Defs:

telecommunication means communication at a distance.

data is the information presented in whatever form.

Data communications are the exchange of data between two devices via some form of transmission medium such as a wire cable or wireless.

network is a set of devices (nodes) connected by communication links.

Protocol is synonymous with rule.

Standards are agreed-upon rules.

ISO is a multinational body to worldwide agreement on international standards and established in 1947..

OSI is a model approved by ISO and introduced in 70s

OSI) model is the standard that covers all aspects of network communications from ISO. It was first introduced in the late 1970s

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Data communications ***are the exchange of data between two devices via some form of transmission medium such as a wire cable or wireless.***

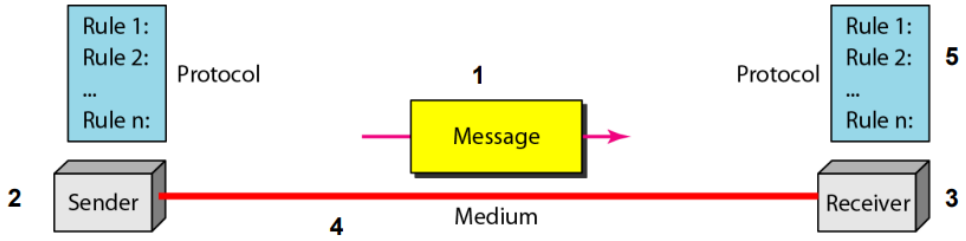
1. ***Delivery → Correct destination***
2. ***Accuracy → Accurate data***
3. ***Timelines → Real-time transmission***
4. ***Jitter → Uneven delay***

Topics discussed in this section:

Components
Data Representation
Data Flow

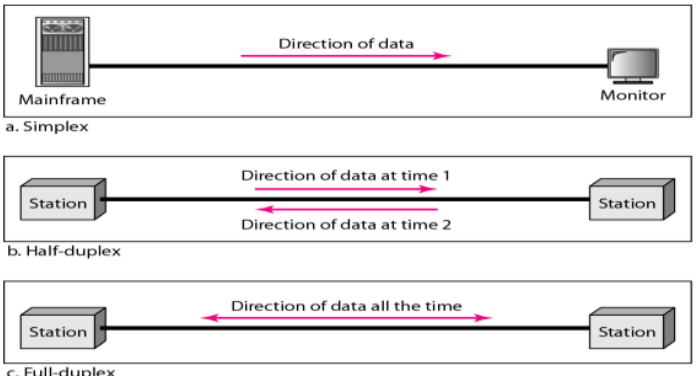
Components

Figure 1.1 ***Five components of data communication***



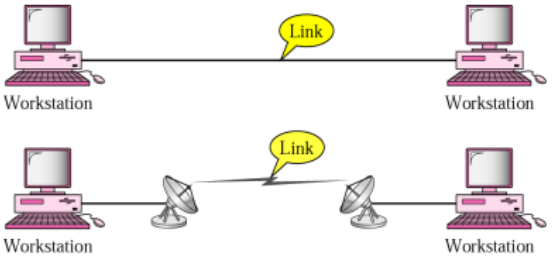
Data flow

- ***Simplex***
- ***Half-duplex***
- ***Full-duplex***



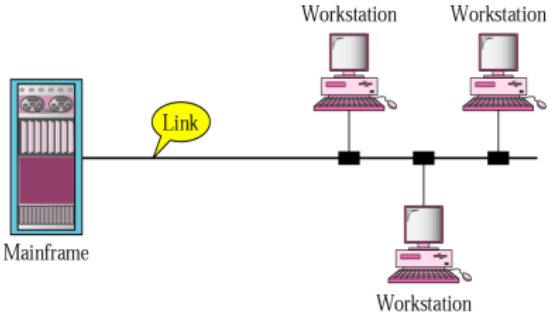
Point to point

- A dedicated link is provided between two devices

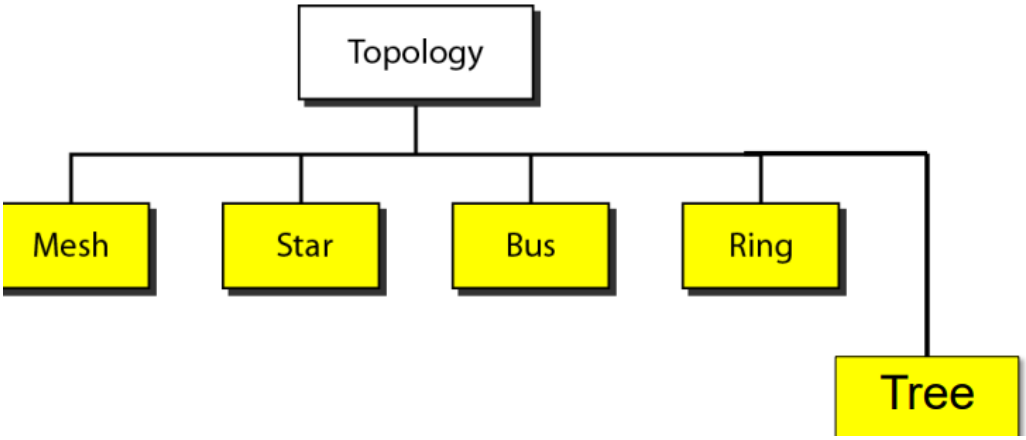


Multipoint

- More than two specific devices share a single link

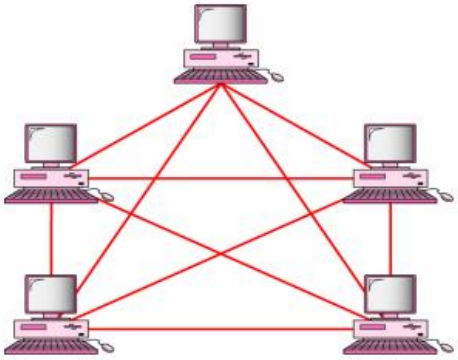


hysical Topology



MESH Topology

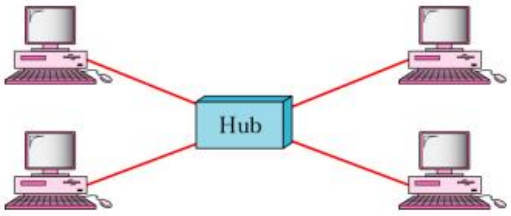
- Every device has a dedicated point-to-point link to every other devices
- Dedicated
  - Link carries traffic only between the two devices it connects
  - A fully connected mesh network has n(n-1)/2 physical channels to link n devices
  - Every device on the network must have n-1 input/output (I/O) ports
- Advantage
  - Less traffic, robust, secure, easy to maintain
- Disadvantage
  - Need more resource (cable and ports), expensive



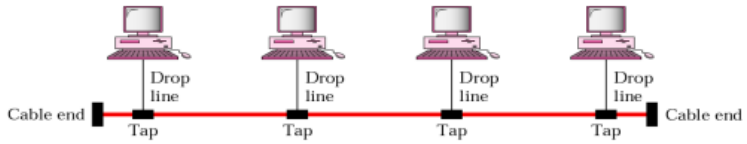
n(n-1)/2 physical duplex links

STAR Topology

- Each device has a dedicated point-to-point link only to a central controller, usually called a hub.
- No direct traffic and link between devices
- Advantages
  - Less expensive
  - Easy to install and reconfigure
  - Robustness
- Disadvantage
  - Single point of failure

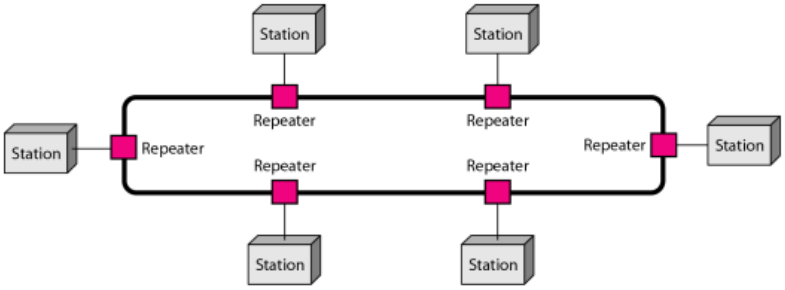


BUS Topology



- A multipoint topology
- All devices are linked through a *backbone* cable
- Nodes are connected to the bus cable by drop lines and taps.
  - Drop line
    - A connection running between the device and the main cable
  - Tap
    - A connector that either splices into the main cable or punctures the sheathing of a cable to create a contact with the metallic core
- Advantage:
  - Ease of installation
- **Disadvantages:**
  - Difficult reconnection and fault isolation
  - Broken or fault of the bus cable stops all transmission

RING Topology



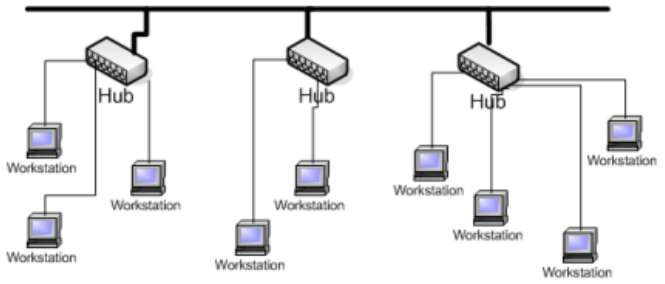
- Each device is dedicated point-to-point connection only with the two devices on either side of it
- A signal is passed along the ring in the direction, from device to device, until it reaches its destination
- Each device in the ring incorporates a repeater

- Advantages
  - Relatively easy to install and reconfigure
  - Fault isolation is simplified
- Disadvantage
  - Unidirectional traffic

Tree Topology

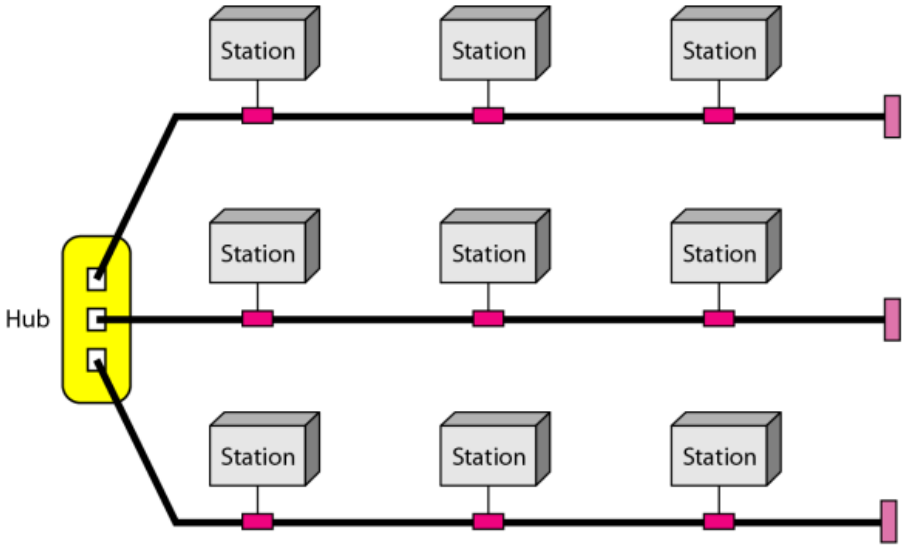
Tree topologies integrate multiple topologies together

Example: Tree topology integrates multiple star topologies together onto a bus



- 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.

A hybrid topology: a star backbone with three bus networks



Protocols

- Syntax → format of the data
- Semantics → meaning of each section
- Timing → when data should be sent and how fast.

Standards

- De facto → by fact (not approved as a standard)
- De jure → by Law (approved)

PROTOCOLS AND STANDARDS

Standards Organizations

- International Organization for Standardization (ISO)
- International Telecommunication Union - Telecommunication Standards (ITU-T)
- American National Standards Institute (ANSI)
- Institute of Electrical and Electronics Engineers (IEEE)
- Electronic Industries Association (EIA)

5 LAYERED TASKS

- A network model is a layered architecture
  - Task broken into subtasks
  - Implemented separately in layers in stack
  - Functions need in both systems
  - Peer layers communicate

- Protocol:
  - A set of rules that governs data communication
  - It represents an agreement between the communicating devices

Layered Architecture

Layers

Layer 7. Application

Layer 6. Presentation

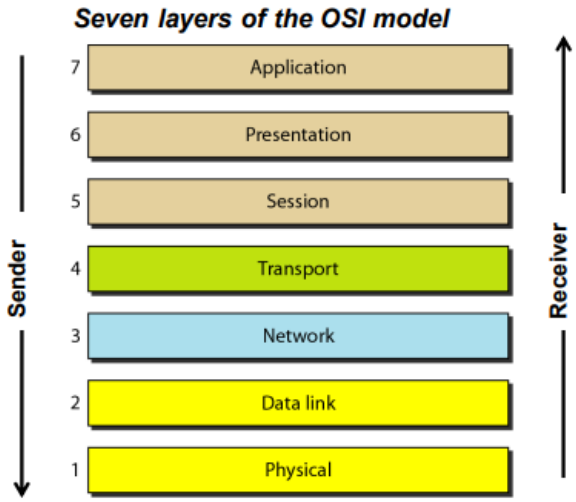
Layer 5. Session

Layer 4. Transport

Layer 3. Network

Layer 2. Data Link

Layer 1. Physical



Layered Architecture

- A layered model
- Each layer performs a subset of the required communication functions
- Each layer relies on the next lower layer to perform more primitive functions
- Each layer provides services to the next higher layer
- Changes in one layer should not require changes in other layers
- The processes on each machine at a given layer are called peer-to-peer process

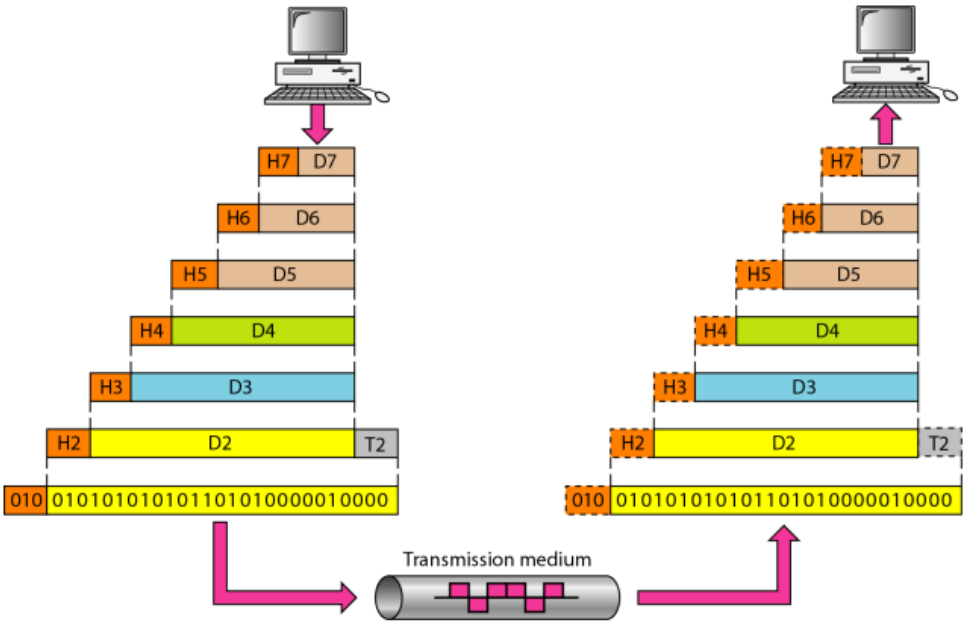
PEER – TO – PEER PROCESS

- Communication must move downward through the layers on the sending device, over the communication channel, and upward to the receiving device
- Each layer in the sending device adds its own information to the message it receives from the layer just above it and passes the whole package to the layer just below it
- At the receiving device, the message is unwrapped layer by layer, with each process receiving and removing the data meant for it

PEER – TO – PEER PROCESS

- The passing of the data and network information down through the layers of the sending device and backup through the layers of the receiving device is made possible by *interface* between each pair of adjacent layers
- Interface defines what information and services a layer must provide for the layer above it.

An exchange using the OSI model



Physical Layer

The physical layer is responsible for movements of individual bits from one hop (node) to the next.

- Function
  - Physical characteristics of interfaces and media
  - Representation of bits
  - Data rate
  - Synchronization of bits
  - Line configuration (point-to-point or multipoint)
  - Physical topology (mesh, star, ring or bus)
  - Transmission mode (simplex, half-duplex or duplex)

Data Link Layer

The data link layer is responsible for moving frames from one hop (node) to the next.

- Function
  - Framing
  - Physical addressing
  - Flow control
  - Error control
  - Access control

Network Layer

The network layer is responsible for the delivery of individual packets from the source host to the destination host.

- Source-to-destination delivery
- Responsible from the delivery of packets from the original source to the final destination
- Functions
  - Logical addressing
  - routing

Transport Layer

The transport layer is responsible for the delivery of a message from one process to another.

- Process-to- process delivery
- Functions
  - Port addressing
  - Segmentation and reassembly
  - Connection control (Connection-oriented or connection-less)
  - Flow control
  - Error control

Session Layer

The session layer is responsible for dialog control and synchronization.

- **It establishes, maintains and synchronize the interaction between communicating system**
- **Function**
  - **Dialog control**
  - **Synchronization (checkpoints)**

Presentation Layer

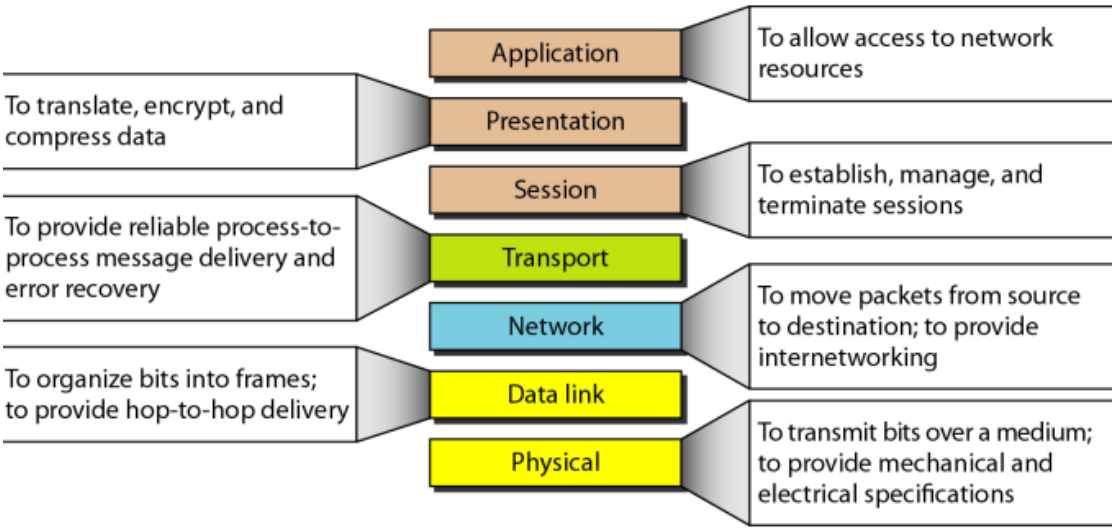
The presentation layer is responsible for translation, compression, and encryption.

- **Concerned with the syntax and semantics of the information exchanged between two system**
- **Functions**
  - **Translation** (EBCDIC-coded text file → ASCII-coded file)
  - **Encryption and Decryption**
  - **Compression**

Application Layer

The application layer is responsible for providing services to the user.

- Functions
  - Network virtual terminal (Remote log-in)
  - File transfer and access
  - Mail services
  - Directory services (Distributed Database)
  - Accessing the World Wide Web



OSI Model

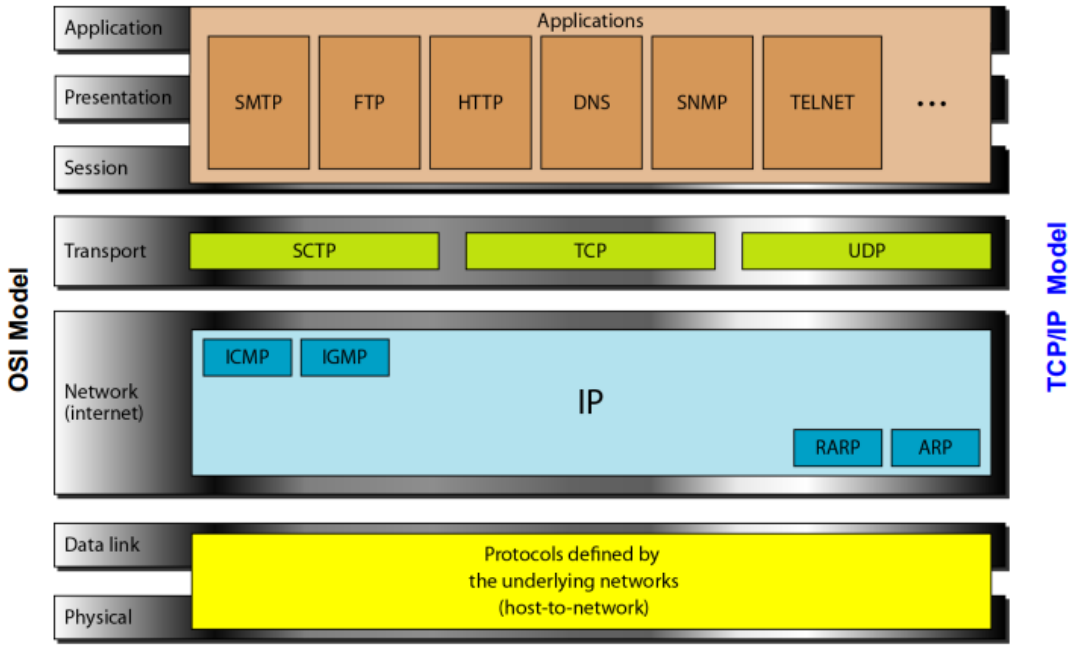
	Data unit	Layer	Function
User support layers	Data	7. Application	Network process to application
		6. Presentation	Data representation and encryption
		5. Session	Inter-host communication
User⇔Network	Segment	4. Transport	End-to-end connections and reliability
Network support layers	Packet	3. Network	Path determination and logical addressing
	Frame	2. Data Link	Physical addressing
	Bit	1. Physical	Media, signal and binary transmission

Sender ↓

↑ Receiver

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.

TCP/IP and OSI model



Internet Layer

TCP/IP support the Internet Protocol IP (unreliable). IP is a host-to-host protocol.
Supporting protocols:

- Address Resolution Protocol (ARP)
- Reverse Address Resolution Protocol (RARP)
- Internet Control Massage Protocol (ICMP)
- Internet Group Massage Protocol (IGMP)

Transport Layer

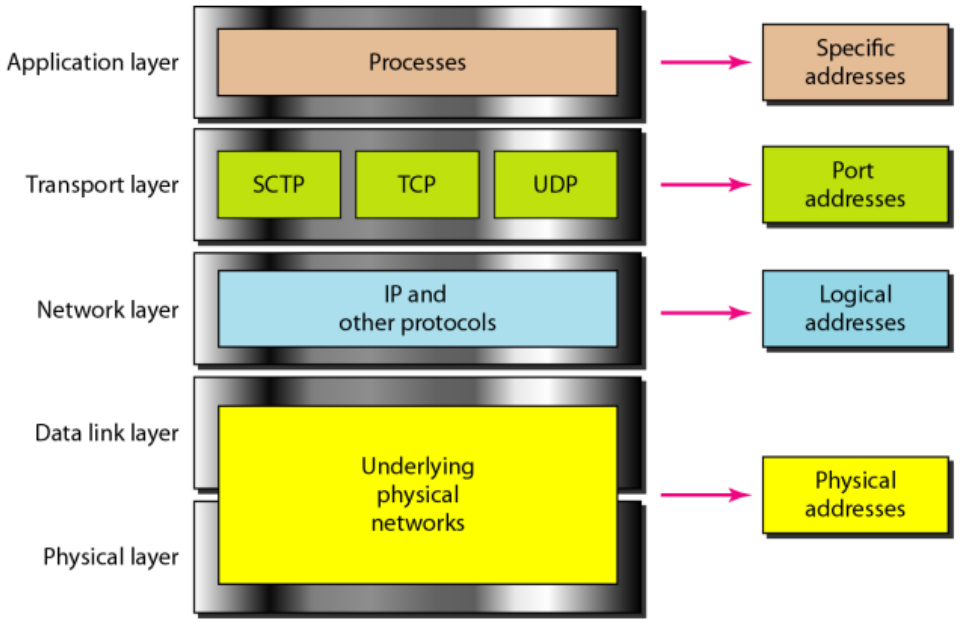
Process-to-process protocol.

- User Datagram Protocol (UDP)
- Transmission Control Protocol (TCP)
- Stream Control Transmission Protocol (SCTP)

1-6 ADDRESSING

Four levels of addresses are used in an internet employing the TCP/IP protocols: physical, logical, port, and specific.

Relationship of layers and addresses in TCP/IP



Physical Address

Physical addresses are imprinted on the NIC. Most local-area networks (Ethernet) use a 48-bit (6-byte) physical address written as 12 hexadecimal digits; every byte (2 hexadecimal digits) is separated by a colon.

Example:

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

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

Physical Address

- known also as the MAC address
- Is the address of a node as defined by its LAN or WAN
- It is included in the frame used by data link layer

The physical addresses in the datagram may change from hop to hop.

Logical Address

- IP addresses are necessary for universal communications that are independent of physical network.
- No two host address on the internet can have the same IP address
- IP addresses in the Internet are 32-bit address that uniquely define a host.

The physical addresses will change from hop to hop, but the logical addresses usually remain the same.

Specific addresses

E-mail address (user1@ksu.edu.sa)

Universal Resource Locator (URL) (www.ksu.edu.sa)

The Domain Name System (DNS) translates human-friendly computer hostnames (URL) into IP addresses. For example, *www.example.com* is translated to *208.77.188.166*

Port addresses

Port address is a 16-bit address represented by one decimal number ranged from (0-65535) to choose a process among multiple processes on the destination host.

- Destination port number is needed for delivery.
- Source port number is needed for receiving a reply as an acknowledgments.

In TCP/IP , a 16-bit port address represented as one single number. Example: 753

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