***Course: 305-02: Mobile Application Development - 1***

*Unit-1: Concepts of Mobile computing.*

* 1. *Fundamentals of Mobile computing:*

***Introduction to 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 other words, you can say that mobile computing allows transmission of data, voice and video via a computer or any other wireless-enabled device without being connected to a fixed physical link. 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.*

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

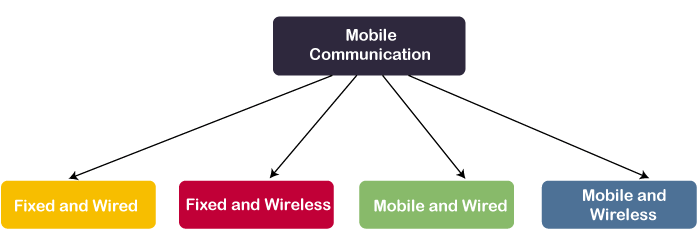
1. *Mobile Communication*
2. *Mobile Hardware*
3. *Mobile Software*

***Mobile Communication:***

*Mobile Communication specifies a framework that is responsible for the working of mobile computing technology. In this case, mobile communication refers to an infrastructure that ensures seamless and reliable communication among wireless devices. This framework ensures the consistency and reliability of communication between wireless devices. The mobile communication framework consists of communication devices such as protocols, services, bandwidth, and portals necessary to facilitate and support the stated services. These devices are responsible for delivering a smooth communication process.*

*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, WiFi 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, WiFi Dongle.*

***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 smartphones, laptops, portable PCs, tablet PCs, Personal Digital Assistants, etc.*



*These devices are inbuilt with a receptor medium that can send and receive signals. These devices are capable of operating in full-duplex. It means they can send and receive signals at the same time. They don't have to wait until one device has finished communicating for the other device to initiate communications.*

***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. This is the operating system for the appliance of mobile devices. In other words, you can say it the heart of the mobile systems. This is an essential component that operates the mobile device.*



*This provides portability to mobile devices, which ensures wireless communication.*

***Applications of Mobile Computing:***

*Following is a list of some significant fields in which mobile computing is generally applied:*

* *Web or Internet access.*
* *Global Position System (GPS).*
* *Emergency services.*
* *Entertainment services.*
* *Educational services.*

*History and Evolution of Mobile Computing*

*The main idea of Mobile computing was evolving since the 1990s. It has evolved from two-way radios to modern day communication devices.*

*Devices used in Mobile Computing*

*Following is the list of most common forms of devices used in mobile computing:*

*1. Portable Computers*

*A portable computer is a computer that is designed in a way that you can move it from one place to another. It includes a display and a keyboard. Generally, portable computers are microcomputers.*

*Compaq Portable and Contemporary portable computer with 3 LCD screens were the early examples of portable computers. Now, portable computers are discontinued.*

*2. Personal Digital Assistant/Enterprise Digital Assistant (PDA or EDA)*

*A Personal Digital Assistant (PDA) is also known as a palmtop computer. Sometimes, it is also called Enterprise Digital Assistant (EDA). A personal Digital Assistant (PDA) is a mobile device used to function as* *a personal information manager or a personal data assistant. Its name, Personal Digital Assistant (PDA), was evolved from Personal Desktop Assistant, a software term for an application that prompts or prods the user of a computer with suggestions or provides a quick reference to contacts and other lists.*

*Apple Newton and UPOP PDA were the early examples of Personal Digital Assistant. Now, a Personal Digital Assistant (PDAs) are also discontinued.*

*3. Ultra-Mobile PC*

*An ultra-mobile PC was a small form factor version of a pen computer. It was a class of laptops whose specifications were launched by Microsoft and Intel in 2006.*

*Samsung q1 ultra-premium was the early example of an ultra-mobile PC. Now, ultra-mobile PCs are also discontinued.*

*4. Laptop*

*A laptop is a small, portable personal computer (PC) built in a foldable device. The folding structure of a laptop is called a clamshell form factor. The flip or clamshell is a form factor of a mobile phone or other devices that include two or more folded sections via a hinge. A laptop typically has a thin LCD or LED computer screen mounted on the inside of the clamshell's upper lid and an alphanumeric keyboard on the inside of the lower lid. Laptops are easy to carry for transportation, and that's why they are best suitable for mobile use.*

*Osborne 1 was the first laptop in the world. See the below picture.*

*You can now find the latest versions of laptops are so thin and efficient for any scientific work.*

*5. Smartphone*

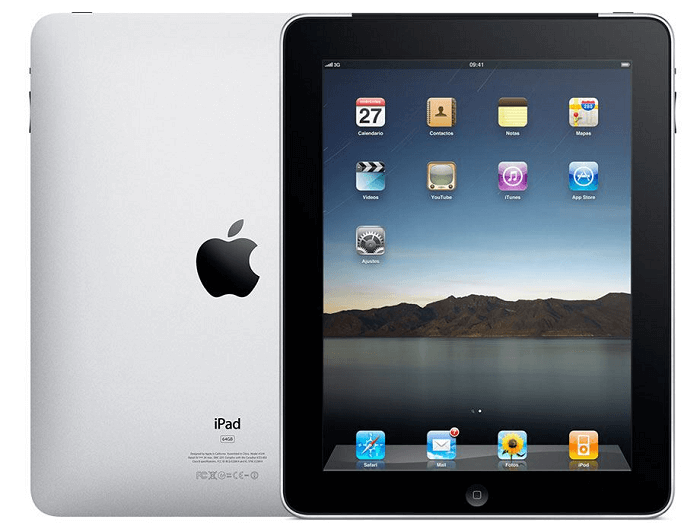
*A smartphone is a mobile device that combines cellular and mobile computing functions into one unit. The smartphones are invented to provide more advanced computing capability and connectivity than basic feature phones.*

*Smartphones are different from basic feature phones by their more robust hardware capabilities and extensive mobile operating systems, which facilitate more comprehensive software, internet i.e., web browsing over mobile broadband, and multimedia functionality i.e., music, video, cameras, and gaming etc., along with the core phone functions such as voice calls and text messaging.*

*IBM Simon Personal Communicator thought to be the first smartphone in the world. Below is the image of IBM Simon Personal Communicator.*

*Early smartphones were invented and marketed as attempting to bridge the functionality of standalone personal digital assistant (PDA) devices with support for cellular telephony but were limited by their bulky form, short battery life, slow, analog cellular networks, and the immaturity of wireless data services. But now, smartphones have the latest features of computers, more than one camera, advanced OS, bigger RAM and ROM. Now, they are also built with some artificial intelligence features such as unlock using facial recognition or fingerprint scanners, waterproof with IP67 and IP68 ratings and many other endless features.*

*Examples of new generation smartphone:*

***6. Tablet Computers***

*A tablet computer is generally known as a tablet. It is a mobile computer with a mobile operating system and a touch-screen display processing circuit, and a rechargeable battery in a single, thin and flat unit. Tablets can do what other personal computers can do, but they don't have some input/output (I/O) abilities that computers have. Nowadays, tablets are very much similar to modern smartphones. The only difference is that tablets are relatively larger than smartphones, with screens 7 inches or larger and may not support a cellular network.*

*First-generation Ipads and Sony Z2 Android were the early examples of tablets.*

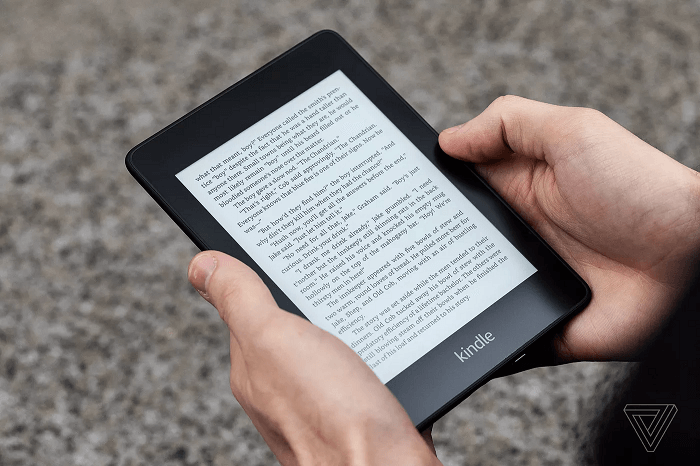
***7. Wearable computers***

*Wearable computers are a type of computer that can be worn by the bearer under, with or on top of clothing. They are also known as body-borne computers or wearables, which are small electronic devices. Some examples of wearable computers are smartwatches, digital fitness bands etc.*



***8. E-reader***

*An e-reader is also called an e-book reader or e-book device. It is a mobile electronic device that is mainly designed to read digital e-books. A right e-reader provides great portability, readability, and battery life. The main advantages of e-readers over printed books are portability. A average e-reader can hold thousands of books while weighing less than one book. The best example of an E-reader is a Kindle.*



*1.1.1 Concepts of fixed and wireless network*

*Fixed vs. Wireless Networks in Mobile Computing*

*Fixed and Wireless Networks are both used in Mobile computing. Fixed networks commonly operate on radio transmission to connect established, wired communications systems. Let's see the differences between fixed and wireless networks in mobile computing.*

***Difference between Fixed and Wireless Networks***

*The differences between Fixed and Wireless networks can be distinguished as that the wireless networks do not require any cables to make a physical connection with the device. It is easily assessable because it is a shared medium. On the other hand, in the case of fixed networks, a physical configuration of devices is mandatory to perform data transmission. In this medium, you have to connect every new device separately and physically to the network. Let's consider and make a comparison between these two technologies used in mobile computing.*

*The following table specifies the main differences between the Fixed and Wireless Networks in mobile computing technology:*

|  |  |  |
| --- | --- | --- |
| *Sr. No* | *Wireless Networks* | *Fixed Networks* |
| *1* | *There is no requirement of any physical configuration in the wireless network.* | *In Fixed Networks, a physical configuration is required in any condition.* |
| *2* | *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.* |
| *3* | *In Wireless Networks, the data transmission rate is comparatively low, so it provides less speed.* | *In Fixed Networks, the rate of data transmission is high, so it provides high speed.* |
| *4* | *Latency is high in Wireless Networks, which finally results in more delay.* | *There is no issue of latency in Fixed Networks because there is a perfect connection established between the devices that provide less delay.* |
| *5* | *The Wireless Networks may be hacked; that's why the security is always low in this type of network.* | *Fixed Networks connections are highly secured.* |

***Issues occurred in Mobile Computing.***

*There is a lot of advantage of using Mobile computing technology. It provides vast features from mobility to portability and from cloud to productivity. But, along with these advantages, you can face specific eye-catching issues while using mobile computing technology. Following is a list of issues we find while using fixed and wireless networks in mobile computing.*

*1. Costly due to Wireless Medium*

*The Mobile computing technology mainly focuses on wireless infrastructure, so the cost of implementation is always high. It also faces issues like efficiency, delays and security, which we have to consider in project establishment.*

*2. Issue due to Device Mobility*

*The device mobility is one of the most significant advantages of mobile computing technology. But, it is one of its major issues too. To obtain the device mobility feature of mobile computing technology, we have to install the highest standards' types of equipment. So, whenever the mobile device changes its environment, we have to restructure its configuration environment.*

*We have to configure the device mobility feature according to the location, environment and surroundings of a mobile device regularly.*

*3. Security Issues in Mobile Computing*

*This is undoubtedly the biggest and one of the most discussed issues we face in mobile computing technology. It arises due to the shared medium ability of mobile computing.*

*The most significant security issues are:*

* *Physical Security or Data Security*
* *System Security or Network Security*

*These issues can be resolved by using some common tactics. These issues are:*

* *Using VPN technology*
* *Using Cryptography & Network Security in your project*
* *Use of Firewall technology in the project*

***Advantages and Disadvantages of Mobile Computing***

***Advantages of Mobile Computing Technology***

***Enhanced Productivity***

*We can use mobile devices in various companies, which can reduce the time and cost for clients and themselves and enhance the productivity of the company.*

***Location Flexibility***

*This technology facilitates users to work efficiently and effectively from whichever location they want to do their tasks. So, a user can work without being in a fixed position. This facility makes them able to carry out numerous tasks at the same time and also benefitted the company.*

***Saves Time***

*The location flexibility facility of mobile computing makes it time-saving. It cuts down the time consumed or wasted while traveling from different locations or to the office and back. It facilitates users to access all the essential documents and files over a secure channel and work on their computers. It has also reduced many unnecessary incurred expenses.*

***Support Cloud Computing***

*By using mobile Computing technology, you can save your documents on an online server and access them anytime and anywhere when you have an internet connection. You can access these files on several mobiles simultaneously.*

***Entertainment***

*Nowadays, mobile devices can be used as an entertainment source. They provide a lot of entertainment facilities to their users.*

*Besides the above advantages, it provides some other facilities such as Device Mobility, Simple Framework, easy and simple infrastructure etc.*

***Disadvantages of Mobile Computing Technology***

*Along with these advantages, there are some disadvantages also of mobile computing technology. Following is the list of biggest disadvantages:*

***Poor Quality of Connectivity***

*This is one of the biggest disadvantages because if you are not near any of these connection providers, your access to the internet may be minimal.*

***Security Issues***

*Mobile VPNs are not very safe to connect, and there is always a chance of security concerns.*

***High on Power Consumption***

*These devices run on batteries that do not tend to long-lasting. So, if in a situation where there is no source of power for charging, then that will be a failure.*

*Besides the above, there are also some disadvantages such as low data transmission rates, High data losses, Frequent network issues etc.*

*1.1.2 Introduction of Multiplexing, Modulation*

*Multiplexing in Mobile Computing*

*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 scarce 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.*

***History of Multiplexing***

*The concept of Multiplexing was originated in telegraphy in the 1870s. Nowadays, it is widely used in communications.*

*George Owen Squier is called the father of Multiplexing in telephony. He was credited for the development of telephone carrier multiplexing in 1910.*

***Key points of Multiplexing***

*Multiplexing is a technique that allows multiple simultaneous analogs or digital signal transmission across a single data link.*

*The main motive behind the development of Multiplexing is to provide simple and easy communication, proper resource sharing and its utilization. This is the best way to utilize and share a limited resource equally among multiple devices.*

*Multiplexing can be classified into the following four types:*

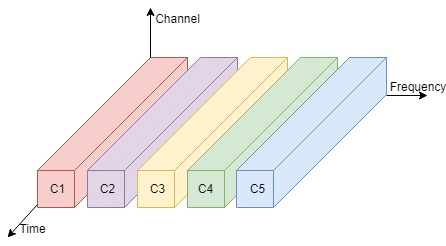
1. *Frequency Division Multiplexing (FDM)*
2. *Time Division Multiplexing (TDM)*
3. *Code Division Multiplexing (CDM)*
4. *Space Division Multiplexing (SDM)*
5. ***Frequency Division Multiplexing (FDM)***

*Frequency division multiplexing or FDM is inherently an analog technology. As the name specifies, in Frequency Division Multiplexing, the frequency dimension spectrum is split into smaller frequency bands. It combines several smaller distinct frequency ranges signals into one medium and sends them over a single medium. In FDM, the signals are electrical signals.*

*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. The customers have to tune to the appropriate frequency (channel) to access the required signal.*

*In FDM, several frequency bands can work simultaneously without any time constraint.*



*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.*

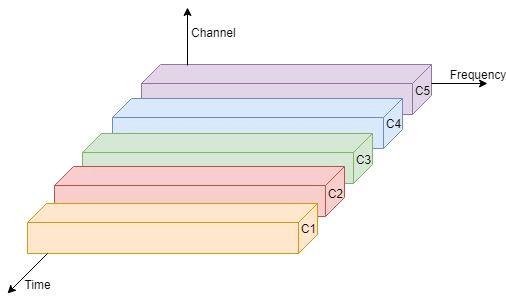
*Usage*

*It is used in Radio and television broadcasting stations, Cable TV etc.*

1. ***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. It is used for a specific amount of time in which the whole spectrum is used.*

*The Time frames of the same intervals are divided so that you can access the entire frequency spectrum at that time frame.*



***Advantages of TDM***

*It facilitates a single user at a time.*

*It is less complicated and has a more flexible architecture.*

***Disadvantages of TDM***

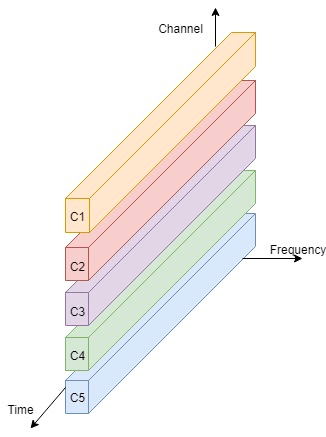
*It isn't easy to implement.*

*Usage*

*It is mainly used in telephonic services.*

1. ***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.*



*Advantages of CDM*

*It is highly efficient.*

*It faces fewer Inferences.*

*Disadvantages of CDM*

*The data transmission rate is low.*

*It is complex.*

*Usage*

*It is mainly used in Cell Phone Spectrum Technology (2G, 3G etc.).*

1. ***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. It means a particular channel will be used against a specific frequency band for some amount of time.*

*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.*

*Usage*

*It is used in GSM (Global Service for Mobile) Technology.*

***Modulation in Mobile Computing***

*Modulation is a process of mixing signals with a sinusoid 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, Analog signals 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.*

***Need for Modulation/ Why Use Modulation?***

*The baseband or low-frequency signals are not such strong and compatible signals that can be used for direct transmission. To make these signals travel longer distances, we have to increase their strength by modulating them with a high-frequency carrier wave. This process doesn't affect the parameters of the modulating signal.*

*Modulation is used to make the message carrying signal strong to be transmitted over a long distance and establish a reliable communication. A high-frequency signal can travel up to a longer distance without getting affected by external disturbances. In Modulation, these high-frequency signals are used as a carrier signal to transmit the message signal. This process is called Modulation. In Modulation, the carrier signals' parameters are changed according to the instantaneous values of the modulating signal.*

*Another reason to modulate a signal is to allow a smaller antenna as we know that a low-frequency signal would need a huge antenna. An antenna needs to be about 1/10th the length of the wavelength of the signal to be efficient. Modulation converts the low-frequency signal into a much higher frequency signal, which has much smaller wavelengths and allows a smaller antenna.*

***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 reception quality is immensely improved.*
* *Receivers are allowed to adjust to the bandwidth.*
* *Multiplexing of signals occurs.*
* *No signal mixing occurs.*

***Types of Modulation***

*Primarily Modulation can be classified into two types:*

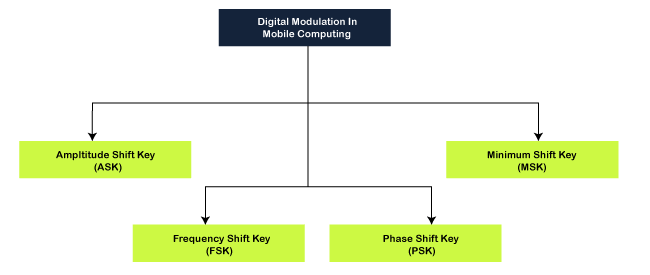
* *Digital Modulation*
* *Analog Modulation*

***Digital Modulation***

*Digital Modulation is a technique in which digital signals/data can be converted into analog signals. For example, Base band signals.*

*Digital Modulation can further be classified into four types:*

* *Amplitude Shift Key(ASK) Modulation*
* *Minimum Shift Key (MSK) Modulation*
* *Frequency Shift Key (FSK) Modulation*
* *Phase Shift Key (PSK) Modulation*

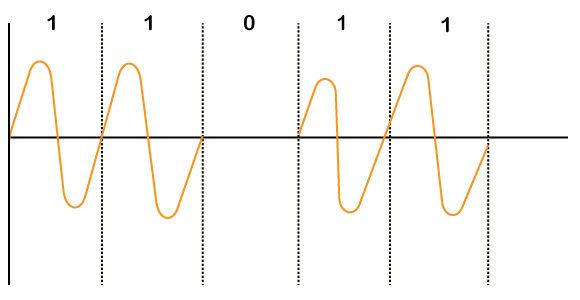


*Amplitude Shift Key (ASK) Modulation*

*As the name suggests, in Amplitude Shift Key or ASKS Modulation, the amplitude is represented by "1," and if the amplitude does not exist, it is represented by "0".*

*Using Amplitude Shift Key Modulation is very simple, and it requires a very low bandwidth.*

*Amplitude Shift Key Modulation is vulnerable to inference or deduction.*

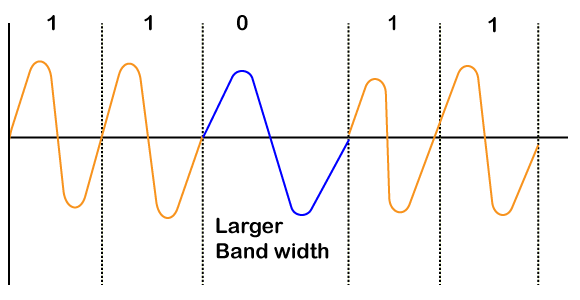


*Minimum Shift Key (MSK) Modulation*

* *The Minimum Shift Key or MSK Modulation is the most effective technique of Modulation and can be implemented for almost every stream of bits. It is easy and effective than Amplitude Shift Key, Frequency Shift Key and Phase Shift Key.*
* *MSK is mostly used because of its ability and flexibility to handle "One(1)" and "Zero(0)" transition of binary bits.*

*Frequency Shift Key (FSK) Modulation*

* *In Frequency Shift Key or FSK Modulation, different notations f1 and f2 are used for different frequencies.*
* *Here, f1 is used to represent bit "1," and f2 represents bit "0".*
* *It is also a simple modulation technique but uses different frequencies for different bits; bandwidth requirement becomes high.*

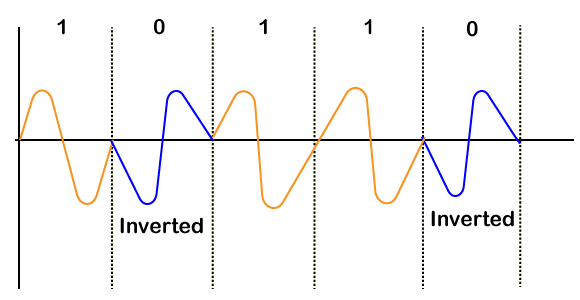


*Phase Shift Key (PSK) Modulation*

*In Phase Shift Key or PSK Modulation, the phase difference is used to differentiate between the "1" and "0" bits.*

*If the bit is "1", a simple wave is drawn, and if the bit becomes "0", the phase of the wave is shifted by "180 or π".*

*PSK Modulation is more complicated than ASK and FSK Modulation, but it is robust too.*



*Analog Modulation in Mobile Computing*

*Analog modulation is a process of transferring analog low-frequency baseband signal such as an audio or TV signal over a higher frequency carrier signal such as a radio frequency band. Baseband signals are always analog to this modulation.*

*In other words, you can say that "Analog Modulation is a technique which is used in analog data signals transmission into digital signals."*

*An example of Analog Modulation is Broadband Signals.*

*There are three properties of a carrier signal in analog modulation i.e., amplitude, frequency and phase. So, the analog modulation can further be classified as:*

*Amplitude Modulation (AM)*

*Frequency Modulation (FM)*

*Phase Modulation (PM)*

*Difference between Digital and Analog Modulation*

*Both digital and analog modulation are used to vary or transform signals from one for to another, but the difference is that an analog-modulated signal is demodulated into an analog baseband waveform. On the other hand, in digital modulation, a digitally modulated signal contains discrete modulation units, called symbols, that are interpreted as digital data.*

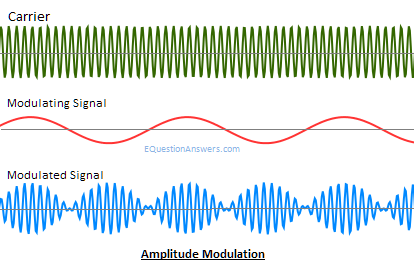
*Amplitude Modulation*

*Amplitude modulation or AM is a modulation technique that is used in electronic communication. It is most commonly used for transmitting messages with a radio carrier wave. It varies the instantaneous amplitude of the carrier signal or waves according to the message signal's instantaneous amplitude.*

*If we denote the message signal as m(t) and c(t)= Acoswct, then amplitude modulation signal F(t) will be written as:*

F(t)= Acoswct+m(t) coswct

F(t)=[A+m(t)] coswct



*History of Amplitude modulation*

*Amplitude modulation was the earliest modulation technique used for transmitting audio in radio broadcasting. It was developed during the first quarter of the 20th century and was based on the Roberto Landell De Moura and Reginald Fessenden's radiotelephone experiments proposed in 1900.*

*Advantages of Amplitude Modulation*

*Amplitude Modulation is easy to implement. It is the simplest type of modulation.*

*Amplitude Modulation, we can easily do Demodulation by using few components and a circuit.*

*The hardware design of both the transmitter and receiver is very simple, that's why it is cost-effective.*

*The receiver used for Amplitude Modulation is very cheap.*

*Disadvantages of Amplitude Modulation*

*Amplitude Modulation is not a very power efficient technique.*

*Amplitude Modulation requires a very high bandwidth that is equivalent to that of the highest audio frequency.*

*Amplitude Modulation is very susceptible to noise. You can easily notice the noise.*

*Usage of Amplitude Modulation*

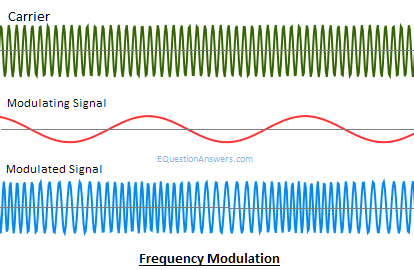
*Amplitude Modulation is used in AM radio communication. AM radio broadcast is an example of Amplitude Modulation.*

*Frequency Modulation*

*Frequency Modulation or FM is the process of encoding the information in a carrier wave by varying the instantaneous frequency of the wave. It varies the instantaneous frequency of the carrier signal according to the instantaneous amplitude of the message signal.*

*If we denote the message signal as m(t) and c(t)= Acoswct, then Frequency modulation signal F(t) will be written as:*

F(t)= Acos(wc t+kf ∫m(α)dα)



*Advantages of Frequency Modulation*

*Frequency Modulation is widely used for FM radio broadcasting.*

*It is also used in telemetry, sound synthesis, seismic prospecting, radar, and monitoring newborns for seizures via EEG, two-way radio systems, magnetic tape-recording systems and some video-transmission systems.*

*The main advantage of using frequency modulation in radio transmission is that it has a larger signal-to-noise ratio. That's why it rejects radio frequency interference better than an equal power amplitude modulation (AM) signal. This is the main reason why most music radio channels prefer to broadcast over FM radio.*

*In FM, Modulation and Demodulation do not receive any channel noise.*

*Disadvantages of Frequency Modulation*

*FM consists of a complicated circuit than AM for modulation and Demodulation.*

*Usage of Frequency Modulation*

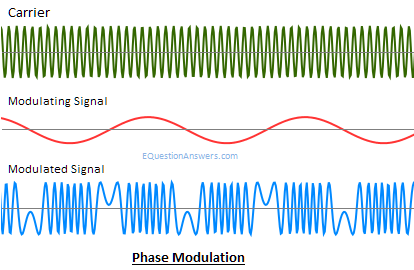
*The main example of Frequency Modulation is FM radio broadcasting.*

*Phase modulation (PM)*

*Phase modulation or PM is the technique of varying the carrier signal's instantaneous phase according to the instantaneous amplitude of the message signal. It encodes the message signal as changes occurred in the instantaneous phase of a carrier signal.*

*If we denote the message signal as m(t) and c(t)= Acoswct, then Phase modulation signal F(t) will be written as:*

F(t)= Acos(wct+kpm(t))



*Advantages of Phase modulation*

*Phase Modulation is mainly used for transmitting radio waves. It is also used in many digital transmission coding schemes and technologies such as Wi-Fi, GSM and satellite television.*

*In PM, Modulation and Demodulation do not receive any channel noise.*

*Disadvantages of Phase modulation*

*The PM modulation and Demodulation consists of a complicated circuit than AM and FM.*

*Usage of Phase modulation*

*Phase Modulation is mainly used in Wi-Fi, GSM and satellite television.*

*1.1.3 Fundamentals of spectrum, Bluetooth technology*

*Spread Spectrum 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, i.e., an electrical signal, electromagnetic signal, or acoustic signal, is deliberately varied and generates a much greater bandwidth than the signal would have if its frequency were not varied.*

*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.*

*Example of Spread Spectrum*

*Let's see an example to understand the concept of spread spectrum in wireless communication:*

*We know that a conventional wireless signal frequency is usually specified in megahertz (MHz) or gigahertz (GHz). It does not change with time (Sometimes it is exceptionally changed in the form of small, rapid fluctuations that generally occur due to modulation). Suppose you want to listen to FM stereo at frequency 104.8 MHz on your radio, and then once you set the frequency, the signal stays at 104.8 MHz. It does not go up to 105.1 MHz or down to 101.1 MHz. You see that your set digits on the radio's frequency dial stay the same at all times. The frequency of a conventional wireless signal is kept as constant to keep bandwidth within certain limits, and the signal can be easily located by someone who wants to retrieve the information.*

*In this conventional wireless communication model, you can face at least two problems:*

*A signal whose frequency is constant is subject to catastrophic interference. This interference occurs when another signal is transmitted on or near the frequency of a specified signal.*

*A constant-frequency signal can easily be intercepted. So, it is not suitable for the applications in which information must be kept confidential between the source (transmitting party) and the receiver.*

*The spread spectrum model is used to overcome with this conventional communication model. Here, the transmitted signal frequency is deliberately varied over a comparatively large segment of the electromagnetic radiation spectrum. This variation is done according to a specific but complicated mathematical function. If the receiver wants to intercept the signal, it must be tuned to frequencies that vary precisely according to this function.*

*Reasons to use Spread Spectrum*

*Spread spectrum signals are distributed over a wide range of frequencies and then collected and received back to the receiver. On the other hand, wide-band signals are noise-like and challenging to detect.*

*Initially, the spread spectrum was adopted in military applications because of its resistance to jamming and difficulty intercepting.*

*Now, this is also used in commercial wireless communication.*

*It is most preferred because of its useful bandwidth utilization ability.*

*Usage of Spread Spectrum*

*There are many reasons to use this spread spectrum technique for wireless communications. The following are some reasons:*

*It can successfully establish a secure medium of communication.*

*It can increase the resistance to natural interference, such as noise and jamming, to prevent detection.*

*It can limit the power flux density (e.g., in satellite down links).*

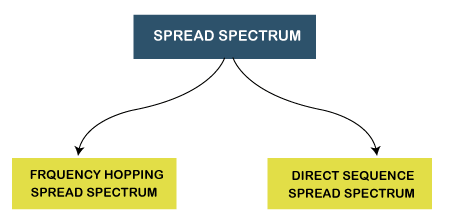
*It can enable multiple-access communications.*

*Types of Spread Spectrum*

*Spread Spectrum can be categorized into two types:*

*Frequency Hopping Spread Spectrum (FHSS)*

*Direct Sequence Spread Spectrum(DSSS)*



*Frequency Hopping Spread Spectrum (FHSS)*

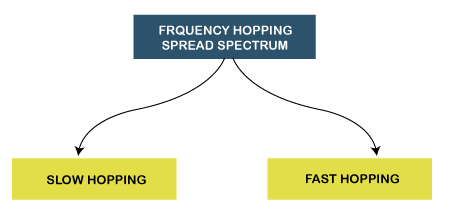
*The Frequency Hopping Spread Spectrum or FHSS allows us to utilize bandwidth properly and maximum. In this technique, the whole available bandwidth is divided into many channels and spread between channels, arranged continuously.*

*The frequency slots are selected randomly, and frequency signals are transmitted according to their occupancy.*

*The transmitters and receivers keep on hopping on channels available for a particular amount of time in milliseconds.*

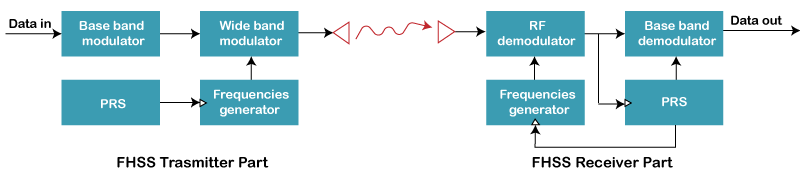
*So, you can see that it implements the frequency division multiplexing and time-division multiplexing simultaneously in FHSS.*

*The Frequency Hopping Spread Spectrum or FHSS can also be classified into two types:*



*Slow Hopping: In slow hopping, multiple bits are transmitted on a specific frequency or same frequency.*

*Fast Hopping: In fast hopping, individual bits are split and then transmitted on different frequencies.*



*Advantages of Frequency Hopping Spread Spectrum (FHSS)*

*The following are some advantages of frequency hopping spread spectrum (FHSS):*

*The biggest advantage of Frequency Hopping Spread Spectrum or FHSS is its high efficiency.*

*The Frequency Hopping Spread Spectrum or FHSS signals are highly resistant to narrowband interference because the signal hops to a different frequency band.*

*It requires a shorter time for acquisition.*

*It is highly secure. Its signals are very difficult to intercept if the frequency-hopping pattern is not known; that's why it is preferred to use in Military services.*

*We can easily program it to avoid some portions of the spectrum.*

*Frequency Hopping Spread Spectrum or FHSS transmissions can share a frequency band with many types of conventional transmissions with minimal mutual interference. FHSS signals add minimal interference to narrowband communications, and vice versa.*

*It provides a very large bandwidth.*

*It can be simply implemented as compared to DsSS.*

*Disadvantages of Frequency Hopping Spread Spectrum (FHSS)*

*The following are some disadvantages of Frequency Hopping Spread Spectrum (FHSS):*

*FHSS is less Robust, so sometimes it requires error correction.*

*FHSS needs complex frequency synthesizers.*

*FHSS supports a lower data rate of 3 Mbps as compared to the 11 Mbps data rate supported by DSSS.*

*It is not very useful for range and range rate measurements.*

*It supports the lower coverage range due to the high SNR requirement at the receiver.*

*Nowadays, it is not very popular due to the emerging of new wireless technologies in wireless products.*

*Applications of Frequency Hopping Spread Spectrum (FHSS)*

*Following is the list of most used applications of Frequency Hopping Spread Spectrum or FHSS:*

*The Frequency Hopping Spread Spectrum or FHSS is used in wireless local area networks (WLAN) standard for Wi-Fi.*

*FHSS is also used in the wireless personal area networks (WPAN) standard for Bluetooth.*

*Direct Sequence Spread Spectrum (DSSS)*

*The 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. In DSSS, the message bits are modulated by a bit sequencing process known as a spreading sequence. This spreading-sequence bit is known as a chip. It has a much shorter duration (larger bandwidth) than the original message bits. Following are the features of Direct Sequence Spread Spectrum or DSSS.*

*In Direct Sequence Spread Spectrum or DSSS technique, the data that needs to be transmitted is split into smaller blocks.*

*After that, each data block is attached with a high data rate bit sequence and is transmitted from the sender end to*

*the receiver end.*

*Data blocks are recombined again to generate the original data at the receiver's end, which was sent by the sender, with the help of the data rate bit sequence.*

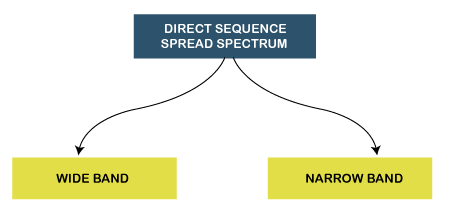
*If somehow data is lost, then data blocks can also be recovered with those data rate bits.*

*The main advantage of splitting the data into smaller blocks is that it reduces the noise and unintentional inference.*

*The Direct Sequence Spread Spectrum or DSSS can also be classified into two types:*

*Wide Band Spread Spectrum*

*Narrow Band Spread Spectrum*



*Advantages of Direct Sequence Spread Spectrum (DSSS)*

*The following are some advantages of Direct Sequence Spread Spectrum or DSSS:*

*Direct Sequence Spread Spectrum or DSSS is less reluctant to noise; that's why the DSSS system's performance in the presence of noise is better than the FHSS system.*

*In Direct Sequence Spread Spectrum or DSSS, signals are challenging to detect.*

*It provides the best discrimination against multipath signals.*

*In Direct Sequence Spread Spectrum, there are very few chances of jamming because it avoids intentional interference such as jamming effectively.*

*Disadvantages of Direct Sequence Spread Spectrum (DSSS)*

*The following are some disadvantages of Direct Sequence Spread Spectrum or DSSS:*

*The Direct Sequence Spread Spectrum or DSSS system takes large acquisition time; that's why its performance is slow.*

*It requires wide-band channels with small phase distortion.*

*In DSSS, the pseudo-noise generator generates a sequence at high rates.*

*Applications of Direct Sequence Spread Spectrum (DSSS)*

*Following is the list of most used applications of Direct Sequence Spread Spectrum or DSSS:*

*Direct Sequence Spread Spectrum or DSSS is used in LAN technology.*

*Direct Sequence Spread Spectrum or DSSS is also used in Satellite communication technology.*

*DSSS is used in the military and many other commercial applications.*

*It is used in the low probability of the intercept signal.*

*It supports Code division multiple access.*

*1.1.4 Concepts of Wireless Application Protocol (WAP)*

*1.1.5 Concepts of Mobile Agents.*

*1.2 Introduction of Android*

*1.2.1 History, concepts and Features of Android*

*1.2.2 Concepts of API framework*

*1.3 Intro. of Android Architecture (Software Stack)*

*1.3.1 kernel Native Libraries*

*1.3.2 Concepts of Native Libraries and Android Runtime (Dalvik VM)*

*1.3.3 Application Framework*

*1.3.4 Application*