[INTRODUCTION TO ICT]

[Final Exam Assignment]

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FINAL EXAM ASSIGNMENT

Q1. What are the relation between hardware and software. And types of software with Logical system architecture.

ANS: -

Relationship Between Hardware and Software:

Essentially, computer software controls computer hardware. These two components are complementary and cannot act independently of one another. In order for a computer to effectively manipulate data and produce useful output, its hardware and software must work together. Without software, computer hardware is useless. Conversely, computer software cannot be used without supporting hardware. Similarly, computer software has to first be loaded into the computer's hardware and then executed. There are several categories of software, with the two main categories being operating-system software, which makes the hardware usable, and application software, which does something useful. Examples of operating systems include Microsoft Windows on a personal computer and Google's Android on a mobile phone. Examples of application software are Microsoft Excel and Angry Birds.

Consider the following analogy: an iPod is used to play recorded music in the form of an MP3. In order to listen to the recorded music, you need three things: an iPod, a speaker, and the MP3 file. In this analogy, both the iPod and the speaker are examples of hardware. The MP3 file, in this case, would represent software. Without the iPod or the speaker, you would not be able to listen to the MP3. By the same token, the iPod and the speaker would be worthless without the MP3 files to play.

Information systems such as geographic information systems, search engines, and data warehouses rely on both hardware and software working in concert to achieve the goal of data manipulation. Computer software drives computer hardware by providing the instructions that tell the hardware what to do. Hardware will not function without software and software will not run without the appropriate hardware.

Types of software:

There are two main types of software: systems software and application software. Systems software includes the programs that are dedicated to managing the computer itself, such as the operating system, file management utilities, and disk operating system (or DOS).

- System software

System software aids the user and the hardware to function and interact with each other. Basically, it is a software to manage computer hardware behavior so as to provide basic functionalities that are required by the user. In simple words, we can say that system software is an intermediator or a middle layer between the user and the hardware. These computer software sanction a platform or environment for the other software to work in. This is the reason why system software is very important in managing the entire computer system. When you first turn on the computer, it is the system software that gets initialized and gets loaded in the memory of the system. The system software runs in the background and is not used by the end-users. This is the reason why system software is also known as 'low-level software'.

- ## Application software:

Application Software, also known as end-user programs or productivity programs are software that helps the user in completing tasks such as doing online research, jotting down notes, setting an alarm, designing graphics, keeping an account log, doing calculations or even playing games. They lie above the system software. Unlike system software, they are used by the end-user and are specific in their functionality or tasks and do the job that they are designed to do. For example, a browser is an application designed specifically for browsing the internet or MS Powerpoint is an application used specifically for making presentations

Definition of system architecture:

Several types of systems architectures are as follows:

- Hardware architecture
- Software architecture
- Enterprise architecture
- Collaborative systems architectures (such as the Internet, intelligent transportation systems, and joint air defense systems)
- Manufacturing systems architectures
- Strategic systems architecture

Q2. Write a note on Multimedia and its type with common media for storage access and transmission in details.

ANS: -

MULTIMEDIA:

Media is something that can be used for presentation of information.

- Two basic ways to present some information are:
    - **Unimedia presentation:** Single media is used to present information
    - **Multimedia presentation:** More than one media is used to present information
- Multimedia presentation of any information greatly enhances the comprehension capability of the user as it involves use of more of our senses.

COMMON MEDIA:

Common media for storage, access, and transmission of information are:

- Text (alphanumeric characters)
- Graphics (line drawings and images)
- Animation (moving images)
- Audio (sound)
- Video (Videographed real-life events)

Multimedia in information technology refers to use of more than one of these media for information presentation to users.

MULTIMEDIA COMPUTER SYSTEM:

Multimedia computer system is a computer having capability to integrate two or more types of media (text, graphics, animation, audio, and video).

In general, size for multimedia information is much larger than plain text information.

Multimedia computer systems require:

- Faster CPU
- Larger storage devices (for storing large data files)
- Larger main memory (for large data size)
- Good graphics terminals

- I/O devices to play any multimedia

TEXT MEDIA:

Alphanumeric characters are used to presentinformation in text form. Computers are widely used for text processing.

Keyboards, OCRs, computer screens, and printers are some commonly used hardware devices for processing text media.

Text editing, text searching, hypertext, and text importing/exporting are some highly desirable features of a multimedia computer system for better presentation and use of text information.

GRAPHICS MEDIA:

Computer graphics deals with generation, representation, manipulation, and display of pictures (line drawings and images) with a computer.

Locating devices (such as a mouse, a joystick, or a stylus), digitizers, scanners, digital cameras, computer screens with graphics display capability, laser printers, and plotters are some common hardware devices for processing graphics media.

Some desirable features of a multimedia computer system are painting or drawing software, screen capturesoftware, clip art, graphics importing, and software support for high resolution.

ANIMATION MEDIA:

Computer animation deals with generation, sequencing, and display (at a specified rate) of a set of images (called frames) to create an effect of visual change or motion, similar to a movie film (video).

Animation is commonly used in those instanceswhere videography is not possible or animation can better illustrate the concept than video.

Animation deals with displaying a sequence of images at a reasonable speed to create an impression of movement. For a jerk-free full motion animation, 25 to 30 frames per second is required.

Scanners, digital cameras, video capture board interfaced to a video camera or VCR, computer monitors with image display capability, and graphics accelerator board are some common hardwaredevices for processing animation media.

Some desirable features of a multimedia computer system with animation facility are animation creation software, screen capture software, animation clips, animation file importing, software support for high resolution, recording and playback capabilities, and transition effects.

VIRTUAL REALITY:

Virtual reality is a relatively new technology using which the user can put a pair of goggles and a glove and tour a three-dimensional world that exists only in the computer, but appears realistic to the user.

AUDIO MEDIA:

Computer audio deals with synthesizing, recording, and playback of audio or sound with a computer

Sound board, microphone, speaker, MIDI devices, sound synthesizer, sound editor and audio mixer are some commonly used hardware devices for processing audio media

Some desirable features of a multimedia computer system are audio clips, audio file importing, software support for high quality sound, recording and playback capabilities, text-to-speech conversion software, speech-to-text conversion software, and voice recognition software.

VIDEO MEDIA:

Computer video deals with recording and display of a sequence of images at a reasonable speed to createan impression of movement.

Each individual image of such a sequence is called a frame.

Video camera, video monitor, video board, and video editor are some of the commonly used hardware devices for processing video media.

Some desirable features of a multimedia computer system with video facility are video clips and recording and playback capabilities.

MULTIMEDIA APPLICATION:

Multimedia presentation.

Foreign language learning.

Video games.

Special effects in films.

Multimedia kiosks as help desks.

Animated advertisements.

Multimedia conferencing.

MEDIA CENTER COMPUTER:

- There is a growing trend of owning a personalcomputer (PC) at home like other electronic equipment
- New terminologies like “infotainment” and “edutainment” have evolved to refer to computers as versatile tools
- Media center PC provides following functionalities:
- Server as PC, TV, radio, and music system
- Serve as digital photo album and digital library
- Server as Game station and DVD/CD Player
- Allows play, pause, and record of TV programs
- Provides Electronic Programming Guide (EPG)

Q3. Write a note on each of the following in details.

(a) Modulation Techniques

(b) Multiplexing

(c) Switching Techniques

(d) Optical Fiber Communication System

ANS: -

MODULATION TECHNIQUES:

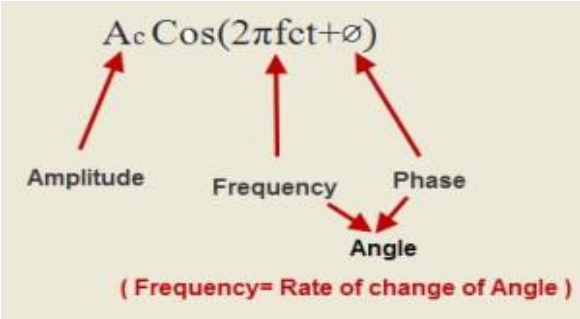
MODULATION:

Modulation is nothing but, a carrier signal that varies in accordance with the message signal. Modulation technique is used to change the signal characteristics. Basically, the modulation is of following two types:

- Analog Modulation
- Digital Modulation

Analog Modulation

In analog modulation, analog signal (sinusoidal signal) is used as a carrier signal that modulates the message signal or data signal. The general function Sinusoidal wave's is shown in the figure below, in which, three parameters can be altered to get modulation – they are amplitude, frequency and phase; so, the types of analog modulation are:



Analog Modulation

- Amplitude Modulation (AM)
- Frequency Modulation (FM)
- Phase Modulation (PM)

Amplitude Modulation:

Amplitude modulation was developed in the beginning of the 20th century. It was the earliest modulation technique used to transmit voice by radio. This type of modulation technique is used in electronic communication. In this modulation, the amplitude of the carrier signal varies in accordance with the message signal, and other factors like phase and frequency remain constant.

The modulated signal is shown in the below figure, and its spectrum consists of the lower frequency band, upper frequency band and carrier frequency components. This type of modulation requires more power and greater bandwidth; filtering is very difficult. Amplitude modulation is used in computer modems, VHF aircraft radio, and in portable two-way radio

Frequency Modulation:

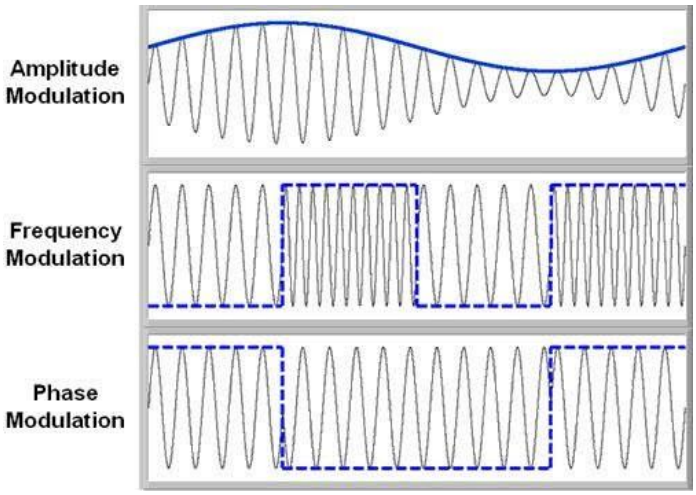
In this type of modulation, the frequency of the carrier signal varies in accordance with the message signal, and other parameters like amplitude and phase remain constant. Frequency modulation is used in different applications like radar, radio and telemetry, seismic prospecting and monitoring newborns for seizures via EEG, etc.

This type of modulation is commonly used for broadcasting music and speech, magnetic tape recording systems, two way radio systems and video transmission systems. When noise occurs naturally in radio systems, frequency modulation with sufficient bandwidth provides an advantage in cancelling the noise.

Phase Modulation:

In this type of modulation, the phase of the carrier signal varies in accordance with the message signal. When the phase of the signal is changed, then it affects the frequency. So, for this reason, this modulation is also comes under the frequency modulation.

Generally, phase modulation is used for transmitting waves. It is an essential part of many digital transmission coding schemes that underlie a wide range of technologies like GSM, WiFi, and satellite television. This type of modulation is used for signal generation in al synthesizers, such as the Yamaha DX7 to implement FM synthesis.

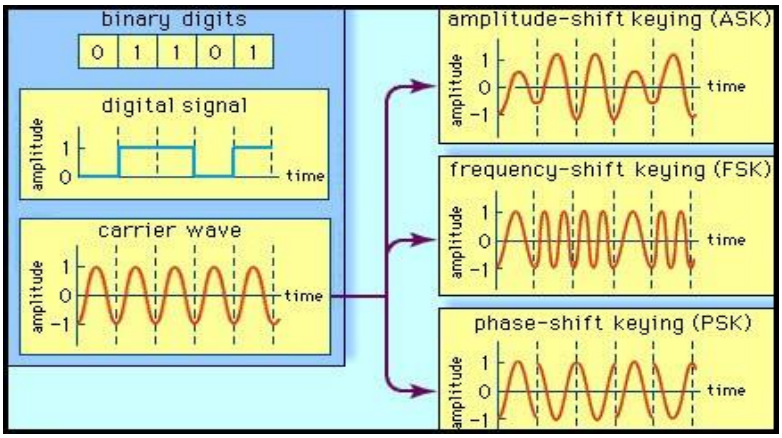


Types of Analog Modulation

Therefore, Analog modulation includes AM, FM and PM and these are more sensitive to noise. If noise enters into a system, it persists and gets carried up to the end receiver. So, this drawback can be overcome by the digital modulation technique.

Digital Modulation:

For a better quality and efficient communication, digital modulation technique is employed. The main advantages of the digital modulation over analog modulation include available bandwidth , high noise immunity and permissible power. In digital modulation, a message signal is converted from analog to digital message, and then modulated by using a carrier wave.



Digital Modulation

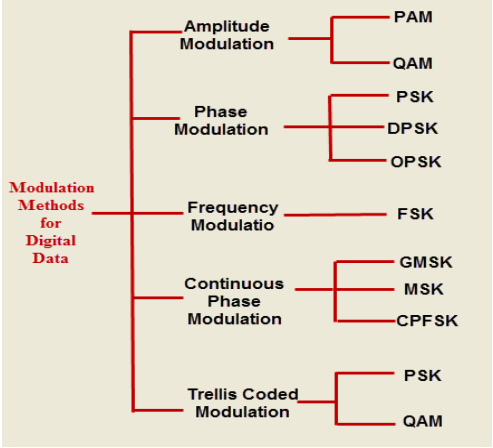
The carrier wave is switched on and off to create pulses such that the signal is modulated. Similar to the analog, in this system, the type of the digital modulation is decided by the variation of the carrier wave parameters like amplitude, phase and frequency.

The most important digital modulation techniques are based on keying such as

Amplitude Shift Keying, Frequency Shift Keying, Phase Shift Keying, Differential Phase Shift Keying, Quadrature Phase Shift Keying, Minimum Shift Keying, Gaussian Minimum Shift Keying, Orthogonal Frequency Division Multiplexing, etc., as shown in the figure.

In an Amplitude shift keying, the amplitude of the carrier wave changes based on the message signal or on the base-band signal, which is in digital format. It is sensitive to noise and used for low-band requirements.

In frequency shift keying, the frequency of the carrier wave is varied for each symbol in the digital data. It needs larger bandwidths as shown in the figure. Similarly, the phase shift keying changes the phase of the carrier for each symbol and it is less sensitive to noise.



Types of Digital Modulation

(b) MULTIPLEXING:

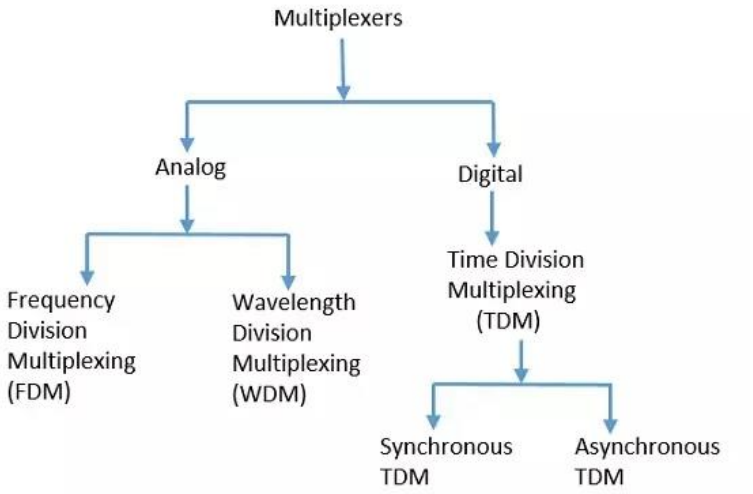
Multiplexing is the process of combining multiple signals into one signal, over a shared medium. If analog signals are multiplexed, it is Analog Multiplexing and if digital signals are multiplexed, that process is Digital Multiplexing.

Multiplexing and Demultiplexing

The process of multiplexing divides a communication channel into several number of logical channels, allotting each one for a different message signal or a data stream to be transferred. The device that does multiplexing can be simply called as a MUX while the one that reverses the process which is demultiplexing, is called as DEMUX.

Types of Multiplexers:

There are mainly two types of multiplexers, namely analog and digital. They are further divided into FDM, WDM, and TDM.



Analog Multiplexing:

The analog multiplexing techniques involve signals which are analog in nature. The analog signals are multiplexed according to their frequency (FDM) or wavelength (WDM).

Frequency Division Multiplexing (FDM)

In analog multiplexing, the most used technique is Frequency Division Multiplexing FDM. This technique uses various frequencies to combine streams of data, for sending them on a communication medium, as a single signal.

Example: A traditional television transmitter, which sends a number of channels through a single cable, uses FDM.

Wavelength Division Multiplexing (WDM)

Wavelength Division Multiplexing is an analog technique, in which many data streams of different wavelengths are transmitted in the light spectrum. If the wavelength increases, the frequency of the signal decreases.

Example: Optical fiber Communications use the WDM technique, to merge different wavelengths into a single light for the communication.

Digital Multiplexing

The term digital represents the discrete bits of information. Hence the available data is in the form of frames or packets, which are discrete.

Time Division Multiplexing (TDM)

In TDM, the time frame is divided into slots. This technique is used to transmit a signal over a single communication channel, with allotting one slot for each message. Of all the types of TDM, the main ones are Synchronous and Asynchronous TDM.

Synchronous TDM

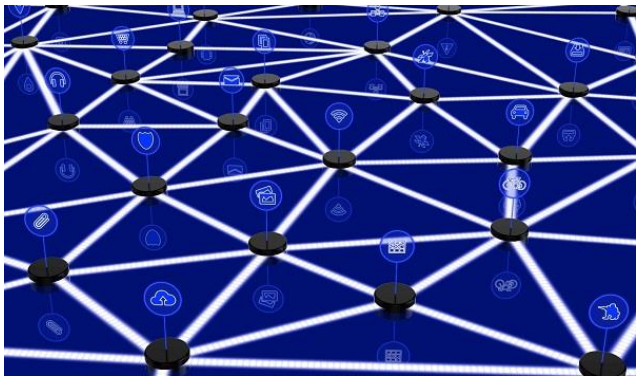
In Synchronous TDM, the input is connected to a frame. If there are 'n' number of connections, then the frame is divided into 'n' time slots. One slot is allocated for each input line. In this technique, the sampling rate is common to all signals and hence same clock input is given. The mux allocates the same slot to each device at all times.

Asynchronous TDM

In Asynchronous TDM, the sampling rate is different for each of the signals and the clock signal is also not in common. If the allotted device, for a time-slot, transmits nothing and sits idle, then that slot is allotted to another device, unlike synchronous.

(C) Switching Techniques:

In large networks, there may be more than one paths for transmitting data from **sender** to receiver. Selecting a path that data must take out of the available options is called **switching**. There are two popular switching techniques – circuit switching and packet switching.



Circuit Switching:

When a dedicated path is established for data transmission between sender and receiver, it is called circuit switching. When any network node wants to send data, be it audio, video, text or any other type of information, a **call request signal** is sent to the receiver and acknowledged back to ensure availability of dedicated path. This dedicated path is then used to send data. ARPANET used circuit switching for communication over the network.

Advantages of Circuit Switching:

Circuit switching provides these advantages over other switching techniques −

- Once path is set up, the only delay is in data transmission speed
- No problem of congestion or garbled message

Disadvantages of Circuit Switching:

Circuit switching has its disadvantages too −

- Long set up time is required
- A request token must travel to the receiver and then acknowledged before any transmission can happen
- Line may be held up for a long time

PACKET SWITCHING:

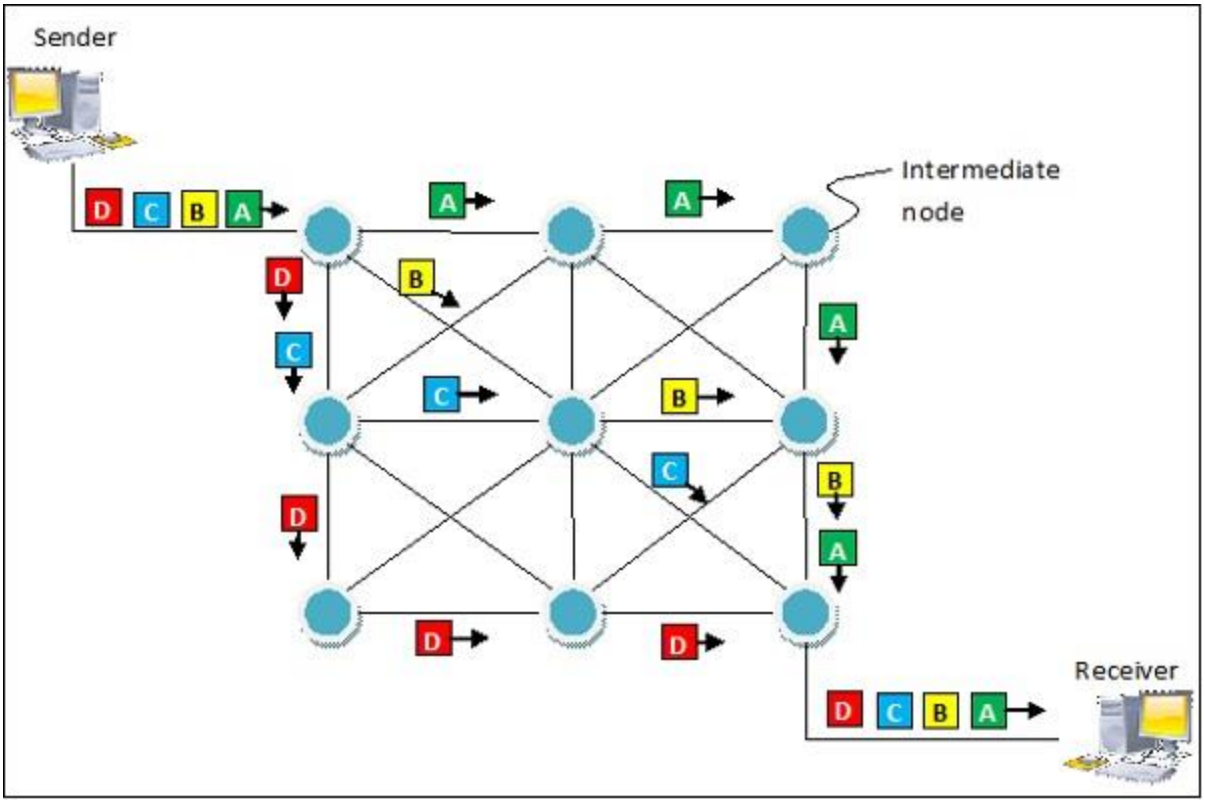
Packet switching is a connectionless network switching technique. Here, the message is divided and grouped into a number of units called packets that are individually routed from the source to the destination. There is no need to establish a dedicated circuit for communication.

Process:

Each packet in a packet switching technique has two parts: a header and a payload. The header contains the addressing information of the packet and is used by the intermediate routers to direct it towards its destination. The payload carries the actual data.

A packet is transmitted as soon as it is available in a node, based upon its header information. The packets of a message are not routed via the same path. So, the packets in the message arrives in the destination out of order. It is the responsibility of the destination to reorder the packets in order to retrieve the original message.

The process is diagrammatically represented in the following figure. Here the message comprises of four packets, A, B, C and D, which may follow different routes from the sender to the receiver.



Advantages and Disadvantages of Packet Switching:

Advantages:

- Delay in delivery of packets is less, since packets are sent as soon as they are available.
- Switching devices don't require massive storage, since they don't have to store the entire messages before forwarding them to the next node.
- Data delivery can continue even if some parts of the network faces link failure. Packets can be routed via other paths.

- It allows simultaneous usage of the same channel by multiple users.
- It ensures better bandwidth usage as a number of packets from multiple sources can be transferred via the same link.

Disadvantages:

- They are unsuitable for applications that cannot afford delays in communication like high quality voice calls.
- Packet switching high installation costs.
- They require complex protocols for delivery.
- Network problems may introduce errors in packets, delay in delivery of packets or loss of packets. If not properly handled, this may lead to loss of critical information.

(D) Optical Fiber Communication System:

Fiber optic communication has revolutionised the telecommunications industry. It has also made its presence widely felt within the data networking community as well. Using fiber optic cable, optical communications have enabled telecommunications links to be made over much greater distances and with much lower levels of loss in the transmission medium and possibly most important of all, fiber optical communications has enabled much higher data rates to be accommodated.

As a result of these advantages, fiber optic communications systems are widely employed for applications ranging from major telecommunications backbone infrastructure to Ethernet systems, broadband distribution, and general data networking.

Development of fiber optics:

Since the earliest days of telecommunications there has been an ever increasing need to transmit more data even faster. Initially single line wires were used. These gave way to coaxial cables that enabled several channels to transmitted over the same cable. However, these systems were limited in bandwidth and optical systems were investigated.

Optical communications became a possibility after the first lasers were developed in the 1960s. The next piece of the jigsaw fell into place when the first optical fibers with a sufficiently low loss for communications purposes were developed in the 1970s. Then, during the late 1970s a considerable amount of research was undertaken. This resulted in the installation of the first optical fiber telecommunications system. It ran over a distance of 45 km and used a wavelength of 0.5 mm and had a data rate of just 45 Mbps - a fraction of what is possible today.

Since then, considerable improvements have been made in the technology. Data rates have improved and in addition to this the performance of the optical fiber has been improved to enable much greater distances to be achieved between repeaters. As an indication of this the speeds that can now be achieved along through a fiber optic system exceed 10 Tbsp.

When the first fiber optic transmission systems were being developed, it was thought that the fiber optic cabling and technology would be prohibitively expensive. However, this has not been the case and costs have fallen to the extent that fiber optics now provides the only viable option for many telecommunications applications. In addition to this it is also used in many local area networks where speed is a major requirement.

Advantages of fiber optics for communications:

There are a number of compelling reasons that lead to the widespread adoption of fiber optic cabling for telecommunications applications:

- Much lower levels of signal attenuation
- Fiber optic cabling provides a much higher bandwidth allowing more data to be delivered
- Fiber optic cables are much lighter than the coaxial cables that might otherwise be used.
- Fiber optics do not suffer from stray interference pickup that occurs with coaxial cabling

Fiber optic transmission system:

Any fiber optic data transmission system will comprise a number of different elements. There are three major elements (marked in bold), and a further one that is vital for practical systems:

- **Transmitter (light source)**
- **Fiber optic cable**
- **Optical repeater**
- **Receiver (Detector)**

The different elements of the system will vary according to the application. Systems used for lower capacity links, possibly for local area networks will employ somewhat different techniques and components to those used by network providers that provide extremely high data rates over long distances. Nevertheless, the basic principles are the same whatever the system.

In the system the transmitter of light source generates a light stream modulated to enable it to carry the data. Conventionally a pulse of light indicates a "1" and the absence of light indicates "0". This light is transmitted down a very thin fiber of glass or other suitable material to be presented at the receiver or detector. The detector converts the pulses of light into equivalent electrical pulses. In this way the data can be transmitted as light over great distances.

Fiber optic transmitter:

Although the original telecommunications fiber optic systems would have used large lasers, today a variety of semiconductor devices can be used. The most commonly used devices are light emitting diodes, LEDs, and semiconductor laser diodes.

The simplest transmitter device is the LED. Its main advantage is that it is cheap, and this makes it ideal for low cost applications where only short runs are needed. However they have a number of drawbacks. The first is that they offer a very low level of efficiency. Only about 1% of the input power enters the optical fiber, and this means that high power drivers would be needed to provide sufficient light to enable long distance transmissions to be made. The other disadvantage of LEDs is that they produce what is termed incoherent light that covers a relatively wide spectrum. Typically the spectral width is between 30 and 60 nm. This means that any chromatic dispersion in the fiber will limit the bandwidth of the system.

In view of their performance, LEDs are used mainly in local-area-network applications where the data rates are typically in the range 10-100 Mb/s and transmission distances are a few kilometres.

Where higher levels of performance are required, i.e. it is necessary that the fiber optic link can operate over greater distances and with higher data rates, then lasers are used. Although more costly, they offer some significant advantages. In the first instance they are able to provide a higher output level, and in addition to this the light output is directional and this enables a much higher level of efficiency in the transfer of the light into the fiber optic cable. Typically the coupling efficiency into a single mode fiber may be as high as 50%. A further advantage is that lasers have a very narrow spectral bandwidth as a result of the fact that they produce coherent light. This narrow spectral width enables the lasers to transmit data at much higher rates because modal dispersion is less apparent. Another advantage is that semiconductor lasers can be modulated directly at high frequencies because of short recombination time for the carriers within the semiconductor material.

Laser diodes are often directly modulated. This provides a very simple and effective method of transferring the data onto the optical signal. This is achieved by controlling current applied directly to the device. This in turn varies the light output from the laser. However for very high data rates or very long distance links, it is more effective to run the laser at a constant output level (continuous wave). The light is then modulated using an external device. The advantage of using an external means of modulation is that it increases the maximum link distance because an effect known as laser chirp is eliminated. This chirp broadens the spectrum of the light signal and this increases the chromatic dispersion in the fiber optic cable.

Fiber optic cable:

The full details and description of fiber optic cabling are found in a separate article / tutorial on this area of the website. In essence a fiber optic cable consists of core, around which is another layer referred to as the cladding. Outside of this there is a protective outer coating.

The fiber optic cables operate because their cladding has a refractive index that is slightly lower than that of the core. This means that light passing down the core undergoes total internal reflection when it reaches the core / cladding boundary, and it is thereby contained within the core of the optical fiber.

Repeaters and amplifiers:

There is a maximum distance over which signals may be transmitted over fiber optic cabling. This is limited not only by the attenuation of the cable, but also the distortion of the light signal along the cable. In order to overcome these effects and transmit the signals over longer distances, repeaters and amplifiers are used.

Opto-electric repeaters may be used. These devices convert the optical signal into an electrical format where it can be processed to ensure that the signal is not distorted and then converted back into the optical format. It may then be transmitted along the next state of the fiber optic cable.

An alternative approach is to use an optical amplifier. These amplifiers directly amplify the optical signal without the need to convert the signal back into an electrical format. The amplifiers consist of a length of fiber optic cable that is doped with a rare earth mineral named Erbium. The treated fiber cable is then illuminated or pumped with light of a shorter wavelength from another laser and this serves to amplify the signal that is being carried.

In view of the much reduced cost of fiber optic amplifiers over repeaters, amplifiers are far more widely used. Most repeaters have been replaced, and amplifiers are used in virtually all new installations these days.

Receivers:

Light travelling along a fiber optic cable needs to be converted into an electrical signal so that it can be processed and the data that is carried can be extracted. The component that is at the heart of the receiver is a photo-detector. This is normally a semiconductor device and may be a p-n junction, a p-i-n photo-diode or an avalanche photo-diode. Photo-transistors are not used because they do not have sufficient speed.

Once the optical signal from the fiber optic cable has been applied to the photo-detector and converted into an electrical format it can be processed to recover the data which can then be passed to its final destination.

Fiber optic transmission of data is generally used for long distance telecommunications network links and for high speed local area networks. Currently fiber optics is not used for the delivery of services to homes, although this is a long term aim for many Telco’s. By using optical fiber cabling here, the available bandwidth for new services would be considerably higher and the possibility of greater revenues would increase. Currently the cost of his is not viable, although it is likely to happen in the medium term.

Q4. What is OSI reference model explain each layer of OSI model in details.

ANS: -

OSI REFERENCE MODEL:

OSI stands for (**Open System Interconnection)** is a reference model that describes how information from a software application in one computer moves through a physical medium to the software application in another computer.

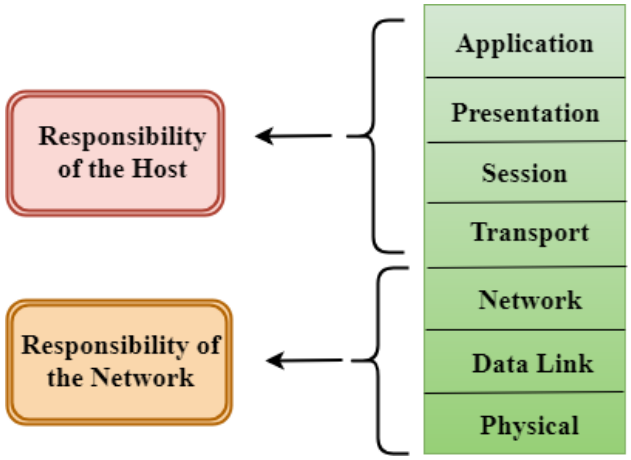
OSI consists of seven layers, and each layer performs a particular network function.

OSI model was developed by the International Organization for Standardization (ISO) in 1984, and it is now considered as an architectural model for the inter-computer communications.

OSI model divides the whole task into seven smaller and manageable tasks. Each layer is assigned a particular task.

Each layer is self-contained, so that task assigned to each layer can be performed independently.

Characteristics of OSI Model:



- The OSI model is divided into two layers: upper layers and lower layers.
- The upper layer of the OSI model mainly deals with the application related issues, and they are implemented only in the software. The application layer is closest to the end

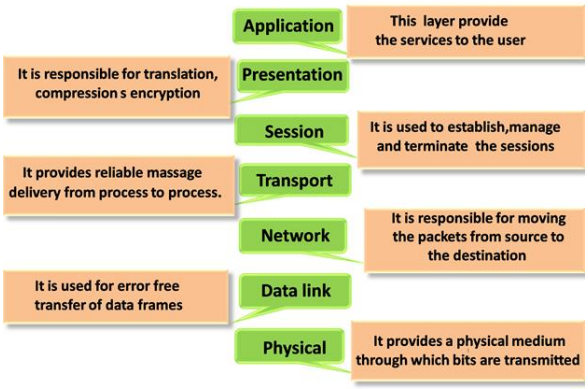
user. Both the end user and the application layer interact with the software applications. An upper layer refers to the layer just above another layer.

- The lower layer of the OSI model deals with the data transport issues. The data link layer and the physical layer are implemented in hardware and software. The physical layer is the lowest layer of the OSI model and is closest to the physical medium. The physical layer is mainly responsible for placing the information on the physical medium.

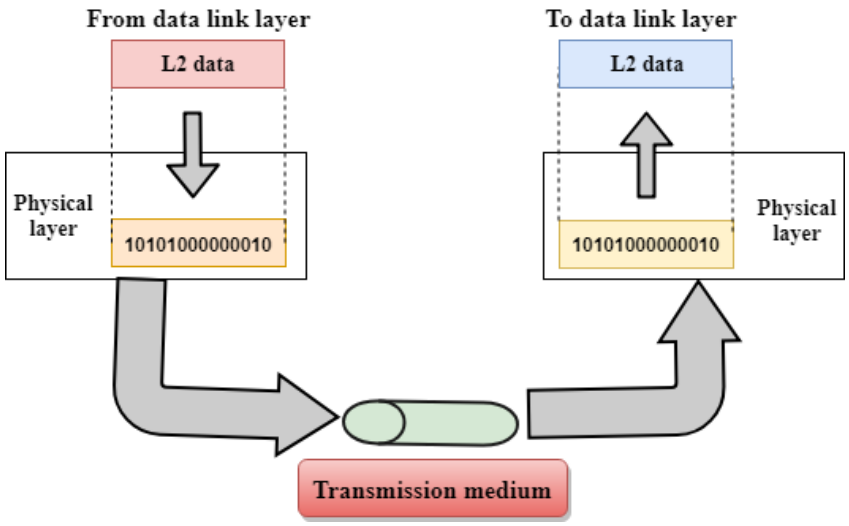
Functions of the OSI Layers

There are the seven OSI layers. Each layer has different functions. A list of seven layers are given below:

1. Physical Layer
2. Data-Link Layer
3. Network Layer
4. Transport Layer
5. Session Layer
6. Presentation Layer
7. Application Layer



Physical layer:

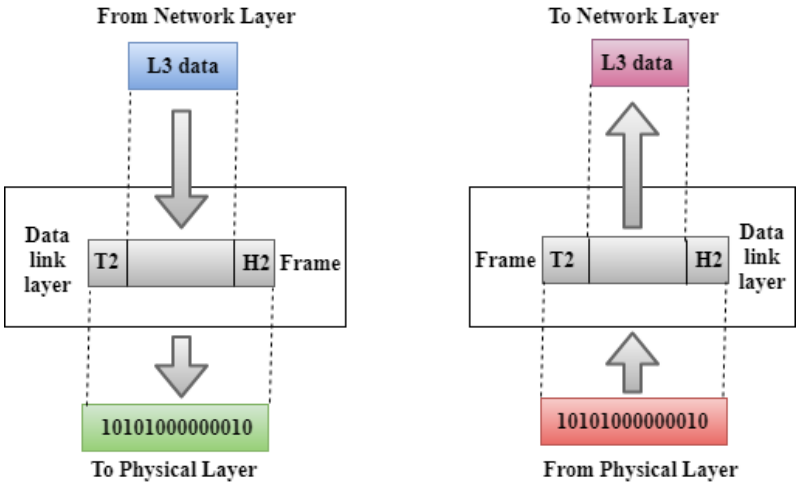


- The main functionality of the physical layer is to transmit the individual bits from one node to another node.
- It is the lowest layer of the OSI model.
- It establishes, maintains and deactivates the physical connection.
- It specifies the mechanical, electrical and procedural network interface specifications.

Functions of a Physical layer:

- **Line Configuration:** It defines the way how two or more devices can be connected physically.
- **Data Transmission:** It defines the transmission mode whether it is simplex, half-duplex or full-duplex mode between the two devices on the network.
- **Topology:** It defines the way how network devices are arranged.
- **Signals:** It determines the type of the signal used for transmitting the information.

Data-Link Layer:



- This layer is responsible for the error-free transfer of data frames.
- It defines the format of the data on the network.
- It provides a reliable and efficient communication between two or more devices.
- It is mainly responsible for the unique identification of each device that resides on a local network.
- It contains two sub-layers:
    - **Logical Link Control Layer**
        - It is responsible for transferring the packets to the Network layer of the receiver that is receiving.
        - It identifies the address of the network layer protocol from the header.
        - It also provides flow control.
    - **Media Access Control Layer**
        - A Media access control layer is a link between the Logical Link Control layer and the network's physical layer.
        - It is used for transferring the packets over the network.

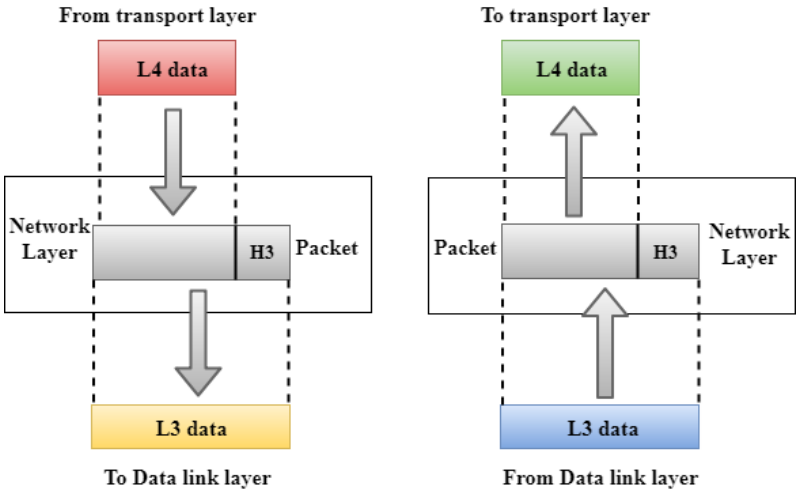
Functions of the Data-link layer:

- **Framing:** The data link layer translates the physical's raw bit stream into packets known as Frames. The Data link layer adds the header and trailer to the frame. The header which is added to the frame contains the hardware destination and source address.

- **Physical Addressing:** The Data link layer adds a header to the frame that contains a destination address. The frame is transmitted to the destination address mentioned in the header.

- **Flow Control:** Flow control is the main functionality of the Data-link layer. It is the technique through which the constant data rate is maintained on both the sides so that no data get corrupted. It ensures that the transmitting station such as a server with higher processing speed does not exceed the receiving station, with lower processing speed.
- **Error Control:** Error control is achieved by adding a calculated value CRC (Cyclic Redundancy Check) that is placed to the Data link layer's trailer which is added to the message frame before it is sent to the physical layer. If any error seems to occurr, then the receiver sends the acknowledgment for the retransmission of the corrupted frames.
- **Access Control:** When two or more devices are connected to the same communication channel, then the data link layer protocols are used to determine which device has control over the link at a given time.

Network Layer:



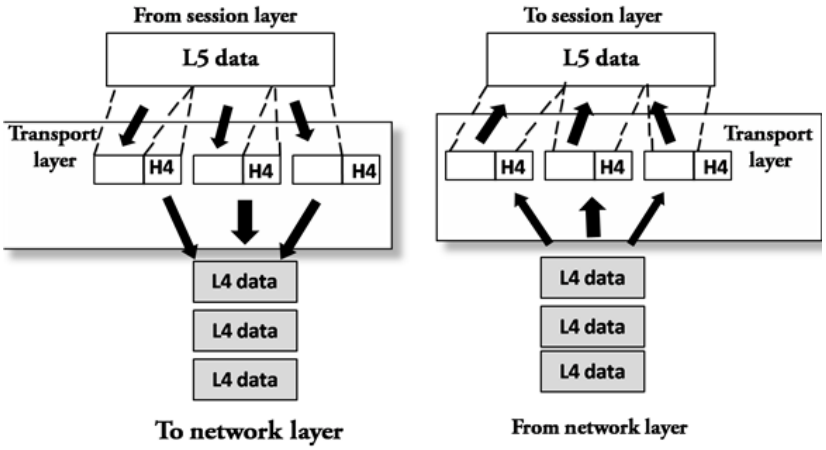
- It is a layer 3 that manages device addressing, tracks the location of devices on the network.
- It determines the best path to move data from source to the destination based on the network conditions, the priority of service, and other factors.
- The Data link layer is responsible for routing and forwarding the packets.
- Routers are the layer 3 devices, they are specified in this layer and used to provide the routing services within an internetwork.
- The protocols used to route the network traffic are known as Network layer protocols. Examples of protocols are IP and Ipv6.

Functions of Network Layer:

- **Internetworking:** An internetworking is the main responsibility of the network layer. It provides a logical connection between different devices.

- **Addressing:** A Network layer adds the source and destination address to the header of the frame. Addressing is used to identify the device on the internet.
- **Routing:** Routing is the major component of the network layer, and it determines the best optimal path out of the multiple paths from source to the destination.
- **Packetizing:** A Network Layer receives the packets from the upper layer and converts them into packets. This process is known as Packetizing. It is achieved by internet protocol (IP).

Transport Layer:



- The Transport layer is a Layer 4 ensures that messages are transmitted in the order in which they are sent and there is no duplication of data.
- The main responsibility of the transport layer is to transfer the data completely.
- It receives the data from the upper layer and converts them into smaller units known as segments.
- This layer can be termed as an end-to-end layer as it provides a point-to-point connection between source and destination to deliver the data reliably.

The two protocols used in this layer are:

- ## Transmission Control Protocol
  - It is a standard protocol that allows the systems to communicate over the internet.
  - It establishes and maintains a connection between hosts.
  - When data is sent over the TCP connection, then the TCP protocol divides the data into smaller units known as segments. Each segment travels over the internet using multiple routes, and they arrive in different orders at the destination. The

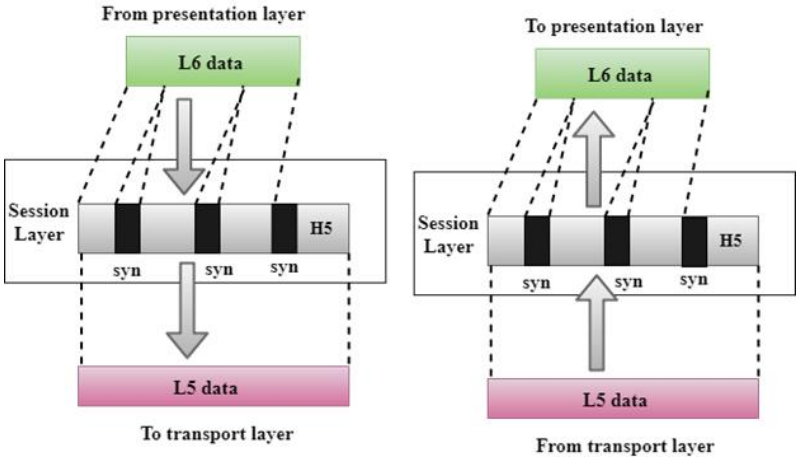
transmission control protocol reorders the packets in the correct order at the receiving end.

- ## User Datagram Protocol
    - User Datagram Protocol is a transport layer protocol.
    - It is an unreliable transport protocol as in this case receiver does not send any acknowledgment when the packet is received, the sender does not wait for any acknowledgment. Therefore, this makes a protocol unreliable.

Functions of Transport Layer:

- **Service-point addressing:** Computers run several programs simultaneously due to this reason, the transmission of data from source to the destination not only from one computer to another computer but also from one process to another process. The transport layer adds the header that contains the address known as a service-point address or port address. The responsibility of the network layer is to transmit the data from one computer to another computer and the responsibility of the transport layer is to transmit the message to the correct process.
- **Segmentation and reassembly:** When the transport layer receives the message from the upper layer, it divides the message into multiple segments, and each segment is assigned with a sequence number that uniquely identifies each segment. When the message has arrived at the destination, then the transport layer reassembles the message based on their sequence numbers.
- **Connection control:** Transport layer provides two services Connection-oriented service and connectionless service. A connectionless service treats each segment as an individual packet, and they all travel in different routes to reach the destination. A connection-oriented service makes a connection with the transport layer at the destination machine before delivering the packets. In connection-oriented service, all the packets travel in the single route.
- **Flow control:** The transport layer also responsible for flow control but it is performed end-to-end rather than across a single link.
- **Error control:** The transport layer is also responsible for Error control. Error control is performed end-to-end rather than across the single link. The sender transport layer ensures that message reach at the destination without any error.

Session Layer:

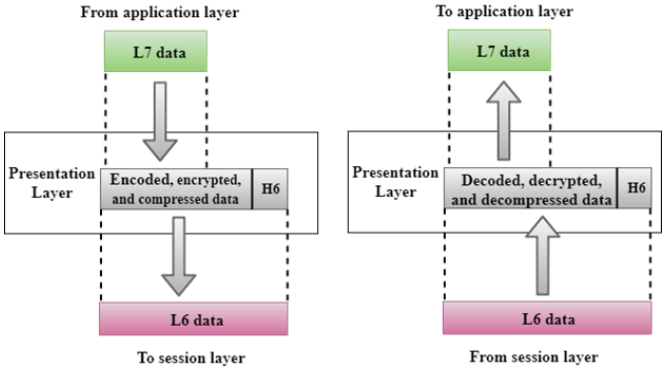


- It is a layer 3 in the OSI model.
- The Session layer is used to establish, maintain and synchronizes the interaction between communicating devices.

Functions of Session layer:

- **Dialog control:** Session layer acts as a dialog controller that creates a dialog between two processes or we can say that it allows the communication between two processes which can be either half-duplex or full-duplex.
- **Synchronization:** Session layer adds some checkpoints when transmitting the data in a sequence. If some error occurs in the middle of the transmission of data, then the transmission will take place again from the checkpoint. This process is known as Synchronization and recovery.

Presentation Layer:



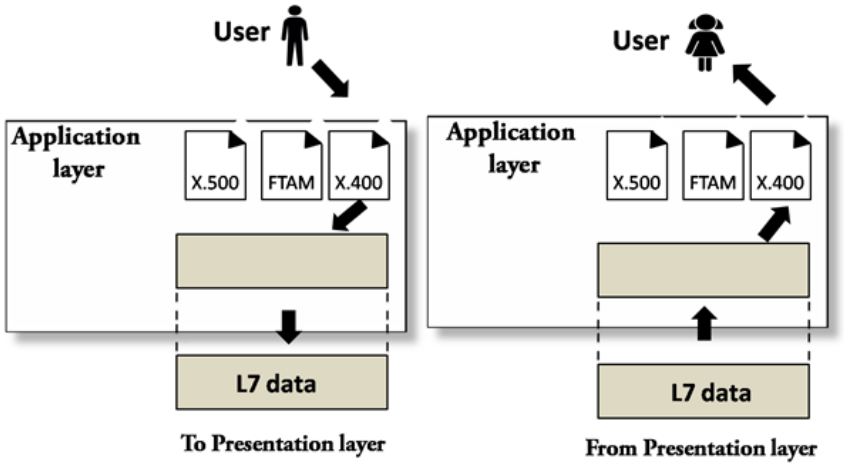
- A Presentation layer is mainly concerned with the syntax and semantics of the information exchanged between the two systems.
- It acts as a data translator for a network.

- This layer is a part of the operating system that converts the data from one presentation format to another format.
- The Presentation layer is also known as the syntax layer.

Functions of Presentation layer:

- **Translation:** The processes in two systems exchange the information in the form of character strings, numbers and so on. Different computers use different encoding methods, the presentation layer handles the interoperability between the different encoding methods. It converts the data from sender-dependent format into a common format and changes the common format into receiver-dependent format at the receiving end.
- **Encryption:** Encryption is needed to maintain privacy. Encryption is a process of converting the sender-transmitted information into another form and sends the resulting message over the network.
- **Compression:** Data compression is a process of compressing the data, i.e., it reduces the number of bits to be transmitted. Data compression is very important in multimedia such as text, audio, video.

Application Layer:



- An application layer serves as a window for users and application processes to access network service.
- It handles issues such as network transparency, resource allocation, etc.
- An application layer is not an application, but it performs the application layer functions.
- This layer provides the network services to the end-users.

Functions of Application layer:

- **File transfer, access, and management (FTAM):** An application layer allows a user to access the files in a remote computer, to retrieve the files from a computer and to manage the files in a remote computer.
- **Mail services:** An application layer provides the facility for email forwarding and storage.
- Directory services: An application provides the distributed database sources and is used to provide that global information about various objects.