

Chapter 1

Introduction to Telecommunication technology (Telecom technology)

Telecommunications, also called telecommunication, is the exchange of information over significant distances by electronic means. A complete, single telecommunications circuit consists of two stations, each equipped with a transmitter and a receiver. The transmitter and receiver at any station may be combined into a single device called a transceiver. The medium of signal transmission can be electrical wire or cable (also known as "copper"), optical fiber or electromagnetic fields. The free-space transmission and reception of data by means of electromagnetic fields is called wireless.

Data is conveyed in a telecommunications circuit by means of an electrical signal called the carrier or carrier wave. In order for a carrier to convey information, some form of modulation is required. The mode of modulation can be broadly categorized as either analog or digital. In analog modulation, some aspect of the carrier is varied in a continuous fashion. The oldest form of analog modulation is amplitude modulation (AM), still used in radio broadcasting at some frequencies. Digital modulation actually predates analog modulation; the earliest form was Morse code. During the 1900s, dozens of new forms of modulation were developed and deployed, particularly during the so-called "digital revolution" when the use of computers among ordinary citizens became widespread.

In some contexts, a broadcast network, consisting of a single transmitting station and multiple receive-only stations, is considered a form of telecommunications. Radio and television broadcasting are the most common examples.

The simplest form of telecommunications takes place between two stations. However, it is common for multiple transmitting and receiving stations to exchange data among themselves. Such an arrangement is called a telecommunications network.

- A telecommunication network is a complete **technical system** for transmission of signals over a distance.
- There are different kinds of telecommunication networks that may have different structure and may utilize different technologies.

– e.g.: telephone network, mobile network, computer network

The main components of different kinds of telecommunication networks are basically the same:

- **Transmission** equipment
- **Switching** equipment
- **Terminal** equipment
- **Support** systems

Transmission technology

- The purpose of every kind of telecommunication network is to transmit signals in the network
- Transmission of signals is done through different kinds of **transmission media** (eg. Fiber optic, Micro wave, PCs, TV, Cellular Radio, FM, Twisted Pair Cable)
- It is possible to differentiate between the types of media depending on how the signals are transmitted and the transmission **capacity** of the media

Bandwidth

- Between two points in the network there is a connection with a certain transmission **capacity**
- The term used for transmission capacity is usually **bandwidth**
- In terms of data volume transmitted, capacity is *bits per second* (binary signs per second)

Leased lines / leased capacity

- Formerly it was common to rent a physical line from a network operator – this was called a **leased line**.
- This phrase may be misleading as the physical lines have very large bandwidth and the customer usually rents only a small part of the line's full capacity.
- **Leased capacity** is a *fixed connection* (though it may be temporary) between two terminal points.

Switching technology

- In a network transmission lines are connected to nodes that usually are known as **switches**
 - Switches are equipment that enable us to connect two or more communication channels as needed.
- We differentiate between two different categories of switching

- **Line switching** is used in the telephone network
- **Packet switching** is mainly used in computer networks

Line or packet switching

- Line switching implies there is an end-to-end connection between two subscribers or terminals in the network.
- Connections may be virtual, and we usually refer to the fact that resources are allocated to the end-to-end connecting for the duration of the call or transmission.
- Packet switching implies that data is divided into smaller units that are transmitted only when there is data to transmit.
- No resources are allocated for an end-to-end connection.

General Considerations about Telecom Technology

Lines:

Line is a connection that is configured to support a normal calling load generated by one individual.

Two prerequisites must be **satisfied** to have successful communication. The first one is **Understandability**. The transmitter and receiver must speak the same languages. The second prerequisites are the **capability to detect errors** as they occur and to have some procedure for resolving those errors. In the case of human communications, intelligent terminals at either end __ human beings can detect noise that may have affected a transmission and request a retransmission, thereby correcting that error. If these two prerequisites are met, then communication can occur. We communicate by using data devices over what is generally termed a transmission line. There are five main types of transmission lines; namely circuits, channels, trunks and virtual circuits- each of which has specific meaning.

Circuits

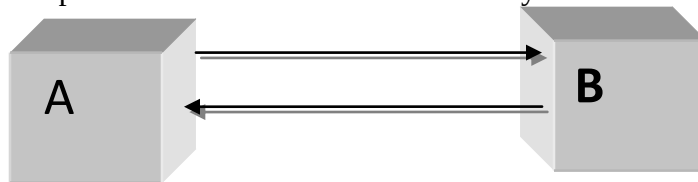
Circuit is the physical path that runs between two or more points. It terminates on point (that is, a point of electrical or interface), and that port can be in the host computer (that is a switching devices used to establish connection), on a multiplexer, or in another device. In and of itself, a circuit does not define the number of simultaneous conversation that can be carried:

that is the function of the types of circuit it is. For example; a simple, traditional telephone circuit is design to carry just one conversation over one physical pathway. However converting that to digital circuits gives you the ability to extract or derive multiple channels over that circuit, subsequently facilitating multiple simultaneous conversations. So, the circuit is the measure of the **physical entity**.

There are two types of circuits: two wire circuit and four wire circuit.

Two-Wire Circuits

- ✓ Has two insulated electrical conductors. One wire is used for transmission of the information. The other wire acts as the return path to complete the electrical circuits.
- ✓ It is generally deployed in the analog local loop, which is the last mile between the subscriber and the subscriber's first point of access into the network.
- ✓ Example of two-wire circuits are shown by the below figure



Four-Wire Circuits

- ✓ Have two pairs of conductors, that is it has two sets of one way transmission path: one path for each direction and complementary path to complete the electrical circuit.
- ✓ It is used where there is a distance between the termination points which requires that the signal be strengthened periodically.
- ✓ For example four-wire circuits connect the various switches that make up PSTN.
- ✓ It is also used with leased line, where a customer may be connecting a location of its own that is separated by distance.
- ✓ Also, all digital circuits are provisioned on a four-wire circuit basis.

Channels

A channel defines a logical conversation path. It is a frequency band, time slot, or wave length (also referred to as lambda) over which a single conversation flows. A channel is a child of a

digital age, because digital facilities enable multiple channels. The number of channels on a transmission line determines the number of simultaneous conversations that can be supported. Because we are becoming more digitalized all the time, you often hear people refer to the number of channels rather than the number of circuits.

Trunks

A trunk is a circuit that is configured to support the normal calling load generated by a group of users. It is a transmission facility that ties together switching systems. A switching system is a device that is used to connect two transmission lines together. There are two major categories of switching system.

- **CPE Switches.** The most prevalent form of switches in the customer premises equipment (CPE) environment is the private branch exchange (PBX), which is called a Private Automatic branch exchange (PABX) in some parts of the world.
 - ✓ **PBX** is used to establish a connection between two points.
 - ✓ It establishes a connection between telephone that is internal to organization, and it establishes a connection between internal extensions and the outside world (that is the PSTN).
- **Network Switches.** A hierarchy of network switches has evolved over time.

Virtual circuits

Today, because of the great interest in and increased use of packet switching, most networks use virtual circuits. Unlike a physical circuit which terminated on a specific physical port, a virtual circuit is a series of logical connections between sending and receiving devices. A virtual circuit is a connection between two devices that act as though it's a direct connection. But, it may in fact be composed of a variety of different routes. These connections are defined by table entries inside the switches. A connection is established after both devices exchange agreement on communications parameters that are important to establishing and maintaining the connection and on providing the proper performance for the application they are supporting. The types of communication parameters that could be included are Message sizes, the path to be taken, how to deal with acknowledgements in the event of errors, flow control procedures, and error control procedures.

- ❖ The term Virtual circuits is largely used to describe connection between two hosts in a packet switching network, where the two hosts can communicate as though they have a dedicated connection although packet may be taking very different routes to arrive at their destination.

☞ There are **two** types of virtual circuits: Permanent virtual circuits (PVC) and Switch virtual circuits (SVC).

☞ The vast majority of implementation today involve PVC

☞ PVCs and SVCs are commonly used in packet switching network(for example ,X.25,Frame Relay, ATM)

PVC

- ✓ PVC is a virtual circuit that is permanently available; that is, the connection always exists between the two locations or two devices in question.
- ✓ Is mutually configured by a network management system, and it remain in place until the user reconfigure the network.
- ✓ It use is analogous to the use of a dedicated private line, because, it provides always-on-condition between two location and two devices.

SVCs

- ✓ Set up on demand
- ✓ They are provisioned dynamically by using signaling techniques
- ✓ It must be reestablished each time data is to be sent and after the data has been sent, the SVC disappears.
- ✓ Therefore it is analogous to a dial up connection in the PSTN.
- ☞ The main benefit of SVC is that you can use it to access the network from any place.
- ☞ The predominant application for SVCs is to accommodate peoples who are working at home, hotel, at an air port or otherwise outside the physical location of the enterprise network.

Types of Network Connection

Three major types of network connection can be made:

- ☞ **Switches Network Connection:-** A switched network connection is referred to as a dial up connection. This implies that you are using a series of network switches to establish the connection between the parties.
- ☞ **Leased Line Network Connection:-** It is also referred to as a Private line. With a leased line, the same location or the devices are always connected and transmission between those location or devices always occur on the same path.
- ☞ **Dedicated Network Connection:-** It is always connected and always use the same path for transmission . However, The end user may own the transmission facilities (rather than lease it) such that it is exclusive to that user.

General Model of Telecommunication Channel

What is Telecommunication channel? In **telecommunications** and computer networking, a **telecommunication channel** or **channel**, refers either to a physical transmission medium such as a wire, or to a logical connection over a multiplexed medium such as a radio **channel**.

We have two types of telecom channels or signals(analog and digital telecom signal or channel).

Analog and digital signals

- **An analog transmission system:**
 - When a use is speaking into a microphone the electric signal in the wires will vary in a similar way to the variation of the air pressure due to sound
- **A digital transmission system:**
 - Only binary signals is transmitted in a digital system
 - We usually name the two signals “0” and “1”
- Analog systems are old and of limited use, a digital transmission system can be efficiently used for both telephony and data networks

Open System Interconnection (OSI Models): Physical Media of Communication

Introduction

The Open Systems Interconnection (OSI) model is a reference tool for understanding data communications between any two networked systems. It divides the communications processes into **seven** layers. Each layer both performs specific functions to support the layers above it and offers services to the layers below it. The **three lowest layers** focus on passing

traffic through the network to an end system. The **top four layers** come into play in the **end system** to complete the process.

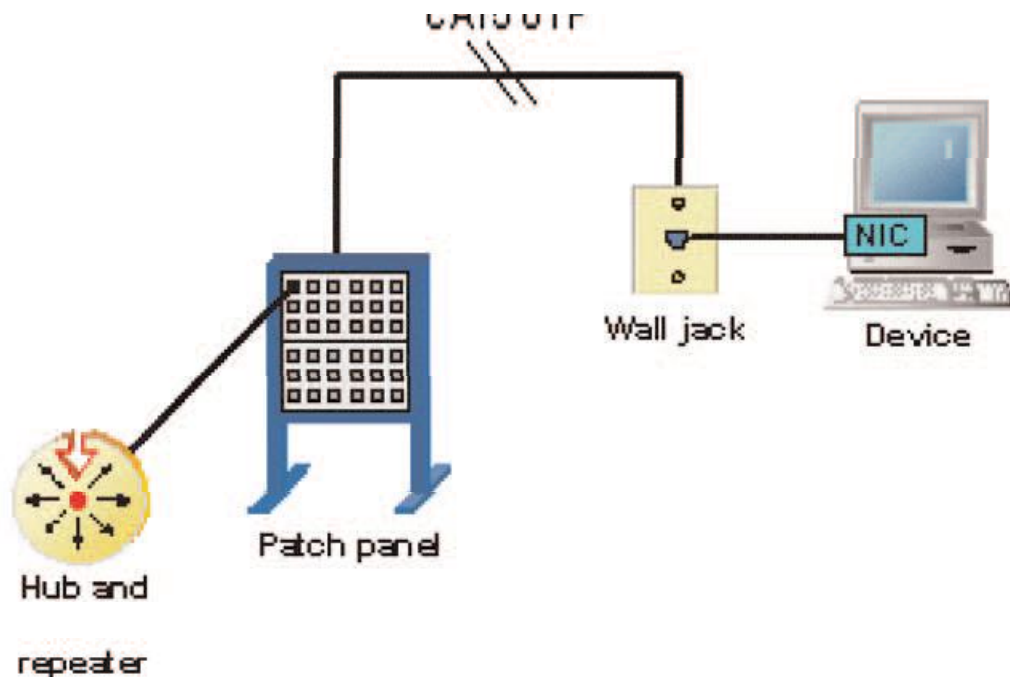
All layers work together in the correct order to move data around a network

The Open System Interconnection model is a seven-layer structure that specifies the requirements for communications between two computers. The ISO (International Organization for Standardization) standard 7498-1 defined this model. This model allows all network elements to operate together, no matter who created the protocols and what computer vendor supports them.

The main benefits of the OSI model include the following:

- Helps users understand the big picture of networking
- Helps users understand how hardware and software elements function together
- Makes troubleshooting easier by separating networks into manageable pieces
- Defines terms that networking professionals can use to compare basic functional relationships on different networks
- Helps users understand new technologies as they are developed
- Aids in interpreting vendor explanations of product functionality

Layer 1 – The Physical Layer



The physical layer of the OSI model defines connector and interface specifications, as well as the medium (cable) requirements. Electrical, mechanical, functional, and procedural specifications are provided for sending a bit stream on a computer network.

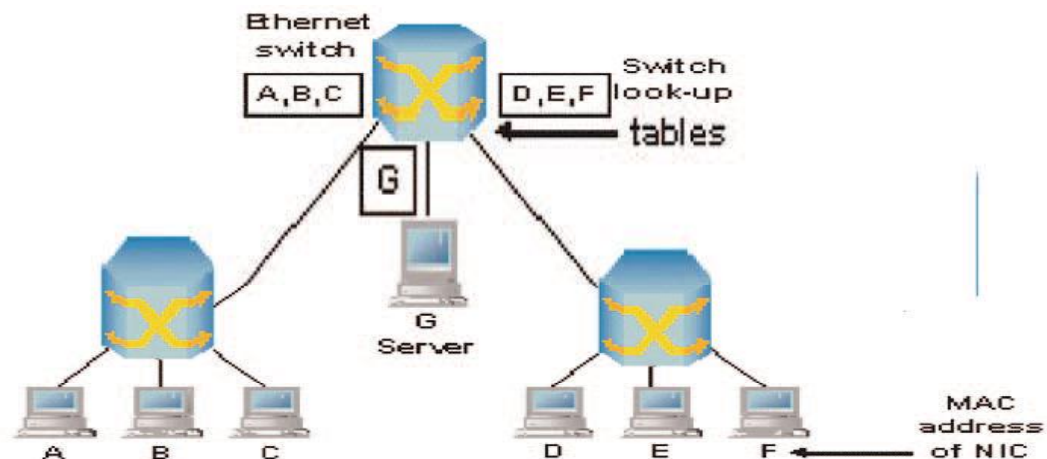
Components of the physical layer include:

- Cabling system components
- Adapters that connect media to physical interfaces
- Connector design and pin assignments
- Hub, repeater, and patch panel specifications
- Wireless system components
- Parallel SCSI (Small Computer System Interface)
- Network Interface Card (NIC)

In a LAN environment, Category 5e UTP (Unshielded Twisted Pair) cable is generally used for the physical layer for individual device connections. Fiber optic cabling is often used for the physical layer in a vertical or riser backbone link. The IEEE, EIA/TIA, ANSI, and other similar standards bodies developed standards for this layer.

Note: The Physical Layer of the OSI model is only part of a LAN (Local Area Network).

Layer 2 – The Data Link Layer



Layer 2 of the OSI model provides the following functions:

- Allows a device to access the network to send and receive messages
- Offers a physical address so a device's data can be sent on the network
- Works with a device's networking software when sending and receiving messages
- Provides error-detection capability

Common networking components that function at layer 2 include:

- Network interface cards
- Ethernet and Token Ring switches
- Bridges

NICs have a layer 2 or MAC address. A switch uses this address to filter and forward traffic, helping relieve congestion and collisions on a network segment.

Bridges and switches function in a similar fashion; however, bridging is normally a software program on a CPU, while switches use Application-Specific Integrated Circuits (ASICs) to perform the task in dedicated hardware, which is much faster.

Layer 3 – The Network Layer

Layer 3, the network layer of the OSI model, provides an end-to-end logical addressing system so that a packet of data can be routed across several layer 2 networks (Ethernet, Token Ring, Frame Relay, etc.). Note that network layer addresses can also be referred to as **logical addresses**. Initially, software manufacturers, such as Novell, developed proprietary layer 3 addressing. However, the networking industry has evolved to the point that it requires a common layer 3 addressing system. The Internet Protocol (IP) addresses make networks easier to both set up and connect with one another. The Internet uses IP addressing to provide connectivity to millions of networks around the world. To make it easier to manage the network and control the flow of packets, many organizations separate their network layer addressing into smaller parts known as subnets. Routers use the network or subnet portion of the IP addressing to route traffic between different networks. Each router must be configured specifically for the networks or subnets that will be connected to its interfaces. Routers communicate with one another using routing protocols, such as Routing Information Protocol (RIP) and Open version of Shortest Path First (OSPF), to learn of other networks that are present and to calculate the best way to reach each network based on a variety of criteria (such as the path with the fewest routers). Routers and other networked systems make these routing decisions at the network layer.

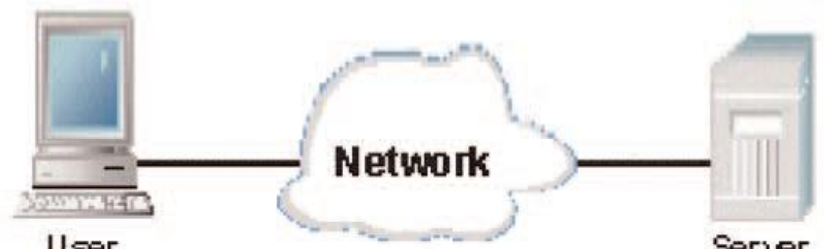
When passing packets between different networks, it may become necessary to adjust their outbound size to one that is compatible with the layer 2 protocol that is being used.

The network layer accomplishes this via a process known as fragmentation. A router's network layer is usually responsible for doing the fragmentation. All reassembly of fragmented packets happens at the network layer of the final destination system.

Two of the additional functions of the network layer are diagnostics and the reporting of logical variations in normal network operation. While the network layer diagnostics may be initiated by any networked system, the system discovering the variation reports it to the original sender of the packet that is found to be outside normal network operation.

The variation reporting exception is content validation calculations. If the calculation done by the receiving system does not match the value sent by the originating system, the receiver discards the related packet with no report to the sender. Retransmission is left to a higher layer's protocol. Some basic security functionality can also be set up by filtering traffic using layer 3 addressing on routers or other similar devices.

Layer 4 – The Transport Layer



Layer 4, the transport layer of the OSI model, offers end-to-end communication between end devices through a network. Depending on the application, the transport layer either offers reliable, connection-oriented or connectionless, best-effort communications.

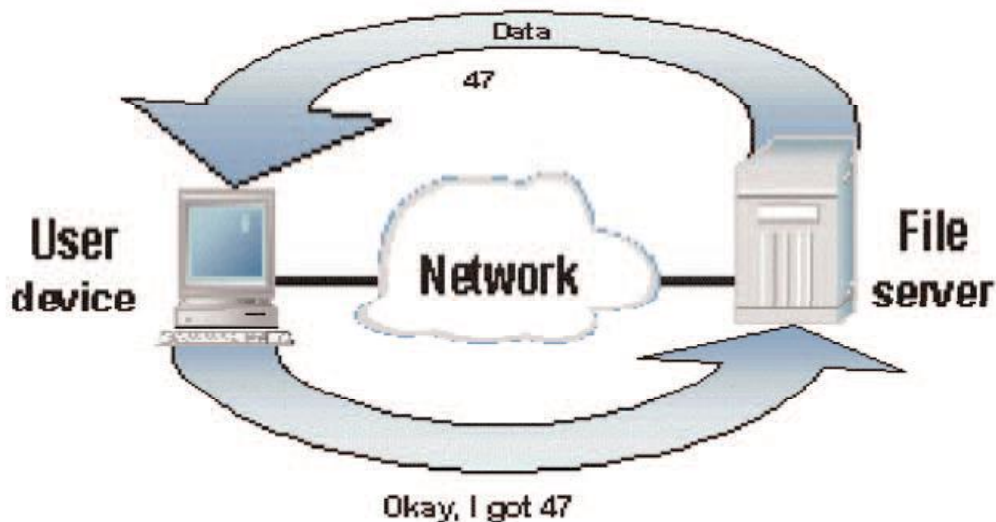
Some of the functions offered by the transport layer include:

- Application identification
- Client-side entity identification
- Confirmation that the entire message arrived intact
- Segmentation of data for network transport
- Control of data flow to prevent memory overruns
- Establishment and maintenance of both ends of virtual circuits
- Transmission-error detection

- Realignment of segmented data in the correct order on the receiving side
- Multiplexing or sharing of multiple sessions over a single physical link

The most common transport layer protocols are the connection-oriented TCP Transmission Control Protocol (TCP) and the connectionless UDP User Datagram Protocol (UDP).

Layer 5 – The Session Layer

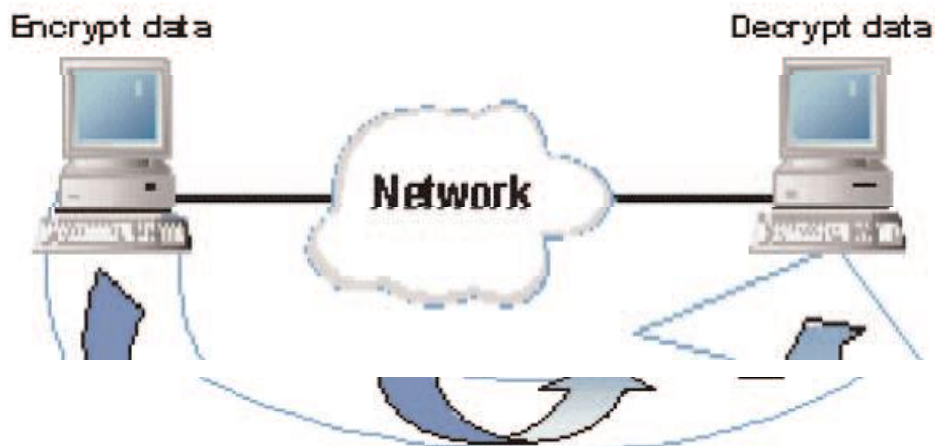


Layer 5, the session layer, provides various services, including tracking the number of bytes that each end of the session has acknowledged receiving from the other end of the session. This session layer allows applications functioning on devices to establish, manage, and terminate a dialog through a network.

☞ Session layer functionality includes:

- Virtual connection between application entities
- Synchronization of data flow
- Creation of dialog units
- Connection parameter negotiations
- Partitioning of services into functional groups
- Acknowledgements of data received during a session
- Retransmission of data if it is not received by a device

Layer 6 – The Presentation Layer



Layer 6, the presentation layer, is responsible for how an application formats the data to be sent out onto the network. The presentation layer basically allows an application to read (or understand) the message.

Examples of presentation layer functionality include:

- Encryption and decryption of a message for security
- Compression and expansion of a message so that it travels efficiently
- Graphics formatting
- Content translation
- System-specific translation

Layer 7 – The Application Layer



Layer 7, the application layer, provides an interface for the end user operating a device connected to a network. This layer is what the user sees, in terms of loading an application (such as Web browser or e-mail); that is, this application layer is the data the user views while using these applications.

Examples of application layer functionality include:

- Support for file transfers
- Ability to print on a network
- Electronic mail
- Electronic messaging
- Browsing the World Wide Web