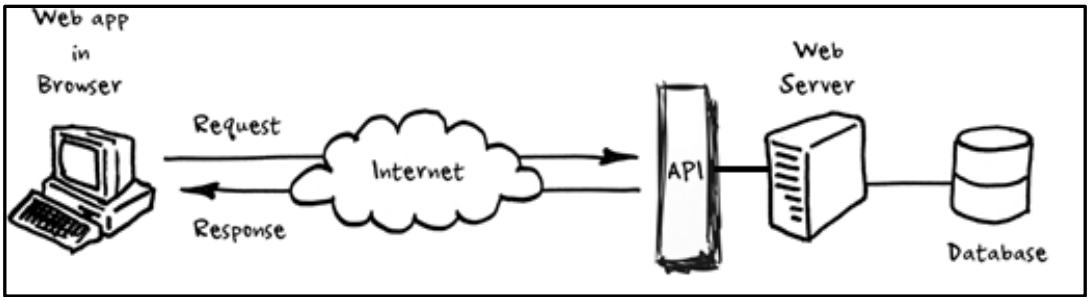
Apps are versatile, but sometimes you want information at a glance instead of having to open an app and wait for it to load. Android widgets let you display just about any feature you choose, right on the home screen—including weather apps, music widgets, or productivity tools that helpfully remind you of upcoming meetings or approaching deadlines.

10) Custom ROMs

This is a big one. Because the Android operating system is open source, developers can tweak the current OS and build their own versions, which users can download and install in place of the stock OS. Some are filled with features, while others change the look and feel of a device. Chances are if there's a feature you want, someone has already built a custom ROM for it.

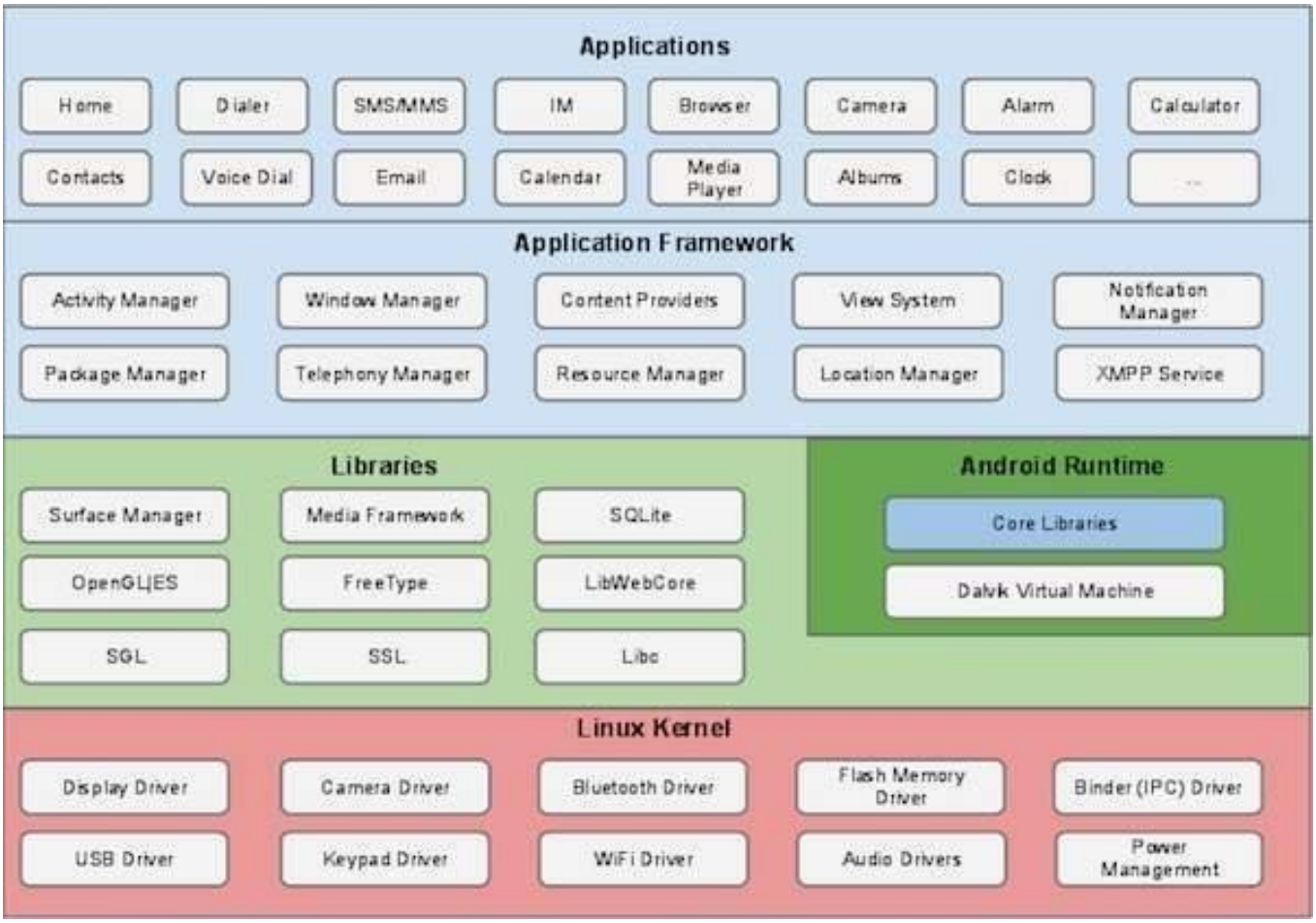
1.2.2 Concepts of API framework

- API is the acronym for Application Programming Interface, which is a software intermediary that allows two applications to talk to each other. Each time you use an app like Facebook, send an instant message, or check the weather on your phone, you're using an API.



1.3 Introduction of Android Architecture (Software Stack)

Android operating system is a stack of software components which is roughly divided into five sections and four main layers as shown below in the architecture diagram.



Linux kernel

At the bottom of the layers is Linux - Linux 3.6 with approximately 115 patches. This provides a level of abstraction between the device hardware and it contains all the essential hardware drivers like camera, keypad, display etc. Also, the kernel handles all the things that Linux is really good at such as networking and a vast array of device drivers, which take the pain out of interfacing to peripheral hardware.

Libraries

On top of Linux kernel there is a set of libraries including open-source Web browser engine WebKit, well known library libc, SQLite database which is a useful repository for storage and sharing of application data, libraries to play and record audio and video, SSL libraries responsible for Internet security etc.

Android Libraries

This category encompasses those Java-based libraries that are specific to Android development. Examples of libraries in this category include the application framework libraries in addition to those that facilitate user interface building, graphics drawing and database access. A summary of some key core Android libraries available to the Android developer is as follows −

- **android.app** − Provides access to the application model and is the cornerstone of all Android applications.
- **android.content** − Facilitates content access, publishing and messaging between applications and application components.
- **android.database** − Used to access data published by content providers and includes SQLite database management classes.
- **android.opengl** − A Java interface to the OpenGL ES 3D graphics rendering API.
- **android.os** − Provides applications with access to standard operating system services including messages, system services and inter-process communication.
- **android.text** − Used to render and manipulate text on a device display.
- **android.view** − The fundamental building blocks of application user interfaces.
- **android.widget** − A rich collection of pre-built user interface components such as buttons, labels, list views, layout managers, radio buttons etc.
- **android.webkit** − A set of classes intended to allow web-browsing capabilities to be built into applications.

Having covered the Java-based core libraries in the Android runtime, it is now time to turn our attention to the C/C++ based libraries contained in this layer of the Android software stack.

Android Runtime

This is the third section of the architecture and available on the second layer from the bottom. This section provides a key component called Dalvik Virtual Machine which is a kind of Java Virtual Machine specially designed and optimized for Android.

The Dalvik VM makes use of Linux core features like memory management and multi-threading, which is intrinsic in the Java language. The Dalvik VM enables every Android application to run in its own process, with its own instance of the Dalvik virtual machine.

The Android runtime also provides a set of core libraries which enable Android application developers to write Android applications using standard Java programming language.

Application Framework

The Application Framework layer provides many higher-level services to applications in the form of Java classes. Application developers are allowed to make use of these services in their applications.

The Android framework includes the following key services −

- **Activity Manager** − Controls all aspects of the application lifecycle and activity stack.
- **Content Providers** − Allows applications to publish and share data with other applications.
- **Resource Manager** − Provides access to non-code embedded resources such as strings, color settings and user interface layouts.
- **Notifications Manager** − Allows applications to display alerts and notifications to the user.
- **View System** − An extensible set of views used to create application user interfaces.

Applications

You will find all the Android application at the top layer. You will write your application to be installed on this layer only. Examples of such applications are Contacts Books, Browser, Games etc.