Unit-1

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Outline

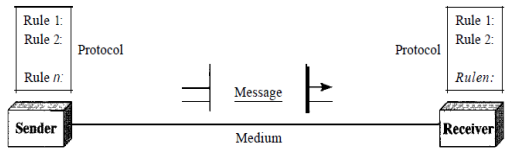
1. Data Communication
2. Networks
3. Protocols and Standards
4. Standard Organizations
5. Line Configuration
6. Topology
7. Transmission Modes
8. Categories of Networks
9. OSI model & TCP/IP model
10. Example network: The internet, X.25, Frame Relay

Data Communication

- Data Communication
  - Data refers to information presented in whatever form is agreed upon by the parties creating and using the data.
  - Data Communications are the exchange of data between two devices via some form of transmission medium such as wire cable.
- Characteristics of Data Communication
  - Delivery – The system must deliver data to the correct destination.
  - Accuracy –The system must deliver data accurately.
  - Timeliness – The system must deliver data in a timely manner.
  - Jitter – Jitter refers to the variation in the packet arrival time. For example Video data must deliver in proper time.

- Components
  - Message: The message is the information to be communicated.
  - Sender: The sender is the device that sends the data message.
  - Receiver: The receiver is the device that receives the message.
  - Transmission Medium: It is the physical path by which a message travels from sender to receiver.
  - Protocol: It is a set of rules that govern data communication.
- Data Representation
  - Text, Numbers, Images, Audio,Video

- *Components* of data communication



2. Networks Performance Criteria

Data Communication Network Criteria	Performance	Transit time
		Response time
		Throughput
		Delay
	Reliability	Frequency of Failure
		Time taken by a link to recover
	Security	Unauthorization
		Protecting data from Damage
		Policy implementation for Recovery measures

3. Protocols & Standards

What is Protocol?

- It is a set of rules that govern data communications.
- It defines
  - *what* is communicated
  - *how* it is communicated
  - *when* it is communicated
- Key elements of a protocol are:
  - Syntax (presentation or structure or format of the data)
  - Semantics (How a particular pattern is to be interpreted, and what action is to be taken)
  - Timing (when data should be sent and how fast they can be sent)

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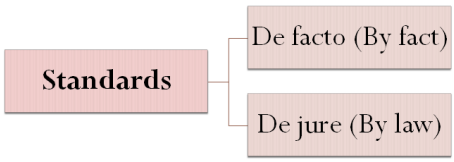
3. Protocols & Standards (Contd.)



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4. Standard Organizations

- Standards Creation Committees formed by:
  - Forums (work with universities and users to test, evaluate, and standardize new technologies)
  - Regulatory Agencies (to protect the public interest by regulating radio, television, and wire/cable communications)
  - Internet Standards (It is a formalized regulation that must be followed)
- Some Standards Creation Committees are:
  - International Organization for Standardization (ISO)
  - International Telecommunication Union-Telecommunication Standards Sector (ITU-T)
  - American National Standards Institute (ANSI)
  - Institute of Electrical and Electronics Engineers (IEEE)
  - Electronic Industries Association (EIA)

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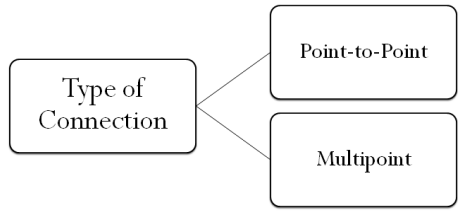
5. Line Configuration



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- Point to Point

- A point to point connection provides a dedicated link between two devices. The entire capacity of the link is reserved for transmission between those two devices.

- Multipoint

- A multipoint connection is one in which more than two specific devices share a single link. Capacity of channel is shared either spatially or temporally.

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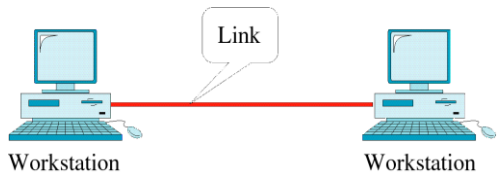
Point-to-Point Line Configuration



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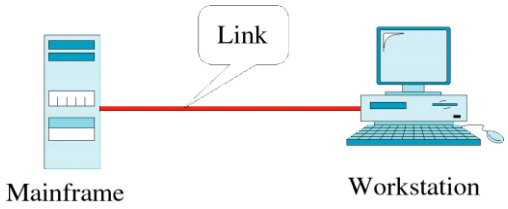
Point-to-Point Line Configuration



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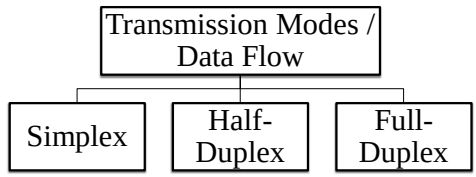
6. Transmission Modes



Point-to-Point Line Configuration

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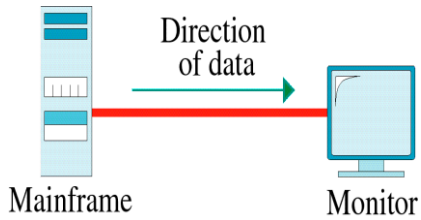
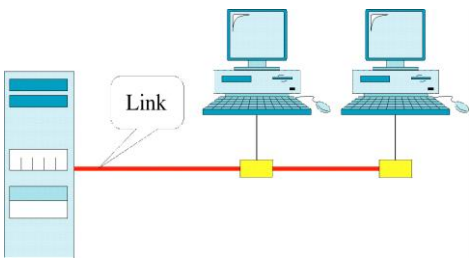
Simplex



Example: Keyboards and traditional monitors

Multipoint Line Configuration



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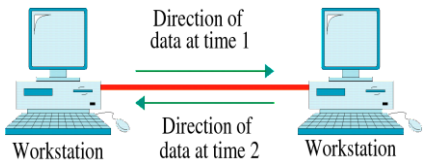
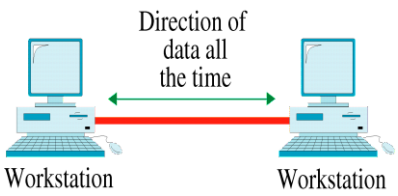
Half-Duplex



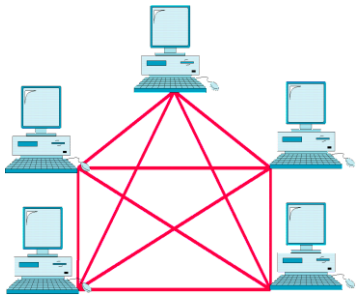
Example: Walkie-talkies and CB (citizens band) radios

Full-Duplex

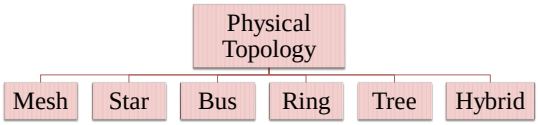


Example: Telephone network

Mesh Topology



7. Topology



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Advantages:

- Data can be transmitted from different devices simultaneously. This topology can stand with high traffic.
- Even if one of the components fails there is always an alternative present. So data transfer doesn't get affected.
- Expansion and modification in topology can be done without disrupting other nodes.

Disadvantages:

- There are high chances of redundancy in many of the network connections.
- Overall cost of this network is way too high as compared to other network topologies.
- Set-up and maintenance of this topology is very difficult. Even administration of the network is tough.

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Mesh Topology

- The Topology of a network is the geometric representation of the relationship of all the links and linking devices(usually called nodes) to one another.
- In mesh topology every device has a dedicated point to point link to every other device.
- Each node is connected to n-1 node so we need n(n-1) link.
- If each physical link allows communication in both directions then we need n(n-1)/2 link duplex mode links.

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Star Topology

- In star topology each device has a dedicated point to point link only to a central controller usually called hub.
- Star topology does not allow direct traffic between devices.
- A Controller act as an exchange.

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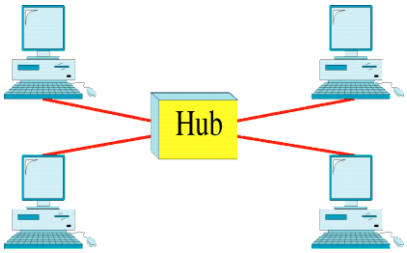
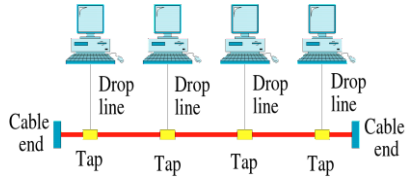
Star Topology



Bus Topology



Advantage:

- Easy to install and wire.
- No disruptions to the network when connecting or removing devices.
- Easy to detect faults and to remove parts.

Disadvantage:

- Requires more cable length than a linear topology.
- If the hub, switch, or concentrator fails, nodes attached are disabled.
- More expensive than linear bus topologies because of the cost of the hubs, etc.

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•Advantages:

- It is easy to set-up and extend bus network.
- Cable length required for this topology is the least compared to other networks.
- Bus topology costs very less.
- Linear Bus network is mostly used in small networks. Good for LAN.

Disadvantage:

-Entire network shuts down if there is a break in the main cable.
- Terminators are required at both ends of the backbone cable.
-Difficult to identify the problem if the entire network shuts down.
-Not meant to be used as a stand-alone solution in a large building.

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Bus Topology

- One long cable acts as a backbone to link all the devices in a network.
- Nodes are connected to the bus cable by drop lines and taps.
- A drop line is a connection running between the device and the main cable.
- As single travels through cable heat generated so there is a limitation of tap on cable at some distance.

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Ring Topology

- In a ring topology each device has a dedicated point to point connection with only the two devices on either side of it.
- Signal is passed along the ring in one direction from device to device until it reaches its destination.
- Each device in the ring incorporates a repeater.

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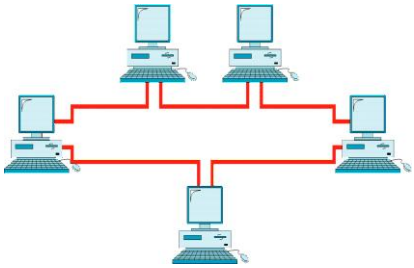
Ring Topology



Advantages:

- It is easy to install and reconfigure.
- in ring topology all the traffic flows in only one direction at very high speed.
- It also has alarm system to inform failure of device.
- There is no need for network server to control the connectivity between workstations.
- Additional components do not affect the performance of network.
- Each computer has equal access to resources.

Disadvantages:

- Each packet of data must pass through all the computers between source and destination. This makes it slower than Star topology.
- If one workstation or port goes down, the entire network gets affected.
- Network is highly dependent on the wire which connects different components.
- MAU's (Multistation Access Unit and network cards are expensive as compared to Ethernet cards and hubs

Advantages

• **Reliable :** Unlike other networks, fault detection and troubleshooting is easy in this type of topology.

•**Scalable:** Its easy to increase the size of network by adding new components, without disturbing existing architecture.

•**Flexible:** Hybrid Network can be designed according to the requirements of the organization and by optimizing the available resources.

•**Effective:** Hybrid topology is the combination of two or more topologies, so we can design it in such a way that strengths of constituent topologies are maximized while there weaknesses are neutralized.

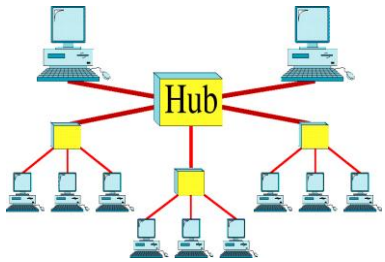
Disadvantages

• **Complexity of Design:** One of the biggest drawback of hybrid topology is its design. Its not easy to design this type of architecture and its a tough job for designers. Configuration and installation process needs to be very efficient.

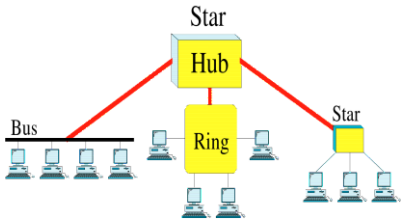
•**Costly Hub:** The hubs used to connect two distinct networks, are very expensive.

•**Costly Infrastructure**: As hybrid architectures are usually larger in scale, they require a lot of cables, cooling systems, sophisticate network devices, etc.

Tree Topology



Hybrid Topology



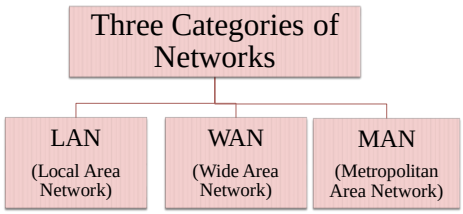
Advantages:

- Point-to-point wiring for individual segments.
- Supported by several hardware and software venders.

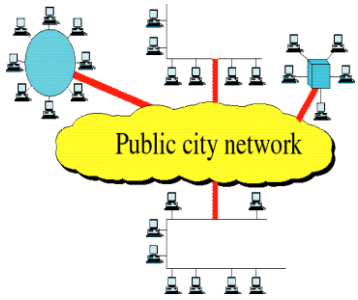
Disadvantages:

- Overall length of each segment is limited by the type of cabling used.
- If the backbone line breaks, the entire segment goes down.
- More difficult to configure and wire than other topologies.

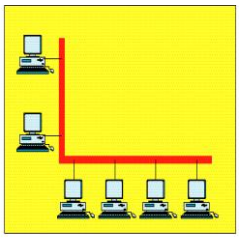
8. Categories of Networks



Metropolitan Area Network



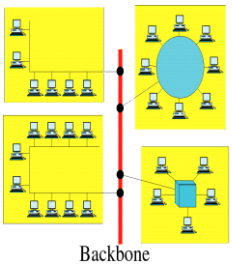
Local Area Network



Single building LAN

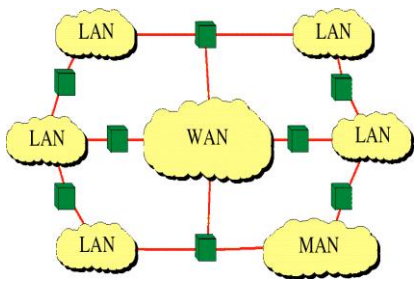
Wide Area Network

Local Area Network



Multiple building LAN

Internetwork (Internet)



9. OSI Model

- ISO is the organization. OSI is the model.
- Before 1990 OSI(Open Systems Interconnection) Model.
- Now a days TCP/IP is used because it tested extensively in the internet.
- An open system is a set of protocols that allows any two different systems to communicate regardless of their underlying architecture.
- OSI model provide communication without changing the logic of the underlying hardware and software.
- The processes on each machine that communicate at a given layer are called peer to peer processes.

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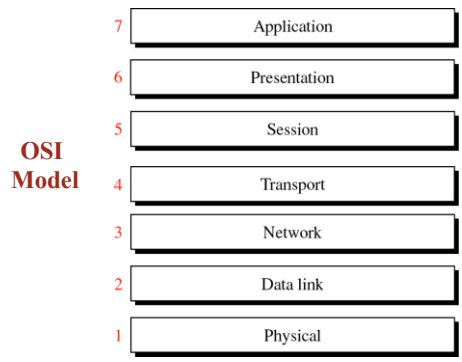

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OSI layer

- Layers 1,2 and 3 includes physical, datalink and network are th e network support layers.
- They deal with the physical aspects of moving data from one device to another.
- Layer 5,6 and 7 include session, presentation and application can be thought of as the user support layers they allow interoperability among unrelated software system.
- Layer 4 the transport layer links the two subgroups and ensure that what the lower layers have transmitted.
- The upper OSI layers are almost software, Lower layers are combination of hardware and software, except physical it is always hardware.

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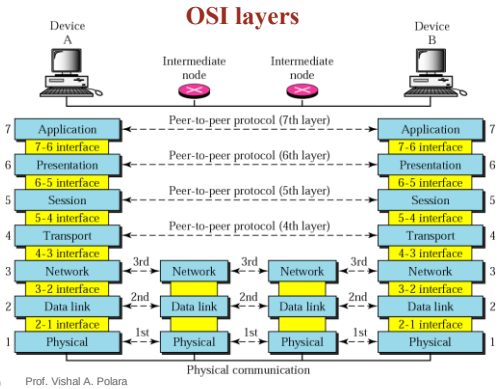

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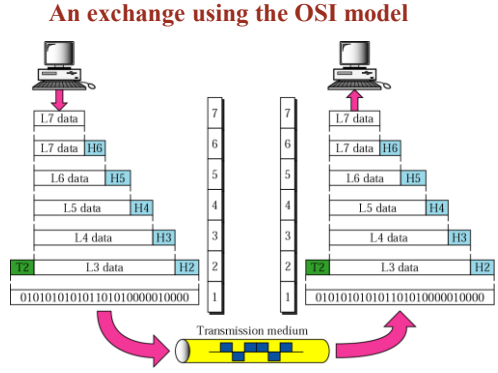

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Physical Layer

- The physical layer coordinates the functions required to carry a bit stream over a physical medium.
- It deals with mechanical and electrical specification of the interface and transmission medium.
- The physical layer is responsible for movements of individual bits from one hop to the next.
- Task of physical layer:

1. Physical characteristics of interfaces and medium:
2. Representation of bits: It contain message in the form of 0 or 1 which is encoded into signals(electrical or optical).
3. Data Rate: The transmission rate the number of bits sent each second.

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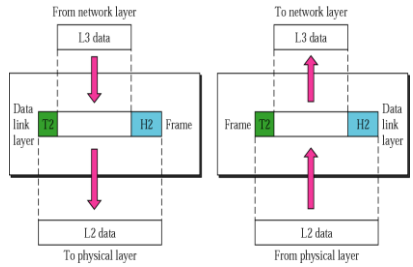
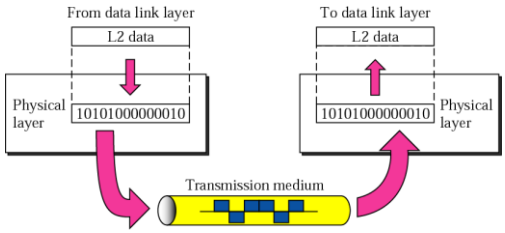
Physical Layer

4. Synchronization of bits: The sender and receiver clock must be synchronized.
5. Line configuration
6. Physical Topology
7. Transmission Modes

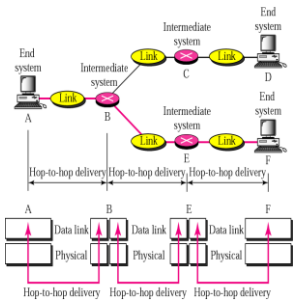
Data Link Layer



Physical Layer



Node-to-node delivery



Data link Layer

- The data link layer transforms the physical layer a raw transmission facility to a reliable link.
- It is responsible for moving frames from one hop(node) to the next.
- Task of data link layer:

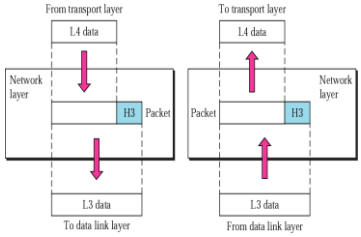
1. Framing: It divides the stream of bits received from the network layer into manageable data units called frames.
2. Physical Addressing: It adds a header to the frame to define the sender or receiver of the frame.
3. Flow Control: The rate of consuming data and sending data maintain by data link layer.
4. Error Control: It provide mechanisms to detect and retransmit damaged or lost frames.
5. Access Control: It provide information of the device which has control over the link.

Network Layer

- It is responsible for the **source to destination** delivery of a packet.
- It deliver packet possible across multiple networks(links).
- There is no requirement of network layer if there is direct link between two devices.
- Task of Network Layer:

1. Logical Addressing: Example IP address
2. Routing: When an independent networks or links are connected to create internetworks or a large network the connecting devices called router.

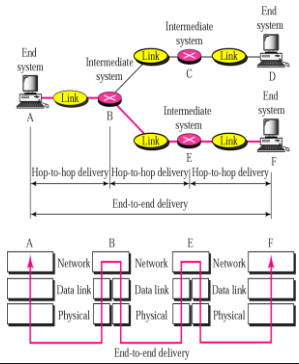
Network Layer



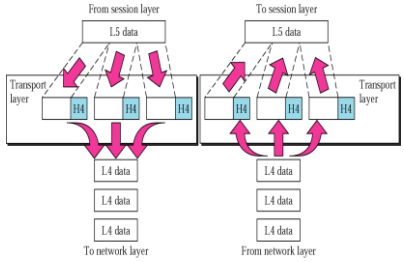
Transport Layer

5. **Error Control:** Error control is end to end rather than across a single link. Error correction is done by means of retransmission.

End-to-end delivery



Transport Layer

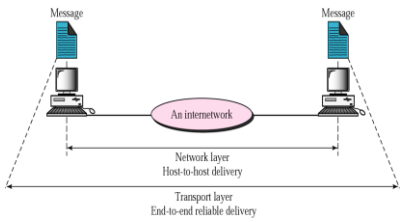


Transport Layer

- It is responsible for **process to process** delivery of the entire message.
- Task of Transport Layer:

1. **Service Point Addressing:** It is responsible for delivery from process to process so it contain service point address.
2. **Segmentation and reassemble:** Dividing message into segment and assign number to each segment so properly collect it at receiving end.
3. **Connection Control:** It provide two types of service, connection less or connection oriented.
4. **Flow control:** It is responsible for delivery end to end rather than across a single link.

Reliable end-to-end delivery of a message



Session Layer

- It is responsible for dialog control and synchronization.
- Task of Session Layer:

1. **Dialog Control**: It allows two systems to enter into a dialog. It allows system to make half duplex or full duplex communication.
2. **Synchronization:** The session allows a process to add checkpoints, to a stream of data. For example if we are sending 1000 file it is good to put checkpoint to make recovery possible.

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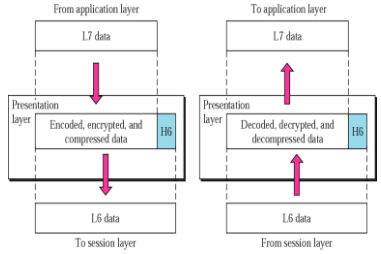
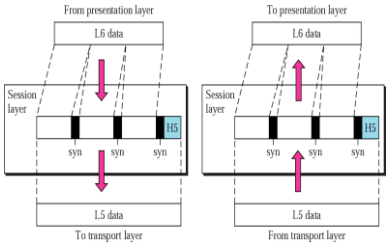
Presentation Layer



Session Layer



Application Layer

- It is responsible for providing service to users.
- It provide user interface and support for services such as electronic mail, remote file access and transfer
- Task of Presentation Layer:

1. **Network Virtual Terminal:** It is a software version of a physical terminal, and it allows a user to log on to a remote host.
2. **File Transfer, Access and mgmt:** It allows user to access file from remote host.
3. **Mail service and directory service:** It provide service for mail and to access for global information.

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Presentation Layer

- It is responsible for Translation, Compression and Encryption.
- Task of Presentation Layer:

1. **Translation:** It is responsible for translation of different encoding systems.
2. **Encryption:** It is responsible to encrypt a file to maintain privacy.
3. **Compression:** It is responsible to reduce a number of bits by using compression technique.t

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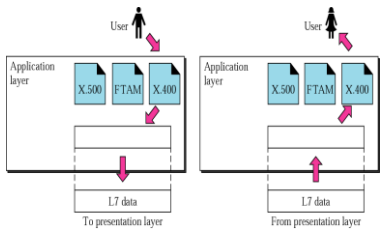
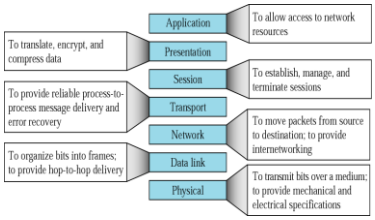
Application Layer



Summary of layers



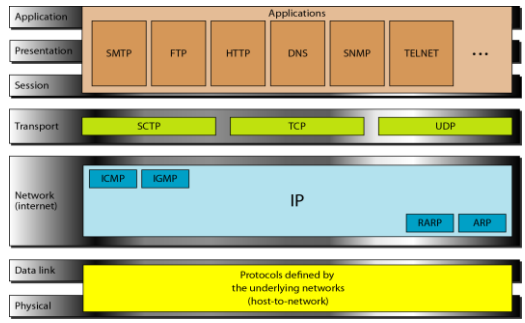
TCP/IP PROTOCOL SUITE

- The layers in the TCP/IP protocol suite do not exactly match those in the OSI model.
- The original TCP/IP protocol suite was defined as having four layers: host-to-network, internet, transport, and application.
- However, when TCP/IP is compared to OSI, we can say that the TCP/IP protocol suite is made of five layers: physical, data link, network, transport, and application.
- OSI model specifies which functions belong to each of its layers while TCP/IP protocol suite contain relatively independent protocols.

OSI Model in Short

Layer #	Name	Mnemonic	Encapsulation Units	Devices or Components	Keywords/Description
7	Application	All	data	PC	Network services for application processes, such as file, print, messaging, database services
6	Presentation	People	data		Standard interface to data for the application layer. MIME encoding, data encryption, conversion, formatting, compression
5	Session	Seem	data		Interhost communication. Establishes, manages and terminates connection between applications
4	Transport	To	segments		End-to-end connections and reliability. Segmentation/desegmentation of data in proper sequence. Flow control
3	Network	Need	packets	router	Logical addressing and path determination. Routing. Reporting delivery errors
2	Data Link	Data	frames	bridge, switch, NIC	Physical addressing and access to media. Two sublayers: Logical Link Control (LLC) and Media Access Control (MAC)
1	Physical	Processing	bits	repeater, hub, transciever	Binary transmission signals and encoding. Layout of pins, voltages, cable specifications, modulation

TCP/IP and OSI model



Connection Oriented Services	Connection Less Services
A connection is to be established before starting the communication	Each message is routed independently from source to destination
Authentication is needed	Does not need any authentication
Makes a connection and checks whether message is received or not and sends again if an error occurs	Does not guarantees a delivery
More reliable than connectionless service	Less reliable than connection oriented service
Connection oriented service interface is stream based	Connectionless service is message based

Physical and Data link Layer

- There is no separate protocol for this two layere.
- It supports all the standard and proprietary protocols.

Network Layer

- It supports IP (Internetworking Protocol) in turn uses four supporting protocols: ARP, RARP, ICMP and IGMP
- Internetworking Protocol(IP):
  - It is an unreliable and connectionless protocol.
  - IP transports data in packets called datagrams, each of which is transported seperately.
  - IP doesnot have record keeping facility.
- Address Resolution Protocol(ARP):
  - It is used to convert logical address into physical address.
  - Each device is usually identified using network interface card.

Network Layer

- Reverse Address Resolution Protocol(RARP):
  - It is used to convert physical address into logical address.
- Internet Control Message Protocol(ICMP):
  - It is a mechanism used by hosts and gateways to send notification of datagram problems back to the sender.
  - It sends query and error reporting messages.
- Internet Group Message Protocol(IGMP):
  - It is used to facilitate the simultaneous transmission of a message to a group of recipients.

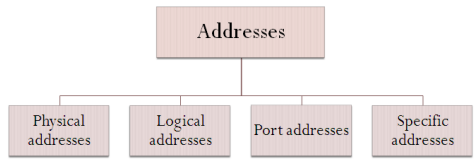
Transport Layer

- It has three protocol TCP,UDP and SCTP
- User Datagram Protocol:
  - It is connection less protocol.
  - It adds only port addresses, checksum, error control and length information to the data from the upper layer.
- Transmission Control Protocol:
  - It is reliable stream transport protocol. Stream means connection oriented.
  - A connection must be established between both ends of a transmission before either can transmit data.
- Stream Control Transmission Protocol:
  - It provides support for voice over the internet.

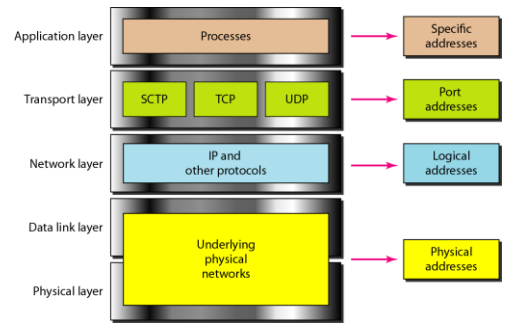
Application Layer

- It is equivalent to the combined session, presentation and application layers in OSI model.

Addresses in TCP/IP



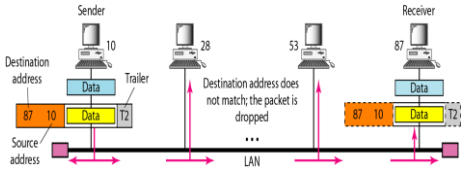
Relationship of layers and addresses in TCP/IP



Physical Addresses

- It is also known as link address. It is included in frame by data link layer.
- It use 6 byte (48bit) physical address.

Example 1 - *Physical addresses*



Example 2

Most local-area networks use a 48-bit (6-byte) physical address written as 12 hexadecimal digits; every byte (2 hexadecimal digits) is separated by a colon, as shown below:

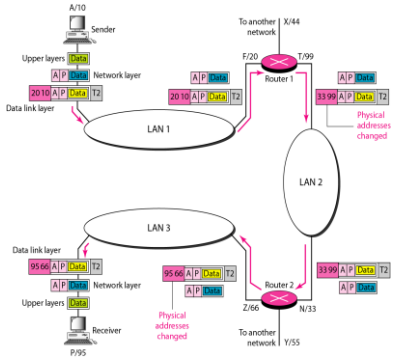
07:01:02:01:2C:4B

A 6-byte (12 hexadecimal digits) physical address.

Logical Addresses

- It is necessary for universal communication that are independent of underlying physical networks.
- It is needed to indentify each host uniquely.
- It is of 32 bit.
- Physical address changes from hope to hope.

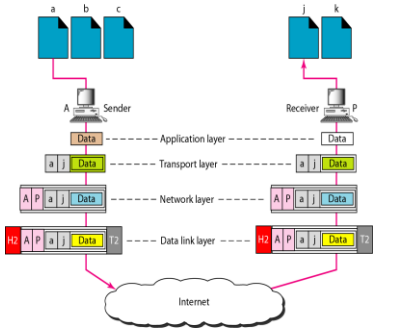
Example 3: IP addresses



Port Address

- It is of 16 bits.
- It requires for communication of individual process independently.

Example 4: Port addresses



A port address is a 16-bit address represented by one decimal number as shown.

Applications	Port numbers
HTTP	80
FTP	20 and 21
Gopher	70
SMTP (e-mail)	25
POP3 (e-mail)	110
Telnet	23
Finger	79

Example 5

753

A 16-bit port address represented as one single number.

2.85

OSI v/s TCP/IP

OSI #	OSI Layer Name	TCP/IP #	TCP/IP Layer Name	Encapsulation Units	TCP/IP Protocols
7	Application	4	Application	data	FTP, HTTP, POP3, IMAP, telnet, SMTP, DNS, TFTP
6	Presentation			data	
5	Session			data	
4	Transport	3	Transport	segments	TCP, UDP
3	Network	2	Internet	packets	IP
2	Data Link	1	Host-to-network	frames	
1	Physical			bits	

- *The physical addresses change from hop to hop, but the logical and port addresses usually remain the same.*

Addresses	Address Length
Physical Address	48 bits
Logical Address	32 bits
Port Address	16 bits

Example Networks

1) Internet
2) X.25
3) Frame Relay

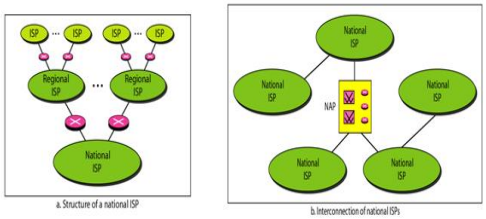
Specific Addresses:

- Some applications have user-friendly addresses that are designed for that specific address.
- Example : the e-mail address (for example, forouzan@fhda.edu) and the Universal Resource Locator (URL) (for example, www.mhhe.com).
- The first defines the recipient of an e-mail
- The second is used to find a document on the World Wide Web.
- These addresses get changed to the corresponding port and logical addresses by the sending computer.

Internet

- International ISP:
  - Connect nations **(IANA(internet assign number authority))**
- National ISP:
  - Backbone networks are connected by NAP (Network Access Points)
- Regional ISP:
  - They are connected to one or more national ISPs
- Local ISP:
  - They provide direct service to end users
  - Each local ISP can be connected to a regional or national ISP
  - It can be a
    - company providing Internet services
    - corporation with a network providing services to own employees
    - nonprofit organization like college or university running their own network

Hierarchical organization of the Internet



Thank You

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