DATCOMM
Introduction to Data and Computer Networks

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Notes

Objectives

- Identify the scope and significance of Data Computer Networking in today's world

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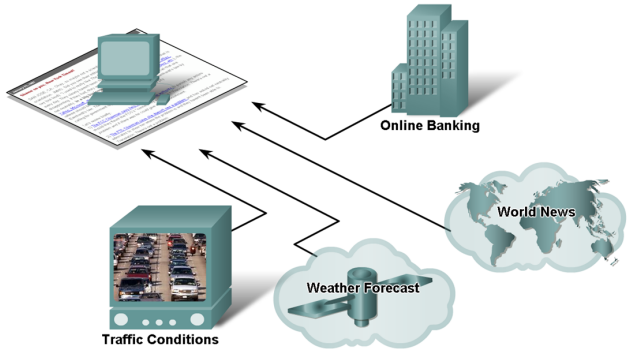
- Define and illustrate Data Communications and Data Network.
- Describe the Network Components and its Architecture.
- Illustrate and explain the Internet.
- Explain the various Network Communication Models

Notes

Why Study Networks?

- Networks support and improve our lives by providing instantaneous local or global communications.



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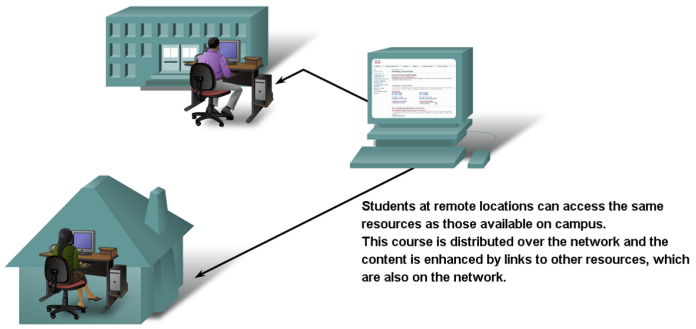
Why Study Networks?

- Networks improve teaching and learning through sharing and collaboration.



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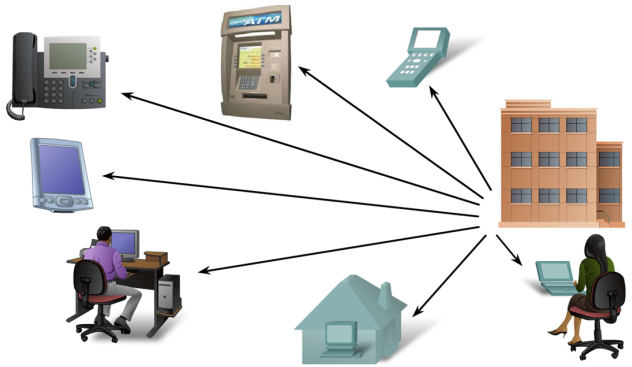

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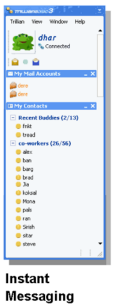
Online Interest Groups

Online Entertainment

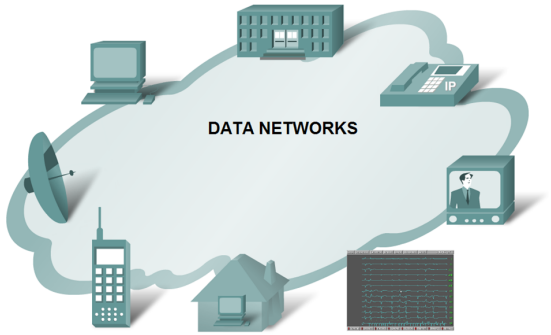


The onboard data network provides a range of services to airline personal seatback video systems.

Instant Messaging

Notes

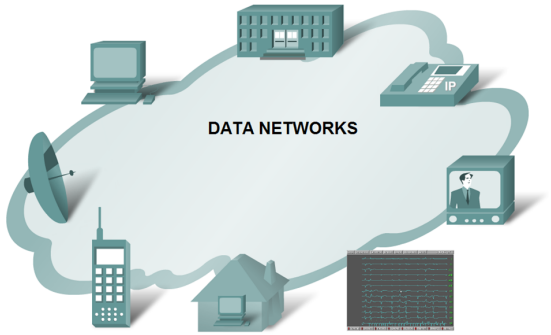
Data Communications



Notes

Data Communications

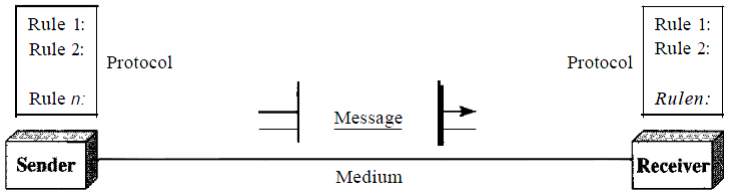
- are the transfer of data from one device to another via some form of transmission medium.



Notes

Data Communications

- The five components that make up a data communications system are the message, sender, receiver, medium, and protocol.



Notes

Possible Quiz Question

A set of rules that govern data communications. It represents an agreement between the communicating devices. Without it, two devices may be connected but not communicating.

A. Message
B. Sender
C. Receiver
D. Medium
E. Protocol

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Possible Quiz Question

It is a fundamental characteristics of a data communication system which refers to the variation in the packet arrival time.

A. Jitter
B. Accuracy
C. Timeliness
D. Delivery
E. All of the above

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- Delivery.
  The system must deliver data to the correct destination.

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- Jitter.
  Jitter refers to the variation in the packet arrival time.

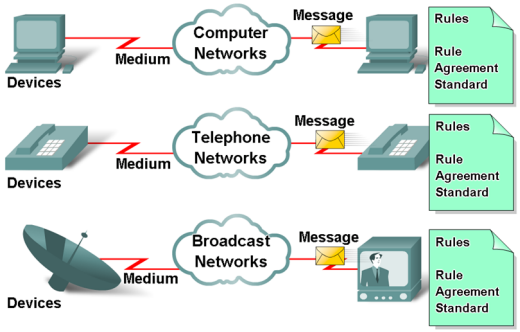
Notes

What is a Network?

Notes

What is a Network?

- A set of communication devices (nodes) connected by media links capable of carrying different types of communications.



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- Devices
  These are used to communicate with one another.

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  These are used to communicate with one another.
- Medium
  This is how the devices are connected together.
- Messages
  Information that travels over the medium.
- Rules / Protocol
  Governs how messages flow across network.

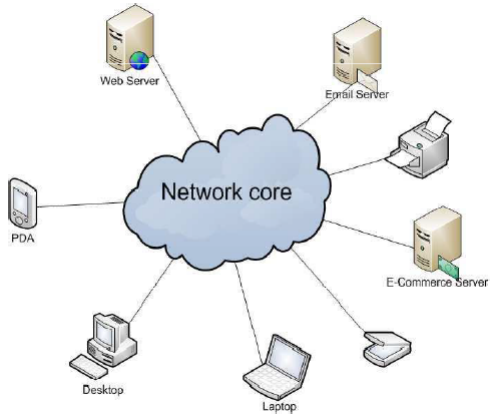
Notes

Computer Network

Notes

Computer Network

- A network of "computers".



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Why Network Computers?

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- To increase productivity by linking computers and computer networks allowing users to share resources and data. Ex.

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- Resources, i.e. I/O devices like cameras & printers
- Network Storage

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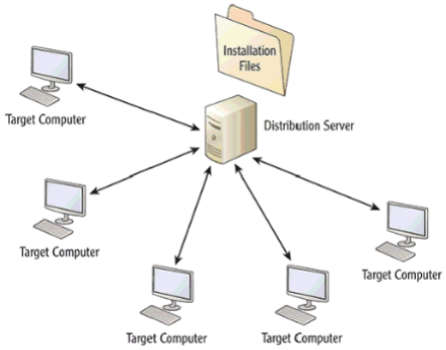
- Data and applications
- Resources, i.e. I/O devices like cameras & printers
- Network Storage
- Backup devices

Notes

Why Network Computers?

- Reduced Cost and Easier Installation of Software.
- Ex. Network installation



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- Improved Security
- Improved Communications
- More Workplace Flexibility
- Reduced Cost of Peripherals
- Centralized Administration

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Network Requirements?

- At least two computers

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Network Requirements?

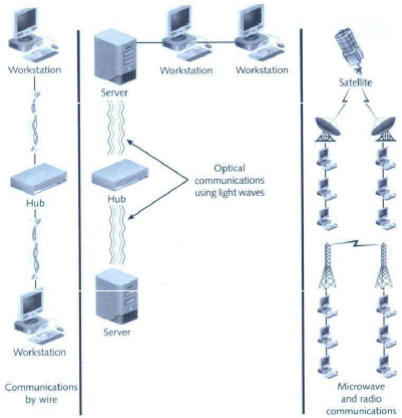
- At least two computers
- A resource that needs to be shared
- A transmission medium
- A communications agreement

Notes

Network Category

By type of MEDIA

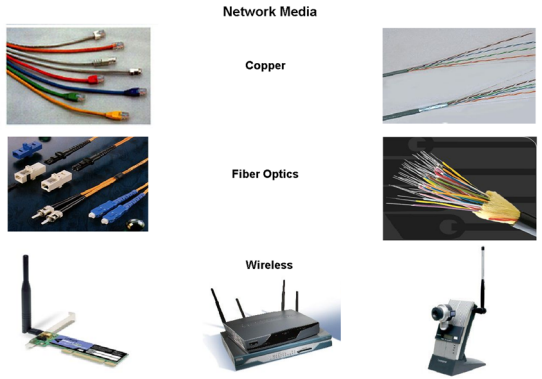
- Wired and Wireless



Notes

Network Media

- this is the channel over which a message travels



Notes

Network Category

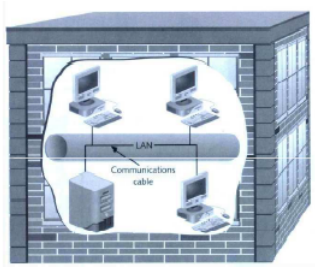
By COVERAGE

Interprocessor distance	Processors located in same	Example
1 m	Square meter	Personal area network
10 m	Room	Local area network
100 m	Building	
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	Wide area network
1000 km	Continent	
10,000 km	Planet	The Internet

Notes

Local Area Network

LAN



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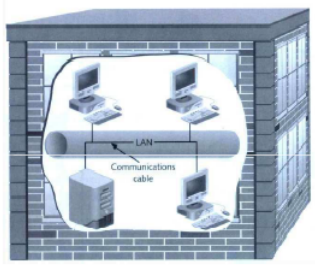
Local Area Network

LAN

- Can be as small as two computers.



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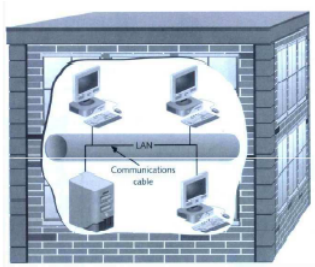

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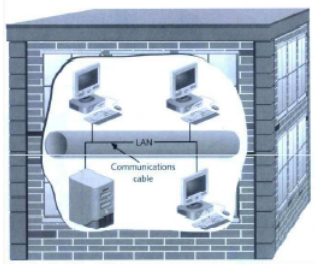
- A network within a building or several buildings.



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Local Area Network

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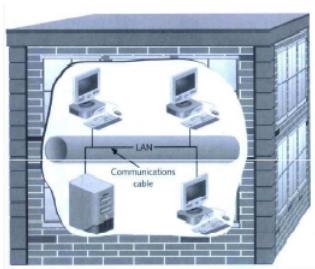
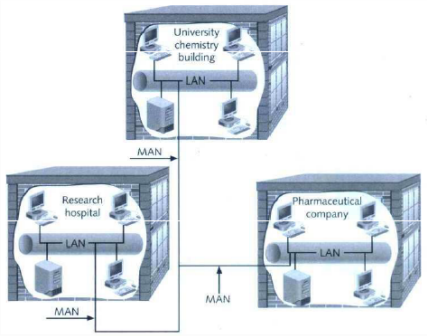
- A network within a building or several buildings.
- Speed at 10, 100, or 1000 Mbps



Notes

Metropolitan Area Network

MAN



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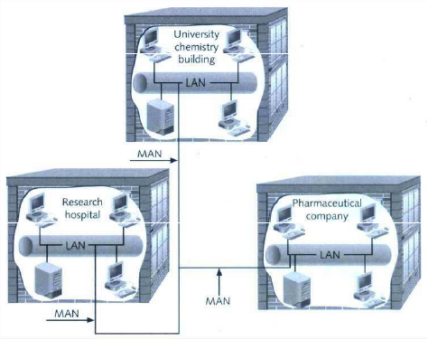
Metropolitan Area Network

MAN

- covers the area inside a town or a city.



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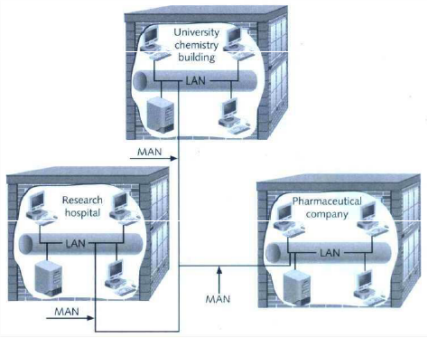
Metropolitan Area Network

MAN

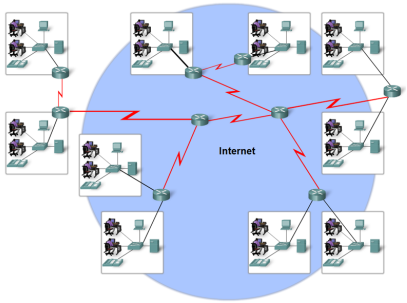
- covers the area inside a town or a city.
- Ex. Cable TV network



Notes

Wide Area Network

WAN

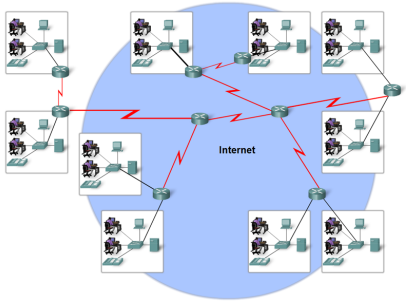


Notes

Wide Area Network

WAN

- provides long-distance transmission of data, image, audio, and video information over large geographic areas that may comprise a country, a continent, or even the whole world.



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- Today, it is very rare to see a LAN, a MAN in isolation; they are connected to one another.

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- When two or more networks are connected, they become an internetwork, or internet.

Notes

Example

- Assume that an organization has two offices, one in Manila and the other in Cebu. The established office on Manila has a bus topology LAN; the newly opened office on Cebu has a star topology LAN. The president of the company lives somewhere in the middle and needs to have control over the company from her home in Boracay.

Notes

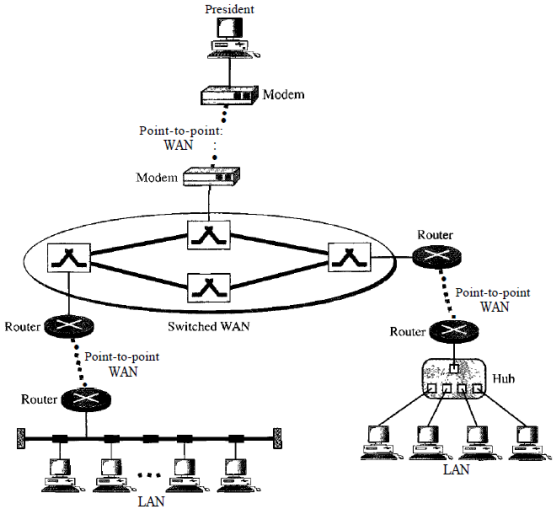
Example

- To create a backbone WAN for connecting these three entities (two LANs and the president's computer), a switched WAN (operated by a service provider such as a telecom company) has been leased. To connect the LANs to this switched WAN, however, three point-to-point WANs are required. These point-to-point WANs can be a high-speed DSL line offered by a telephone company or a cable modern line offered by a cable TV provider.

Notes

Illustration

Four WANs + two LANs



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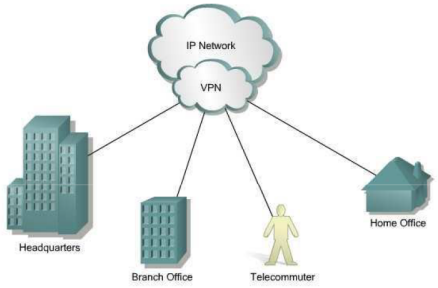
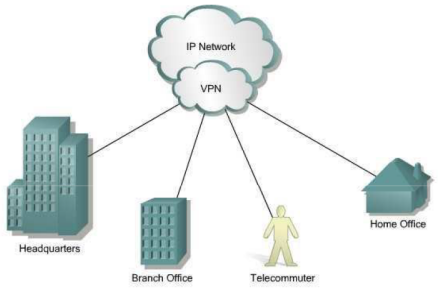
Virtual Private Network
VPN



Notes

Virtual Private Network
VPN

- It enables a host computer to send and receive data across shared or public networks as if it were a private network with all the functionality



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Other Networks

- Campus Area Network, Corporate Area Network (CAN)
  essentially a local area network.

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  A network, typically of devices centered around the user
- Wireless PAN (WPAN)
  a typical implementation of a PAN
- Sensor Networks
  A specialized network of devices typically used for monitoring

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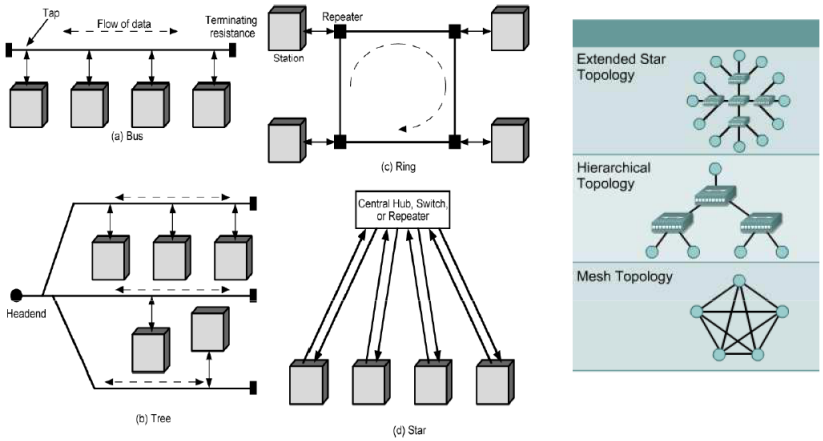
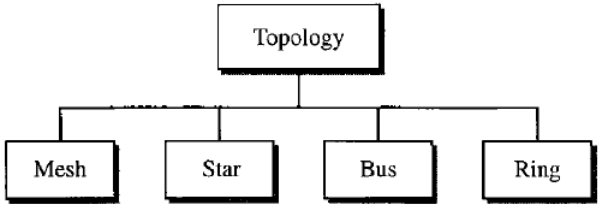
Network Topology



Notes

Network Topology

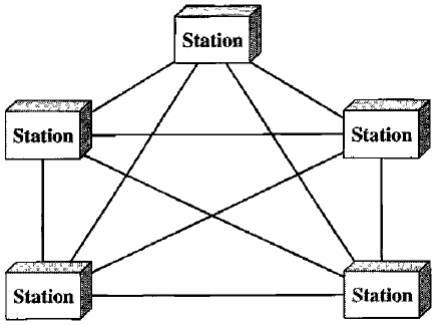
Four Basic Topologies



Notes

Mesh Topology

- Every device has a dedicated point-to-point link to every other device.



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Possible Quiz Question

- How many duplex-mode links do we have on a mesh network with n nodes?

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Mesh Topology

Advantages

- Dedicated links guarantees that each connection can carry its own data load, thus eliminating the traffic problems.

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- A mesh topology is robust.
- The advantage of privacy or security.

- Point-to-point links make fault identification and fault isolation easy.

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Mesh Topology

Disadvantages

- Installation and reconnection are difficult because every device must be connected to every other device.

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- Installation and reconnection are difficult because every device must be connected to every other device.

- Bulk of the wiring can be greater than the available space (in walls, ceilings, or floors) can accommodate.

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Mesh Topology

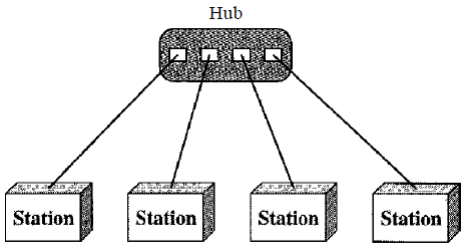
Disadvantages

- Installation and reconnection are difficult because every device must be connected to every other device.
- Bulk of the wiring can be greater than the available space (in walls, ceilings, or floors) can accommodate.
- Hardware required to connect each link (I/O ports and cable) can be prohibitively expensive.

Notes

Star Topology

- Each device has a dedicated point-to-point link only to a central controller, usually called a hub.



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Star Topology

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- Less expensive than a mesh topology.

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Star Topology

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- Less expensive than a mesh topology.
- Easy to install and reconfigure.
- Easy fault identification and fault isolation.

- Relatively robust because if one link fails, only that link is affected.

Notes

Star Topology

Disadvantages

- Dependency of the whole topology on one single point, the hub. If the hub goes down, the whole system is dead.

Notes

Star Topology

Disadvantages

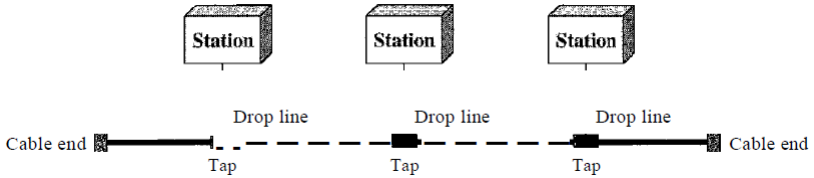
- Dependency of the whole topology on one single point, the hub. If the hub goes down, the whole system is dead.

- Often more cabling is required in a star than in some other topologies (such as ring or bus).

Notes

Bus Topology

- One long cable acts as a backbone to link all the devices in a network.
- Drop line is a connection running between the device and the main cable.



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Bus Topology

Advantages

- Ease of installation.

Notes

Bus Topology

Advantages

- Ease of installation.
- Uses less cabling than mesh or star topologies, hence less expensive.

Notes

Bus Topology

Disadvantages

- Difficult reconnection and fault isolation.

Notes

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- Difficult to add new devices.

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- Signal reflection at the taps can cause degradation in quality.

Notes

Bus Topology

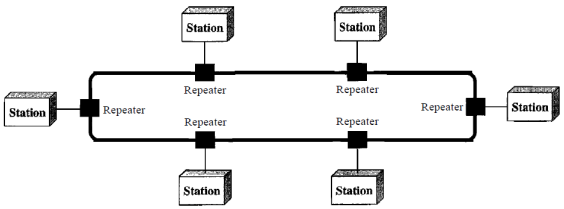
Disadvantages

- Difficult reconnection and fault isolation.
- Difficult to add new devices.
- Signal reflection at the taps can cause degradation in quality.
- A fault or break in the bus cable stops all transmission.

Notes

Ring Topology

- Each device has a dedicated point-to-point connection with only the two devices on either side of it.
- When a device receives a signal intended for another device, its repeater regenerates the bits and passes them along.



Notes

Ring Topology
Advantages

- Easy to install and reconfigure.

Notes

Ring Topology
Advantages

- Easy to install and reconfigure.
- Fault isolation is simplified. Generally in a ring, a signal is circulating at all times. If one device does not receive a signal within a specified period, it can issue an alarm.

Notes

Ring Topology

Disadvantages

- Unidirectional traffic can be a disadvantage. In a simple ring, a break in the ring (such as a disabled station) can disable the entire network.

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Ring Topology

Disadvantages

- Unidirectional traffic can be a disadvantage. In a simple ring, a break in the ring (such as a disabled station) can disable the entire network.
- Today, the need for higher-speed LANs has made this topology less popular.

Notes

Network Architecture

According to Security Relationships

- Peer-to-peer Network (P2P).

Notes

Network Architecture

According to Security Relationships

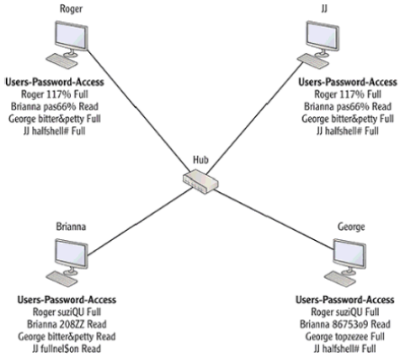
- Peer-to-peer Network (P2P).
- Client-server Network.

Notes

Peer-to-peer Network (P2P)

Workgroup

- shared data is distributed on each computers.



Notes

Peer-to-peer Network (P2P)

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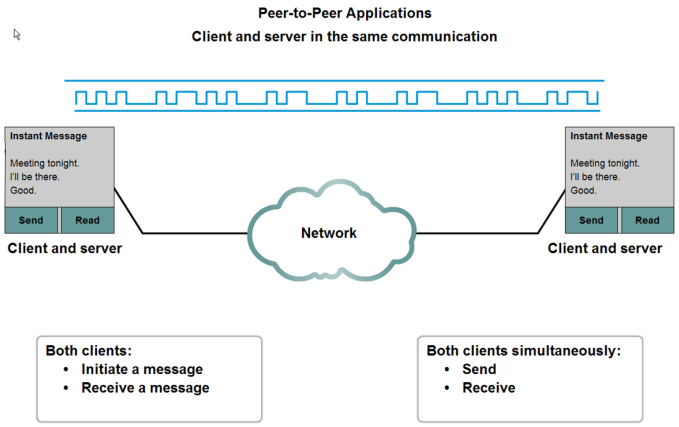

Notes

Peer-to-peer Network (P2P)

Pros and Cons

- Advantages
  - Low cost
  - Easy to set up
  - No server required

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Pros and Cons

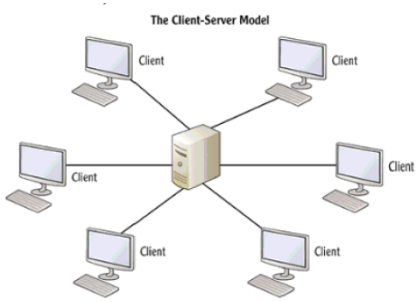
- Advantages
  - Low cost
  - Easy to set up
  - No server required

- Disadvantages
  - No centralized control of security
  - Administrative burden of maintaining accounts on all computers
  - Not scalable

Notes

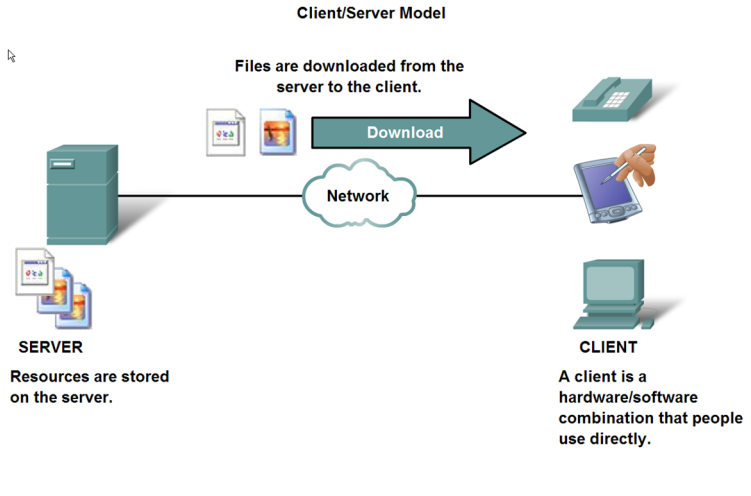
Client-server Network

- shared data is centralized on a device called a file server.



Notes

Client-server Network



Notes

Client-server Network

Pros and Cons

- Advantages
  - Centralized administration
  - Single sign-on
  - Reduced broadcast traffic
  - Scalability

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Client-server Network

Pros and Cons

- Advantages
  - Centralized administration
  - Single sign-on
  - Reduced broadcast traffic
  - Scalability

- Disadvantages
  - Higher cost
  - More challenging technically
  - Single point of failure with a single file server

Notes

Network Transmission Modes

- Unicast (One-to-one).
  a single source host is sending information to a single destination host

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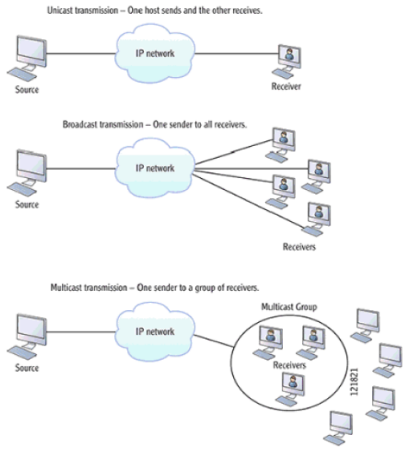
Notes

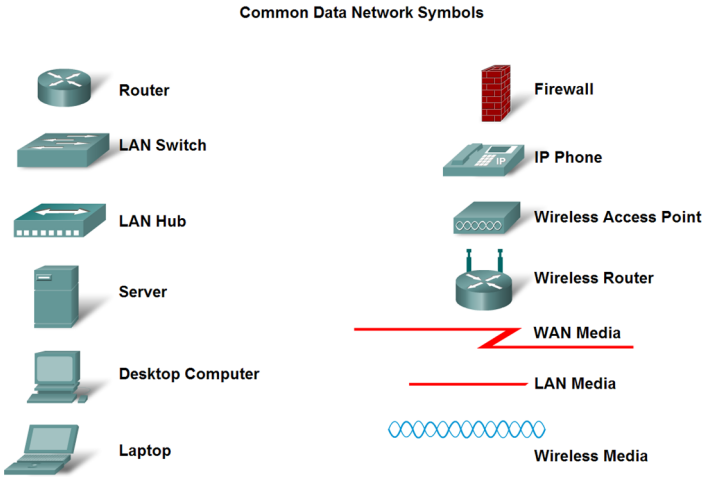
Transmission Modes

Illustration



Notes

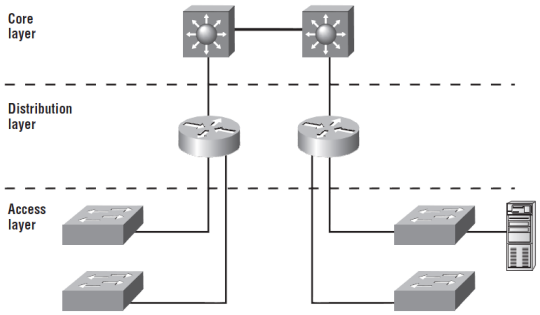
Network Representations



Notes

Heirarchical Topology

Cisco hierarchical model



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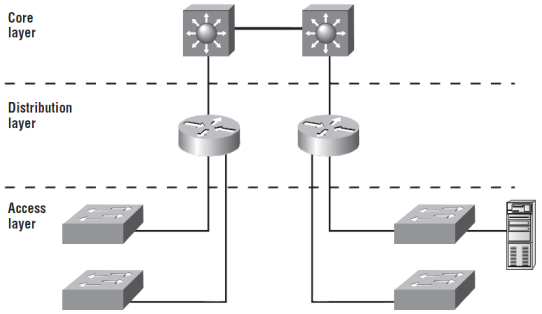
- Core layer ==> backbone



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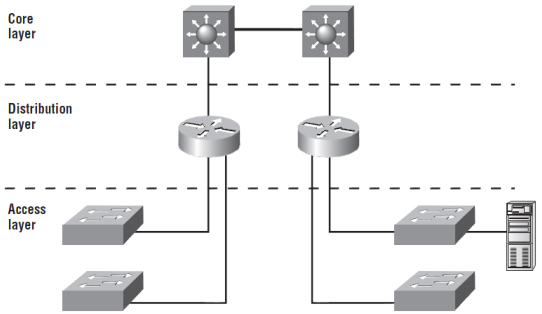

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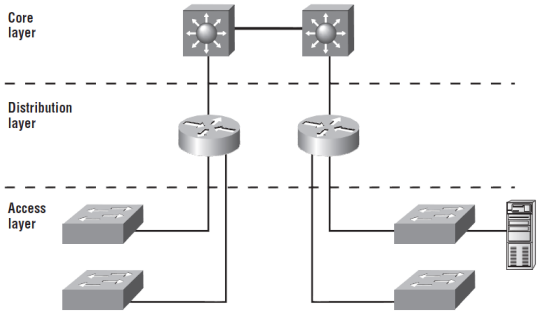
- Core layer ==> backbone
- Distribution layer ==> routing
- Access layer ==> switching



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Core layer (Backbone)

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- If there is a failure in the core, every single user can be affected.

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- provides routing, filtering, and WAN access and to determine how packets can access the core, if needed.
- Place to implement security and policies for the network including address translation and firewalls.

Notes

Cisco hierarchical model

Access layer (Switching)

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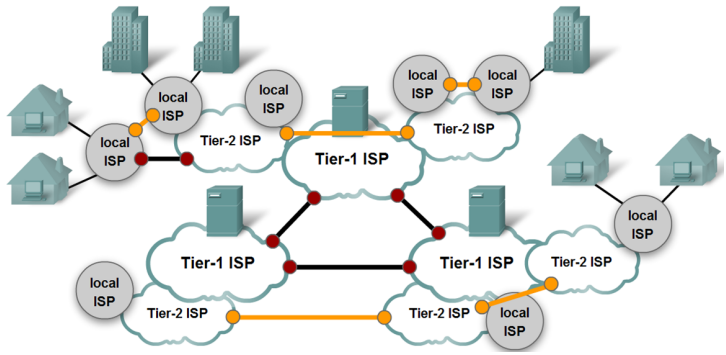
Notes

Structure of the Internet



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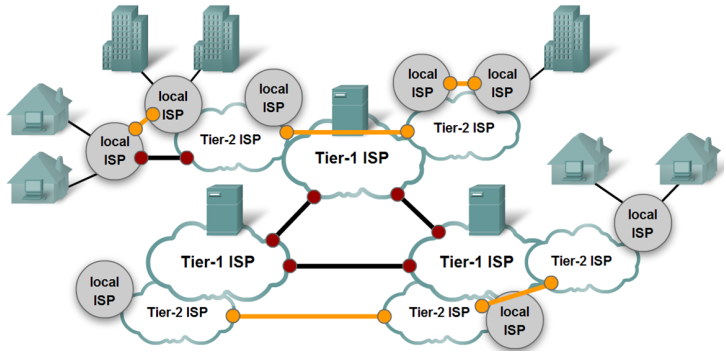

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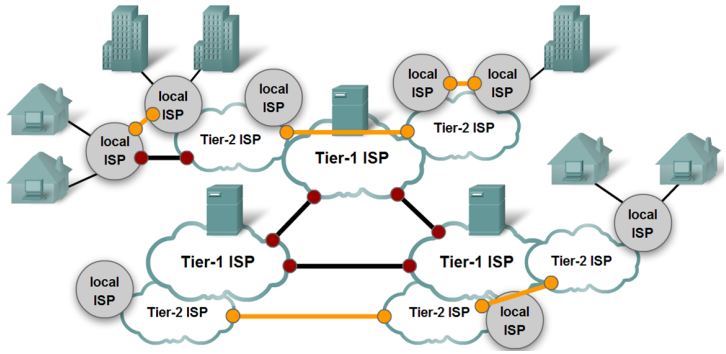

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Structure of the Internet

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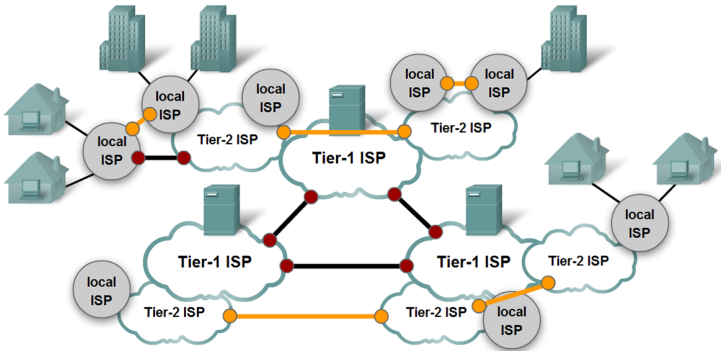

Notes

Access Networks

Connects end hosts to the network core

RESIDENTIAL ACCESS:

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ACCESS WITHIN ENTERPRISE LAN's:

- Ethernet/IEEE 802.3 and Wifi

Notes

WAN Technologies

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- Links the components of the Internetwork core.

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- Links the components of the Internetwork core.
- Includes:
  X.25
  Frame Relay
  ISDN, BISDN
  ATM
  SONET/SDH

Notes

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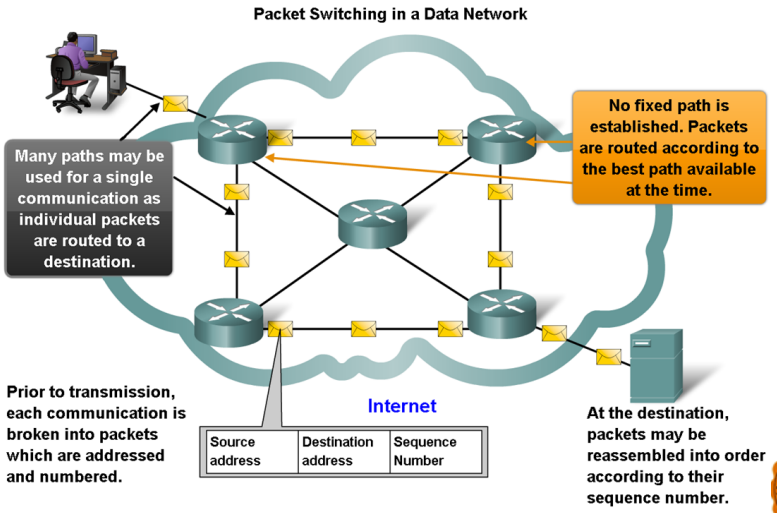
Packet Switching



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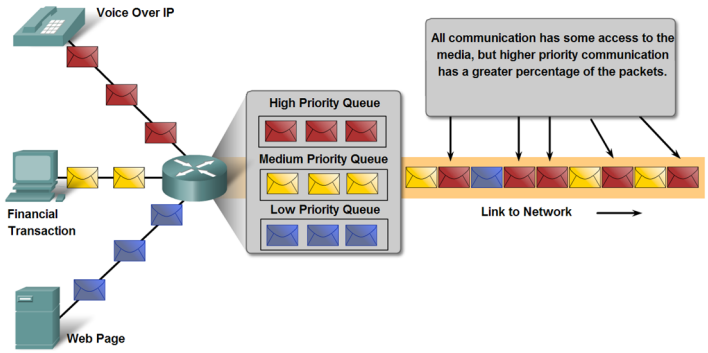
  A virtual-circuit switching network with extensive flow and error control.
- Frame Relay (1.544 - 44.376 Mbps)
  uses variable-length packets, called frames; strips out most of the overhead involved with error control.
- Asynchronous transfer mode (ATM)
  uses fixed-length packets, called cells.
  (10s, 100s of Mbps, and Gbps range)

Notes

Quality of Service
QoS

Using Queues to Prioritize Communication



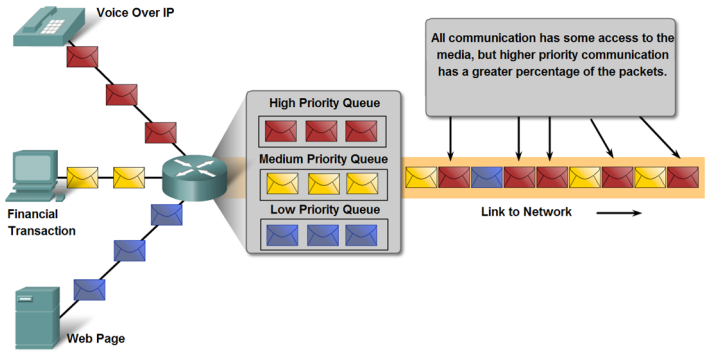
Queuing according to data type enables voice data to have priority over transaction data, which has priority over web data.

Notes

Quality of Service
QoS

- treat different traffic flows differently.

Using Queues to Prioritize Communication



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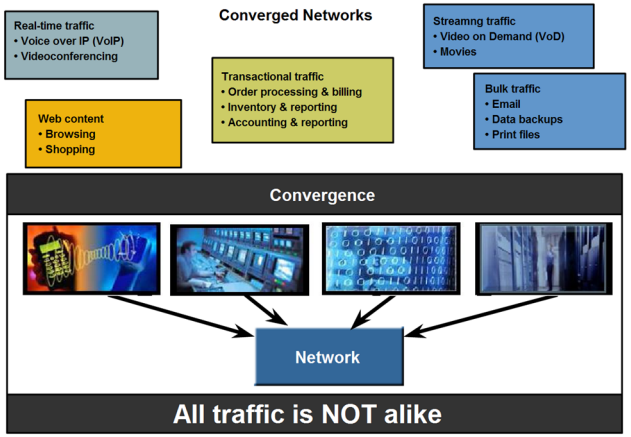
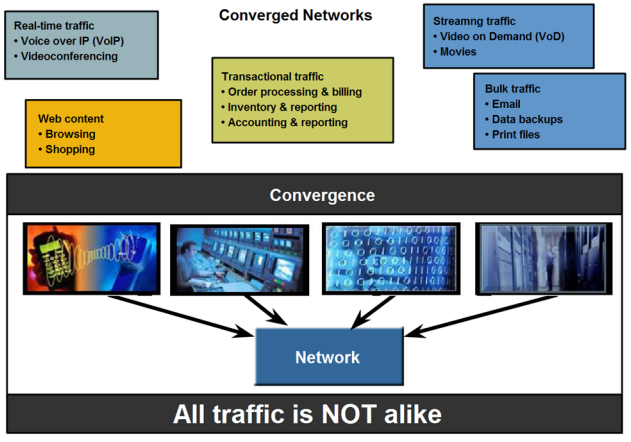


Notes

Quality of Service
QoS

- ensure quality of service for applications that require it.



Notes

Quality of Service
QoS

Quality of Service Matters

Communication Type	Without QoS	With QoS
Streaming video or audio	 Choppy picture starts and stops.	 Clear, continuous service.
Vital Transactions	Time : Price 02:14:05 $1.54 Just one second earlier...	Time : Price 02:14:04 $1.52 The price may be better.
Downloading web pages (often lower priority)	 Web pages arrive a bit later...	 But the end result is identical.

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Quality of Service
QoS

- appropriate QoS strategy for a given type of traffic.

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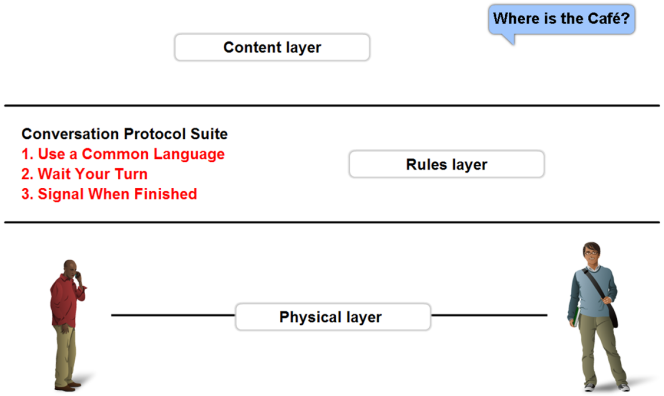
Rules

- shared conventions for communicating information.
- defines WHAT is communicated, HOW it is communicated, and WHEN it is communicated.
- Protocols specify
  Syntax: Data format, and Signal levels
  Semantics: Meaning of each bit section; Flow control, Error handling
  Timing: Speed match, and Sequencing

Notes

Protocols

Illustration



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Protocol Architecture

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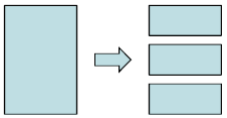
- layered structure of hardware and software that supports the exchange of data between systems and supports distributed applications, such as email and file transfer.
- at each layer of a protocol architecture, one or more common protocols are implemented in communicating systems.

Notes

Protocol Architecture

- Two approaches
  1. Monolithic (single module)
  2. Modular (layered)



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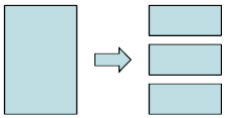
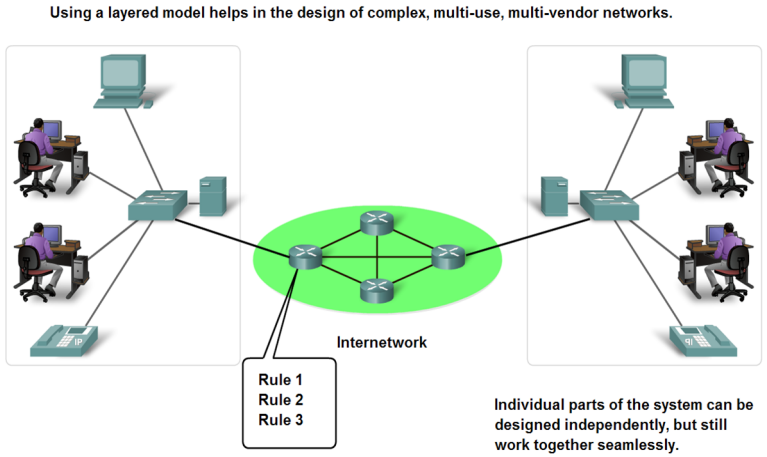


- Advantages of Modular Approach
  1. Breaks complex tasks into subtasks.
  2. Changes in one layer do not affect other layers.

Notes

Layered Model

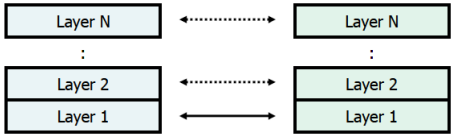
Illustration



Notes

Layered Protocol Architecture

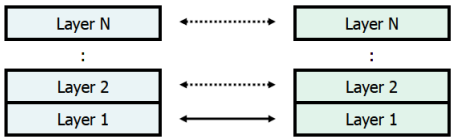
- Each layers acts as a module.



Notes

Layered Protocol Architecture

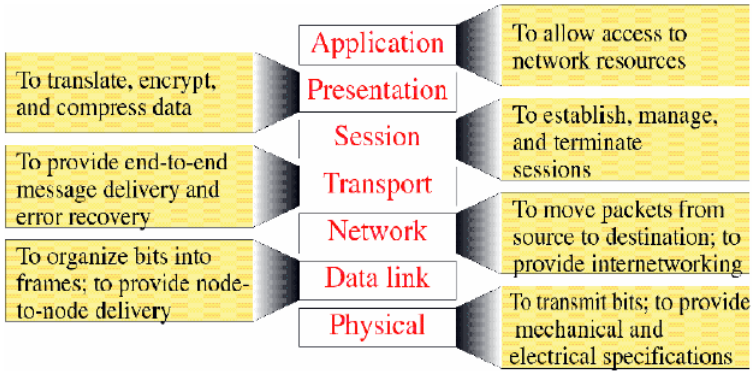
- Each layers acts as a module.
- Communication occurs
  1. between different modules on the same system
  2. between similar modules on different systems



Notes

Layered Architecture
Example

- Open Systems Interconnection model (OSI).



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OSI Reference Model

- layered framework developed by International Organization for Standardization (ISO) for the design of network systems that allows communication between all types of computer systems.

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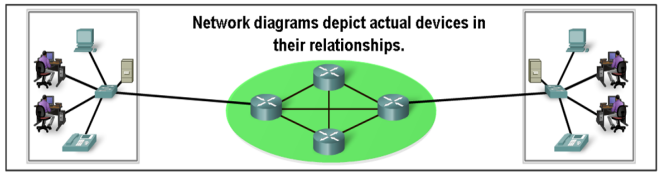
- layered framework developed by International Organization for Standardization (ISO) for the design of network systems that allows communication between all types of computer systems.
- consists of seven separate but related layers, each of which defines a part of the process of moving information across a network.
- not a protocol; it is a reference model.

Notes

OSI Reference Model

Models Provide Guidance



OSI Model

- Application
- Presentation
- Session
- Transport
- Network
- Data Link
- Physical

A networking model is only a representation of network operation. The model is not the actual network.

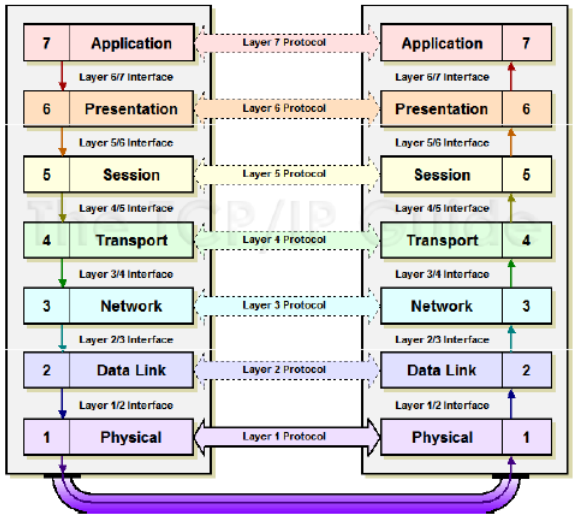
TCP/IP Model

- Application
- Transport
- Internet
- Network Access

Notes

OSI Reference Model

Host-to-host link



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OSI Model Layers

- Layers 1, 2, and 3 - physical, data link, and network - are the network support layers

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- Layers 1, 2, and 3 - physical, data link, and network - are the network support layers
- they deal with the physical aspects of moving data from one device to another (such as electrical specifications, physical connections, physical addressing, and transport timing and reliability)

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OSI Model Layers

- Layers 5, 6, and 7 - session, presentation, and application - can be thought of as the user support layers;
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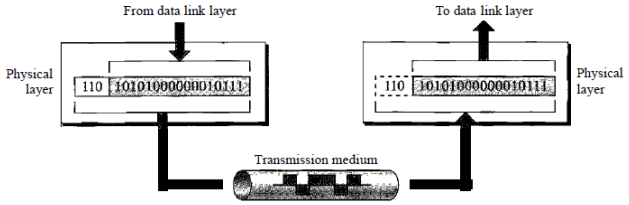
OSI Model Layers

- Layers 5, 6, and 7 - session, presentation, and application - can be thought of as the user support layers;
  they allow interoperability among unrelated software systems.
- Layer 4, the transport layer, links the two subgroups and ensures that what the lower layers have transmitted is in a form that the upper layers can use.

Notes

Physical Layer (PHY)

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



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- deals with the mechanical and electrical specifications of the interface and transmission medium.
- defines the procedures and functions that physical devices and interfaces have to perform for transmission to occur

Notes

Physical Layer Concerns

- Physical characteristics of interfaces and medium.

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- Representation of bits.

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- Line configuration.
- Transmission mode.

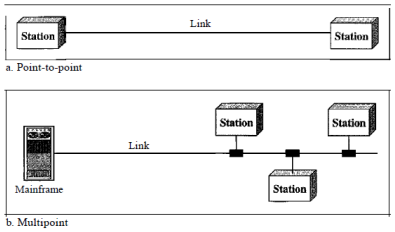
Notes

Remember

Line Configuration

connection of devices to the media.

- Point-to-point configuration
  two devices are connected through a dedicated link.



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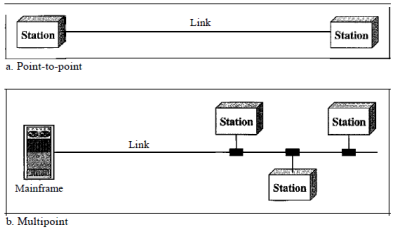
- Multipoint configuration
  a link is shared among several devices



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Transmission mode

direction of transmission between two devices.

- Simplex mode
  only one device can send; the other can only receive.

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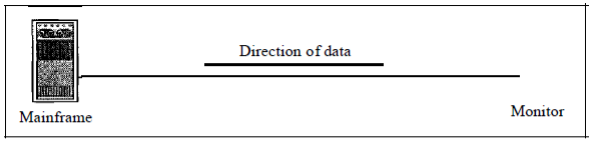
- Half-duplex mode
  two devices can send and receive, but not at the same time.
- Full-duplex mode
  two devices can send and receive at the same time.

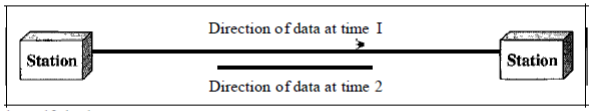
Notes

Transmission mode

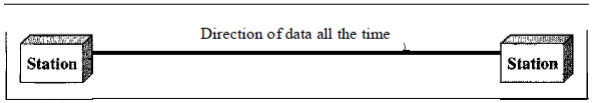
Data flow
(simplex, half-duplex, and full-duplex)



a. Simplex



b. Half-duplex



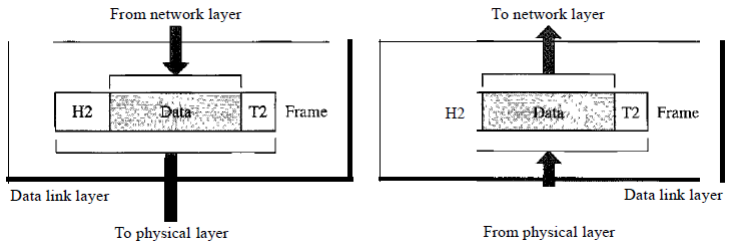
c. Full-duplex

Notes

Data Link Layer (DLL)

or simply Link Layer

- is responsible for moving frames from one hop (node) to the next.



Notes

Data Link Layer (DLL)

- transforms the physical layer, a raw transmission facility, to a reliable link.

Notes

Data Link Layer (DLL)

- transforms the physical layer, a raw transmission facility, to a reliable link.

- makes the physical layer appear error-free to the upper layer (network layer).

Notes

Data Link Layer Concerns

- Framing
  divides the stream of bits received from the network layer into manageable data units called frames

Notes

Data Link Layer Concerns

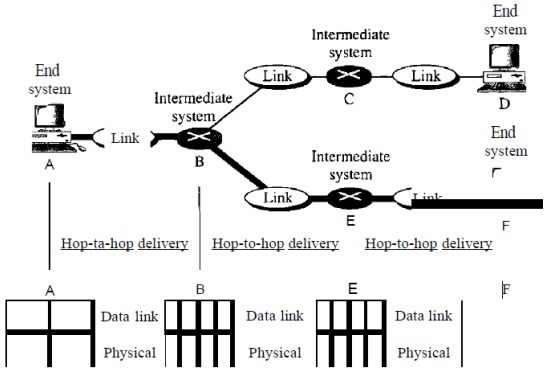
- Framing
  divides the stream of bits received from the network layer into manageable data units called frames
- Physical addressing
  adds a header to the frame to define the sender and/or receiver of the frame. If the frame is intended for a system outside the sender's network, the receiver address is the address of the device that connects the network to the next one.

Notes

Data Link Layer (DLL)

Hop-to-hop delivery

- communication at the data link layer occurs between two adjacent nodes



Notes

Data Link Layer Concerns

- Flow control
  imposes a flow control mechanism to avoid overwhelming the receiver.

Notes

Data Link Layer Concerns

- Flow control
  imposes a flow control mechanism to avoid overwhelming the receiver.
- Error control
  Adds reliability to the physical layer by adding mechanisms to detect and retransmit damaged or lost frames.

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Data Link Layer Concerns

- Flow control
  imposes a flow control mechanism to avoid overwhelming the receiver.
- Error control
  Adds reliability to the physical layer by adding mechanisms to detect and retransmit damaged or lost frames.

- Access control
  in multipoint configuration, link layer protocols are necessary to determine which device has control over the link at any given time.

Notes

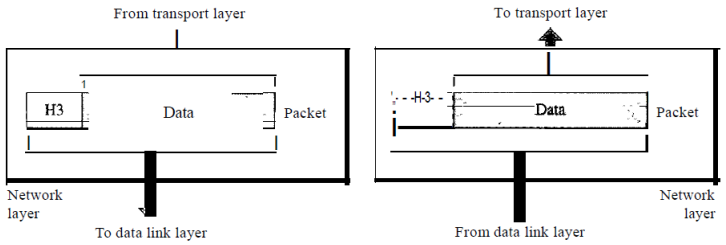
Data Link Layer Example

- Ethernet (802.3) and Media Access Control (MAC) address applied to the network adaptor by the manufacturer during production.

Notes

Network Layer

- is responsible for the delivery of individual packets from the source host to the destination host.



Notes

Network Layer

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- If two systems are connected to the same link, there is usually no need for a network layer.
- If the two systems are attached to different networks with connecting devices between the networks, there is often a need for the network layer to accomplish source-to-destination delivery.

Notes

Network Layer Concerns

- Logical addressing
  if a packet passes the network boundary, we need another addressing system to help distinguish the source and destination systems.

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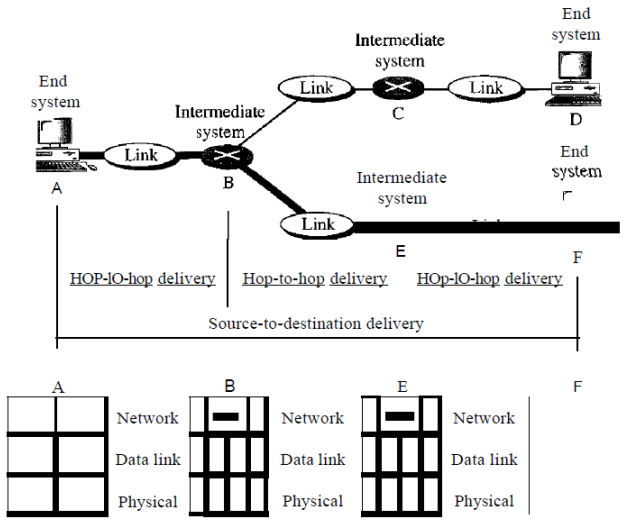
Network Layer Concerns

- Logical addressing
  if a packet passes the network boundary, we need another addressing system to help distinguish the source and destination systems.
- Routing
  provides mechanism to route or set the path of the packets to their final destination

Notes

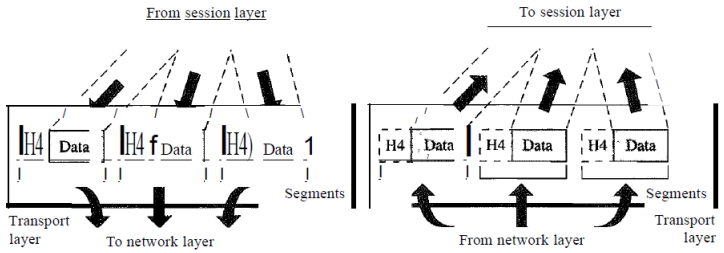
Network Layer



Notes

Transport Layer

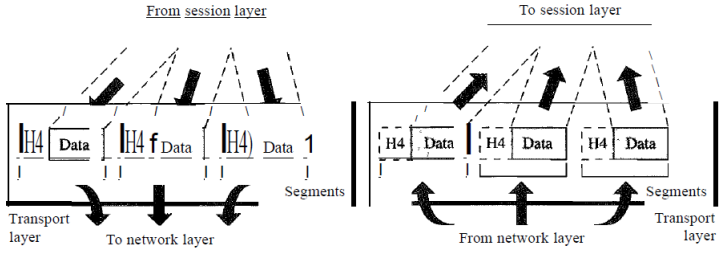
- is responsible for process-to-process delivery of the entire message.



Notes

Transport Layer

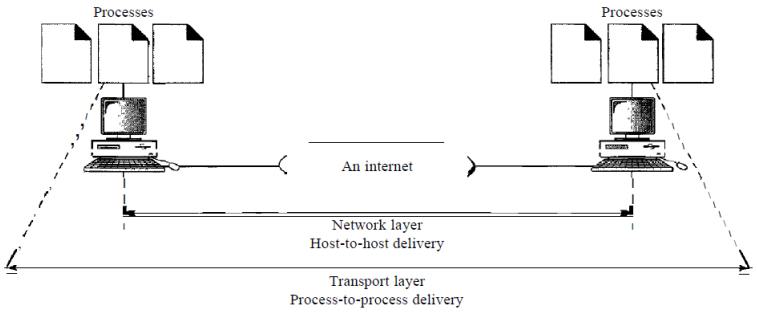
- is responsible for process-to-process delivery of the entire message.
- a process is an application program running on a host.



Notes

Transport Layer

- ensures that the whole message arrives intact and in order.



Notes

Understand

- The network layer gets each packet to the correct computer; the transport layer gets the entire message to the correct process on that computer.

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- The network layer gets each packet to the correct computer; the transport layer gets the entire message to the correct process on that computer.
- Network layer does not recognize any relationship between the packets it delivers and treats each one independently.
- The transport layer, however, ensures that the whole message arrives intact and in order, overseeing both error control and flow control.

Notes

Transport Layer Concerns

- Service-point addressing
  address for delivery from a specific process (running program) on one computer to a specific process (running program) on the other.

Notes

Transport Layer Concerns

- Service-point addressing
  address for delivery from a specific process (running program) on one computer to a specific process (running program) on the other.
- Segmentation and reassembly
  message is divided into transmittable segments, with each segment containing a sequence numbers enabling the transport layer to reassemble the message correctly.

Notes

Transport Layer Concerns

- Connection control
  either connectionless or connection-oriented.

Notes

Transport Layer Concerns

- Connection control
  either connectionless or connection-oriented.
- End-to-end Flow control

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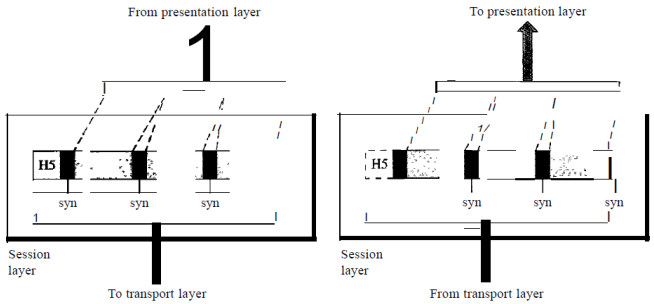
  either connectionless or connection-oriented.
- End-to-end Flow control
- Process-to-process Error control
- Transport layer protocol and the port number

Notes

Session Layer

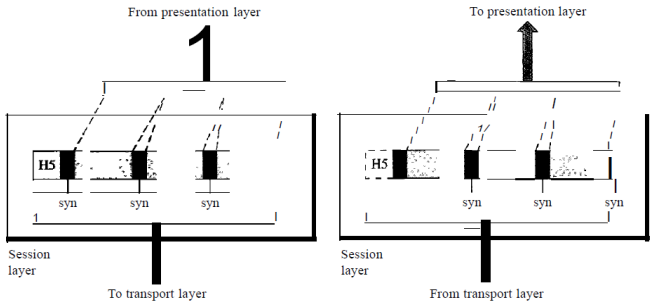
- is responsible for dialog control and synchronization.



Notes

Session Layer

- is responsible for dialog control and synchronization.
- establishes, maintains, & synchronizes the interaction among communicating systems.



Notes

Session Layer Concerns

- Dialog control
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  allows the communication between two
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  allows the communication between two
  processes to take place in either half-duplex or
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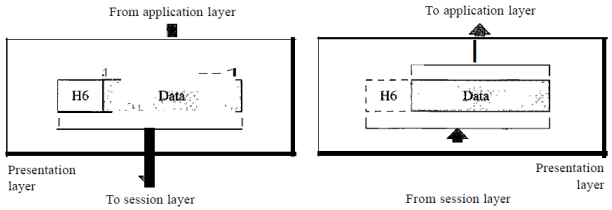
- Synchronization
  allows a process to add checkpoints, or
  synchronization points, to a stream of data.

Notes

Presentation Layer

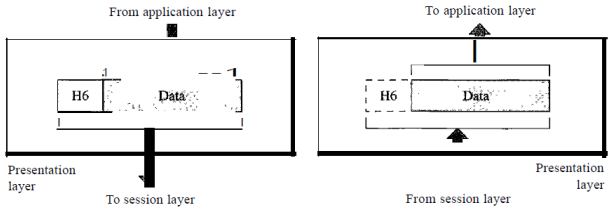
- is responsible for translation, compression, and encryption.



Notes

Presentation Layer

- is responsible for translation, compression, and encryption.
- concerned with the syntax and semantics of the information exchanged between two systems.



Notes

Presentation Layer Concerns

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- Encryption
  the sender transforms the original information to another form and sends the resulting message.
- Compression
  reduce the number of bits.

Notes

Presentation Layer Examples

- JPEG- Joint Photographic Experts Group

Notes

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- MPEG- The Moving Picture Experts Group's standard

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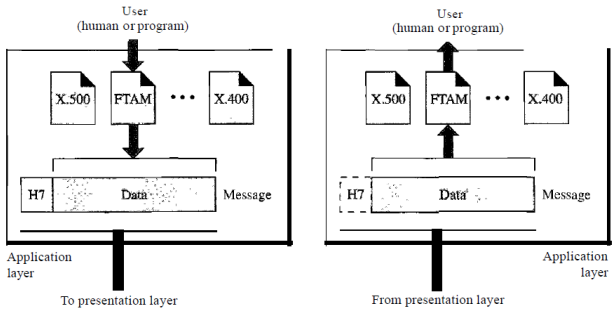
- TIFF- Tagged Image File Format

Notes

Application Layer

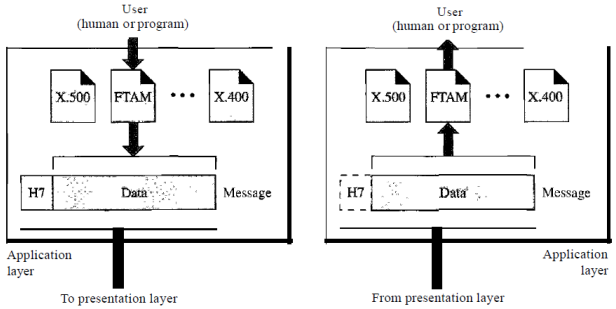
- is responsible for providing services to the user.



Notes

Application Layer

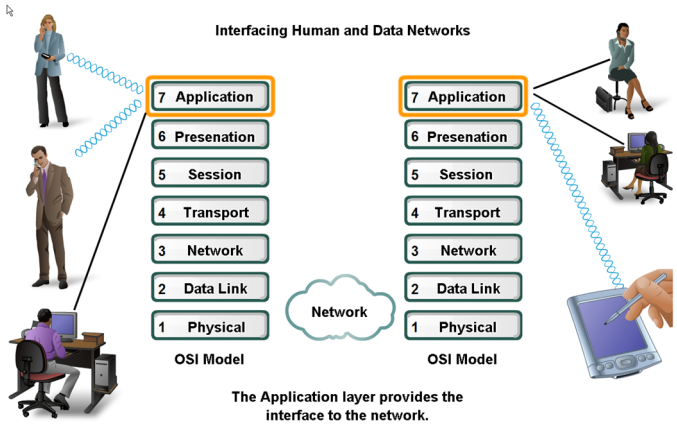
- is responsible for providing services to the user.
- enables the user, whether human or software, to access the network.



Notes

Application Layer

The Interface Between Human and Data Networks



Notes

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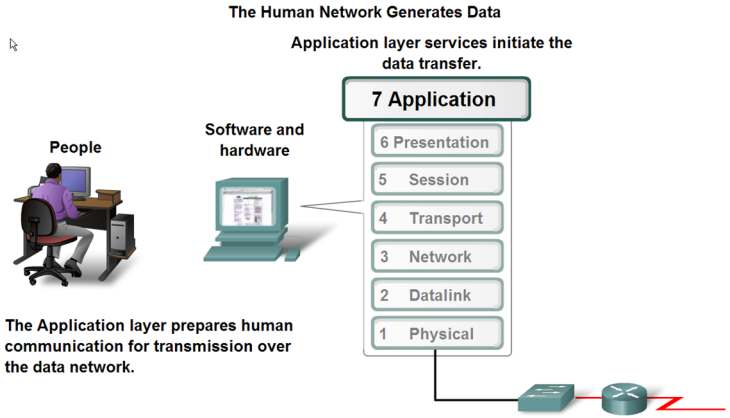

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Application Layer Concerns

- Network virtual terminal
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  allows a user to access files in a remote host, and to manage or control files

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- Directory services

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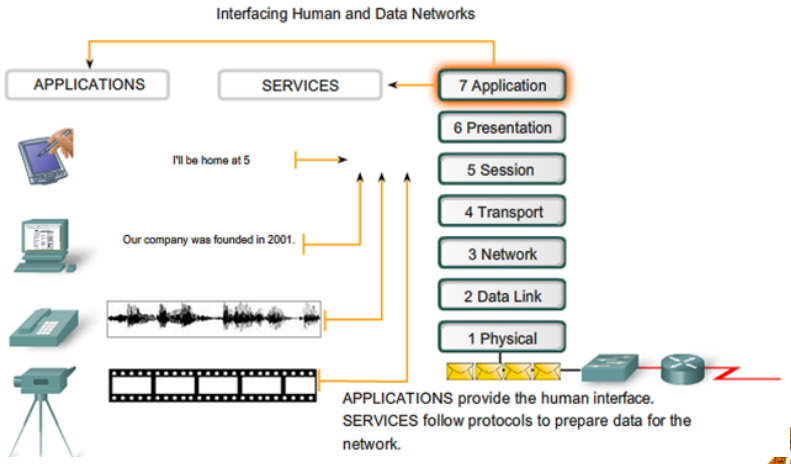
Application Layer



Notes

Application Layer Examples

- World Wide Web (WWW)

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- Internet navigation utilities
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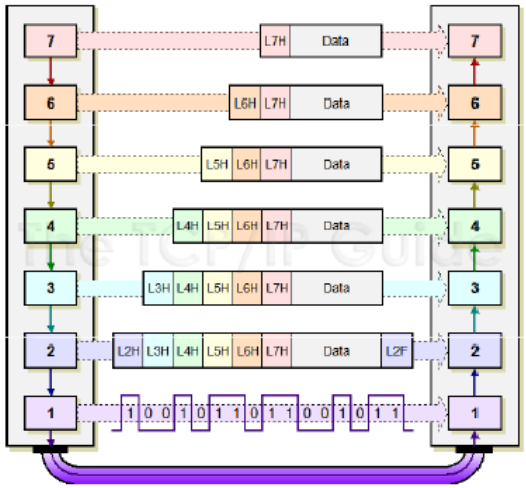
- File Transfer Protocol (FTP) transfers
- Simple Mail Transfer Protocol (SMTP) email transfers

Notes

OSI Reference Model

Data exchange and Encapsulation



Notes

Data Encapsulation

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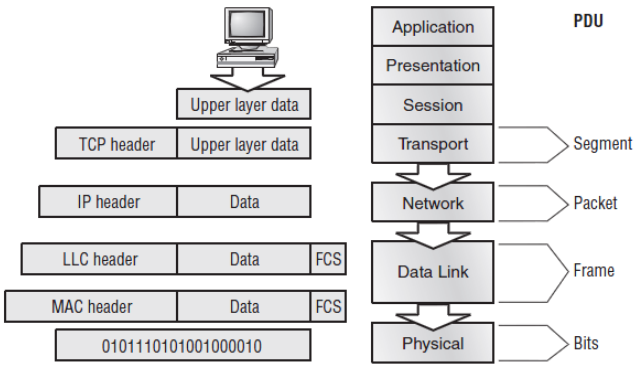
- The data portion at level $N-1$ carries the whole PDU (data and header and maybe trailer) from level N.
- For level $N-1$, the whole PDU coming from level N is treated as one integral unit.

Notes

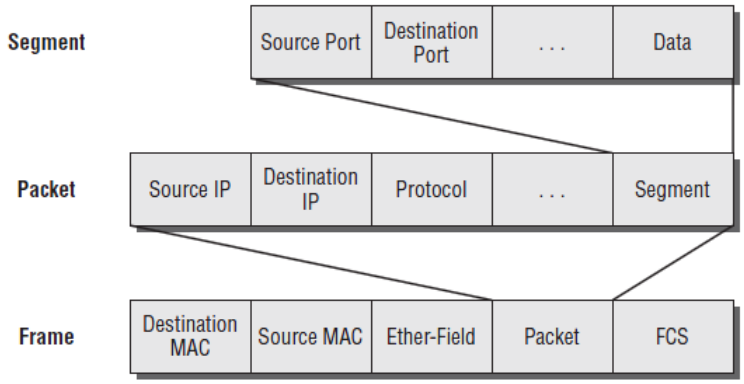
Data Encapsulation



Notes

Data Encapsulation

PDU and layer Addressing



Notes

Data Segmentation

- Segment the data stream into small bounded size blocks or PDUs.

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Data Segmentation

- Segment the data stream into small bounded size blocks or PDUs.
- the network may accept data blocks only up to a certain size (53 octets for atm, 1526 octets for Ethernet)
- Advantages
  ∘ Efficient error control with PDU size ∘ Fewer bits retransmitted in the event of failure ∘ Better access to shared transmission facilities, with shorter delay ∘ Smaller buffers at receiver stations

Notes

Data Segmentation

- Disadvantages
  - Larger overhead with smaller PDU size
  - More interrupts as PDUs announce their arrival
  - More time spent to process many smaller PDUs
  - Reassembly is an issue to be addressed

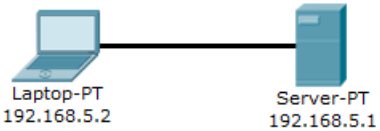
Notes

OSI Example

Imagine that you are on DLSU website and you have clicked a link on the page. By doing so you have just made a request of the web server to send you a document (most web pages exist as documents with an .html extension). This document will be sent to your computer which will use the proper application (your Internet browser) to display the document so you can view it.

Notes

Example



Computer	IP Address	MAC Address	Port Number
Web server	192.168.5.1	5-5-5-5-5-5	TCP 80
Laptop	192.168.5.2	6-6-6-6-6-6	TCP 80

Notes

Web server End
SOURCE

- Layer 7 obtains the data in the form of the HTML document.

Notes

Web server End
SOURCE

- Layer 7 obtains the data in the form of the HTML document.
- Layer 6 adds information about the formatting.

Notes

Web server End
SOURCE

- Layer 7 obtains the data in the form of the HTML document.
- Layer 6 adds information about the formatting.

- Layer 5 adds information required to create a session between the web server and the web browser on the laptop.

Notes

Web server End
SOURCE

- Layer 4 adds the transport protocol and the source and destination port numbers, in this case TCP (it's a unicast) and port 80 (HTTP).

Notes

Web server End
SOURCE

- Layer 4 adds the transport protocol and the source and destination port numbers, in this case TCP (it's a unicast) and port 80 (HTTP).
- Layer 3 adds the source and destination IP addresses, in this case a source of 192.168.5.1 and a destination of 192.168.5.2.

Notes

Web server end
SOURCE

- Layer 2 learns the destination MAC address and adds the source and destination MAC addresses, in this case, a source of 5-5-5-5-5-5 and destination of 6-6-6-6-6-6.

Notes

Web server end
SOURCE

- Layer 2 learns the destination MAC address and adds the source and destination MAC addresses, in this case, a source of 5-5-5-5-5-5 and destination of 6-6-6-6-6-6.
- Layer 1 converts the entire package into bits and sends it across the network to the laptop.

Notes

Laptop end
DESTINATION

- Layer 1 receives the bits in electrical format, converts them to be read by layer 2, and hands them to layer 2.

Notes

Laptop end
DESTINATION

- Layer 1 receives the bits in electrical format, converts them to be read by layer 2, and hands them to layer 2.

- Layer 2 examines the destination MAC address to see whether it is addressed to it, sees the MAC address of 6-6-6-6-6-6 (its own), drops that part of the transmission, and hands the remaining data to layer 3.

Notes

Laptop end
DESTINATION

- Layer 1 receives the bits in electrical format, converts them to be read by layer 2, and hands them to layer 2.
- Layer 2 examines the destination MAC address to see whether it is addressed to it, sees the MAC address of 6-6-6-6-6-6 (its own), drops that part of the transmission, and hands the remaining data to layer 3.
- Layer 3 examines the destination IP address to ensure that it is its own (192. 168.5.2), drops that part, and hands the rest of the package to layer 4.

Notes

Laptop end
DESTINATION

- Layer 4 examines the destination port number (port 80), alerts the browser that HTTP data is coming in, drops that part, and hands the rest of the package to layer 5.

Notes

Laptop end
DESTINATION

- Layer 4 examines the destination port number (port 80), alerts the browser that HTTP data is coming in, drops that part, and hands the rest of the package to layer 5.
- Layer 5 uses the information that was placed on this layer by the web server to create the session between the web server and the web browser and then hands the rest of the information to layer 6.

Notes

Laptop end
DESTINATION

- Layer 6 performs any format translation that may be required and hands the remaining data (the HTML document) to layer 7.

Notes

Laptop end
DESTINATION

- Layer 6 performs any format translation that may be required and hands the remaining data (the HTML document) to layer 7.
- The layer 7 application (the web browser) receives the HTML document and opens the document in the browser window.

Notes

☞Understand

Which of the following is not an advantage of networking reference models?

A. They encourage standardization by defining what functions are performed at particular layers of the model.

B. They prevent changes in one layer from causing a need for changes in other layers, speeding development.

C. They ensure that networks perform better.

D. They encourage vendors to build on each other's developments through use of a common framework.

E. None of the above

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Notes

☞Understand

Which layer of the OSI model is responsible for coordinating the exchanges of information between the layer 7 applications or services that are in use?

A. Application

B. Session

C. Data-Link

D. Physical

E. None of the above

Notes

☞Understand

Which layer of the OSI model is responsible for coordinating the exchanges of information between the layer 7 applications or services that are in use?

A. Application
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Notes

☞Understand

What is the information that is used on layer 3 of the OSI model?

A. A bit pattern
B. MAC addresses
C. IP addresses
D. Port numbers
E. All of the above

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What is the information that is used on layer 3 of the OSI model?

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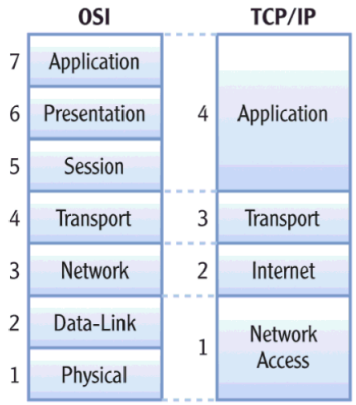
Notes

✍Reading Assignment

- Illustrate and Contrast OSI and TCP/IP models.

Notes

OSI and TCP/IP models Comparison



Notes

OSI and TCP/IP Model

- There are seven layers in the OSI model and four in the TCP/IP model.

Notes

OSI and TCP/IP Model

- There are seven layers in the OSI model and four in the TCP/IP model.
- The top three layers of the OSI model (Application, Presentation and Session) map to the Application layer of the TCP/IP model.

Notes

OSI and TCP/IP Model

- There are seven layers in the OSI model and four in the TCP/IP model.
- The top three layers of the OSI model (Application, Presentation and Session) map to the Application layer of the TCP/IP model.

- The bottom two layers of the OSI model (Data-Link and Physical) map to the Network Access layer of the TCP/IP model.

Notes

OSI vs. TCP/IP Model

- In the OSI model, it was envisioned that the Session layer would handle the establishment and management of the communication session between the application or service being used.

Notes

OSI vs. TCP/IP Model

- In the OSI model, it was envisioned that the Session layer would handle the establishment and management of the communication session between the application or service being used.
- In TCP/IP, those functions are performed by the TCP /IP protocol itself at a different layer, the Transport layer.

Notes

OSI vs. TCP/IP Model

- OSI model envisioned the host devices as deaf, dumb, and blind bystanders to the networking process, not participants (dumb terminal).

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OSI vs. TCP/IP Model

- OSI model envisioned the host devices as deaf, dumb, and blind bystanders to the networking process, not participants (dumb terminal).

- In TCP/IP, the hosts participate and take part in functions such as end-to-end verification, routing, and network control (intelligent role players)

Notes

OSI vs. TCP/IP Model

- When TCP/IP was developed, it was decided that the division of the bottom layer into Data-Link and Physical layers was unnecessary.

Notes

OSI vs. TCP/IP Model

- When TCP/IP was developed, it was decided that the division of the bottom layer into Data-Link and Physical layers was unnecessary.

- Thus their functions are combined in the Network Access layer of the TCP/IP model.

Notes

TCP/IP Model

- Developed by US Defense Advanced Research Project Agency (DARPA) for ARPANET packet switched network.

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- generally referred to as the TCP/IP protocol suite, which consists of a large collection of protocols.
- predates the OSI reference model.

Notes

TCP/IP Model

- Transmission Control Protocol (TCP) is the primary transport layer (layer 4) protocol, and is responsible for connection establishment and management and reliable data transport between software processes on devices.

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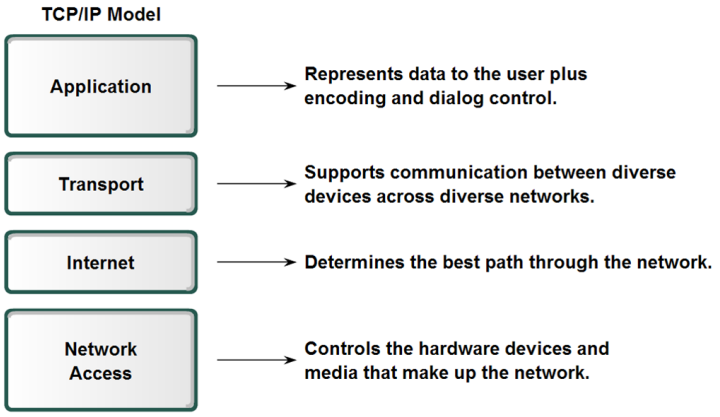
- Transmission Control Protocol (TCP) is the primary transport layer (layer 4) protocol, and is responsible for connection establishment and management and reliable data transport between software processes on devices.
- Internet Protocol (IP) is the primary OSI network layer (layer 3) protocol that provides addressing, datagram routing and other functions in an internetwork.

Notes

TCP/IP Model



Notes

TCP/IP Layers

- Application (Process) Layer

Notes

TCP/IP Layers

- Application (Process) Layer
- Host-to-host (Transport) Layer

Notes

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TCP/IP Layers

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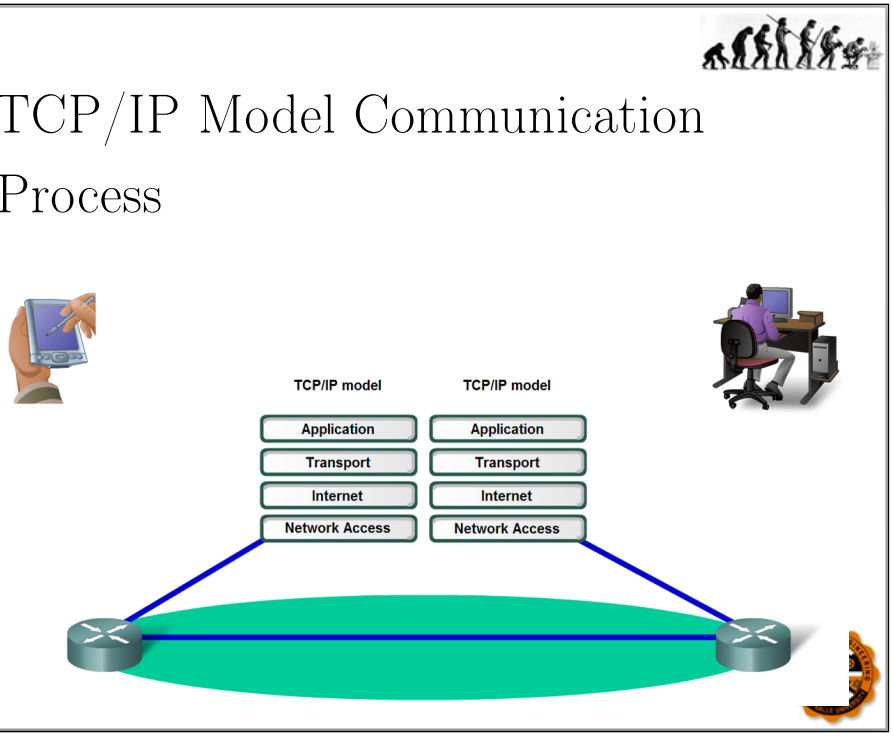
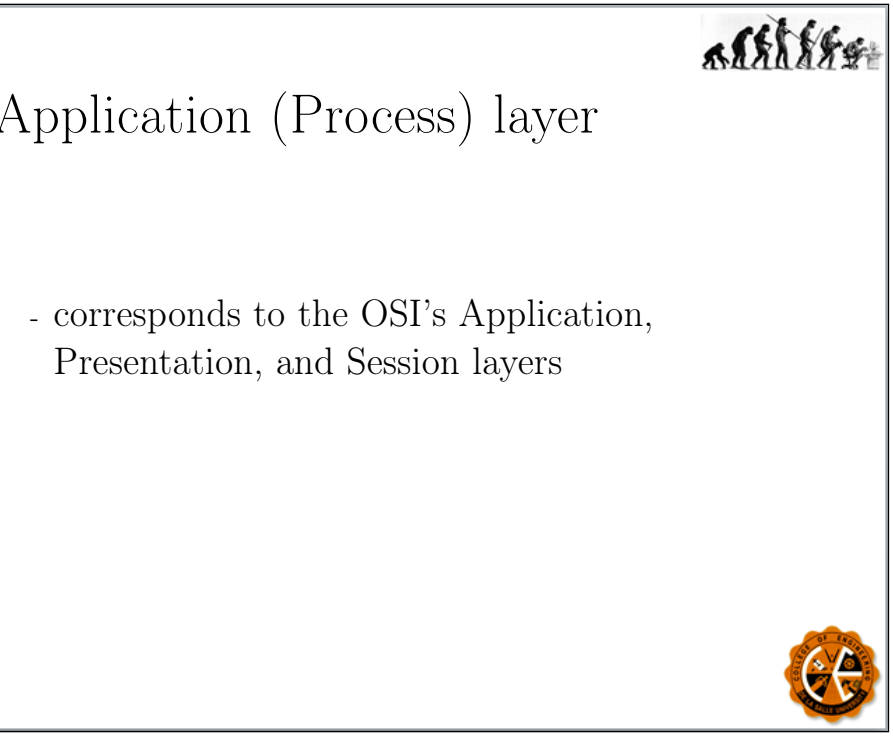
- Host-to-host (Transport) Layer
- Internet Layer
- Network Access/Interface Layer

Notes



TCP/IP Model Communication Process

Notes



Application (Process) layer

- corresponds to the OSI's Application, Presentation, and Session layers

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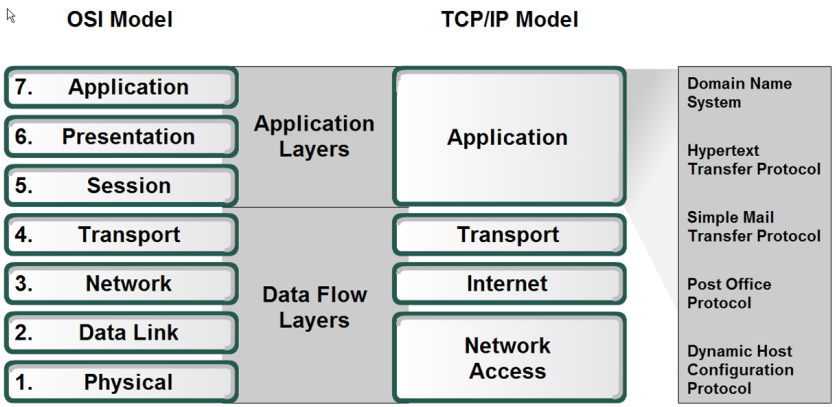
- controls user-interface specifications.

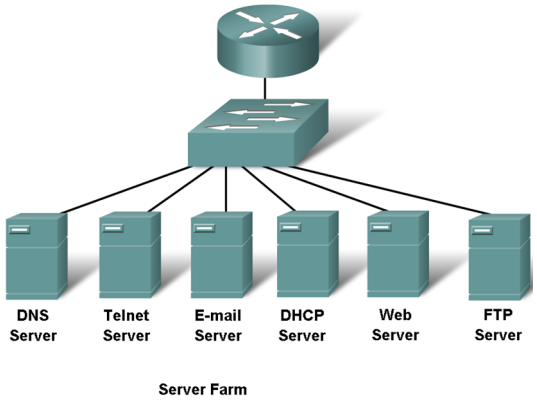
Notes

Application layer services



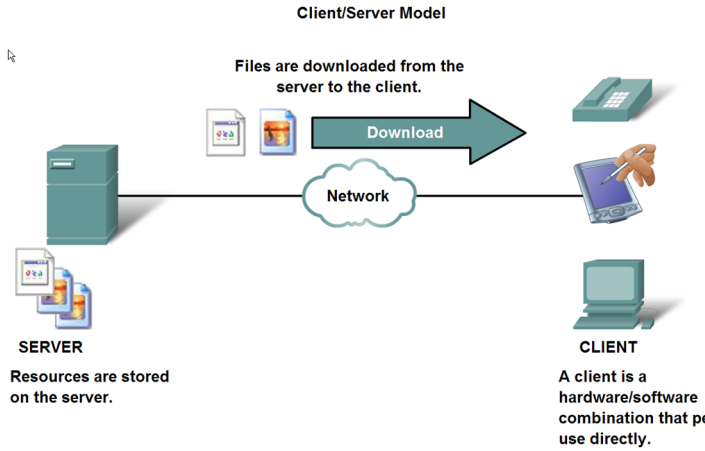
Notes

Application layer services



Notes

Recall



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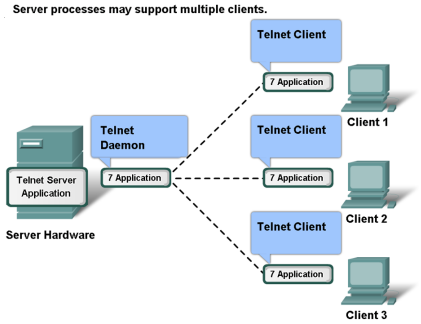
Telnet / Terminal Emulation

- allows a user on a remote client machine, called the Telnet client, to access the resources of another machine, the Telnet server.



Notes

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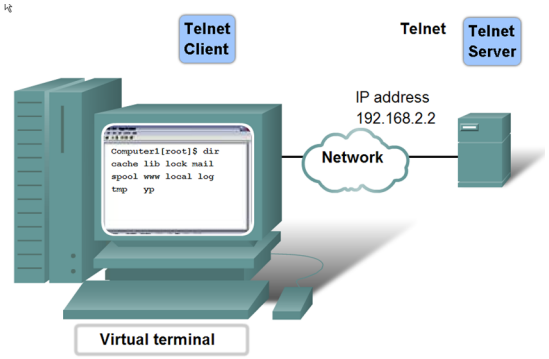


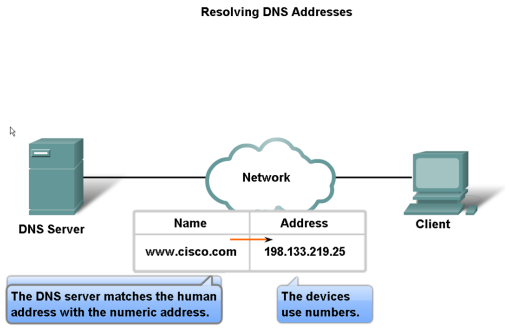
Telnet provides a way to use a computer, connected via the network, to access a network device as if the keyboard and monitor were directly connected to the device.

Notes

Domain Name Service

DNS

- resolves hostnames-specifically, Internet names, such as www.dlsu.edu.ph

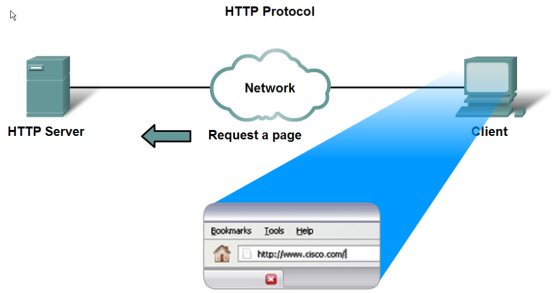


Notes

HTTP

Hypertext transfer protocol

- rules governing the delivery of web pages to the client



Notes

Understand

- Differentiate HTTP and HTML?

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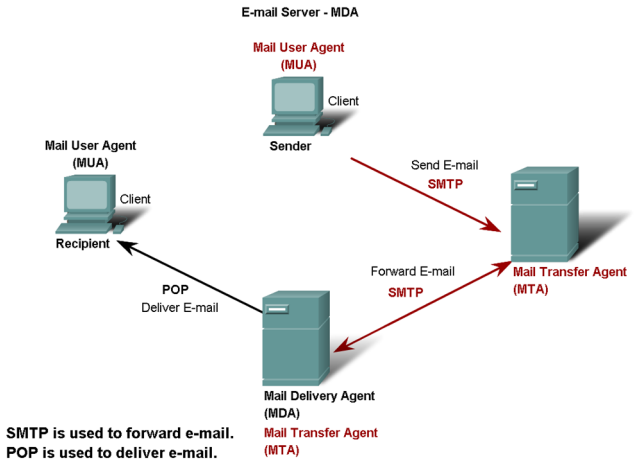
  Definitions of tags that are added to Web documents to control their appearance.
- HTTP: hypertext transfer protocol
  The rules governing the conversation between a Web client and a Web server.

Notes

POP and SMTP

Post Office and Simple Mail Transport Protocols

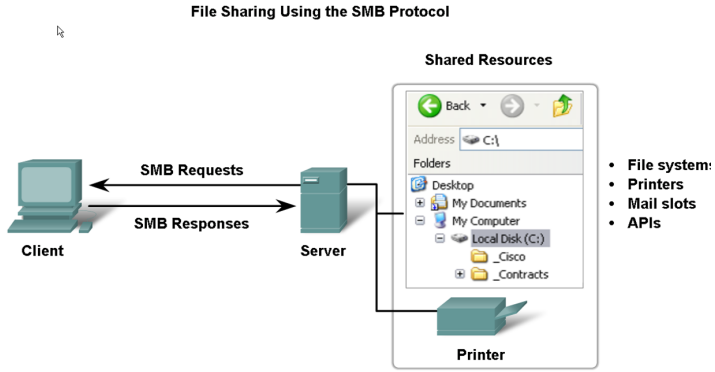


SMTP is used to forward e-mail.
POP is used to deliver e-mail.

Notes

Server Message Block (SMB) Protocol

- supports file sharing in Microsoft-based networks

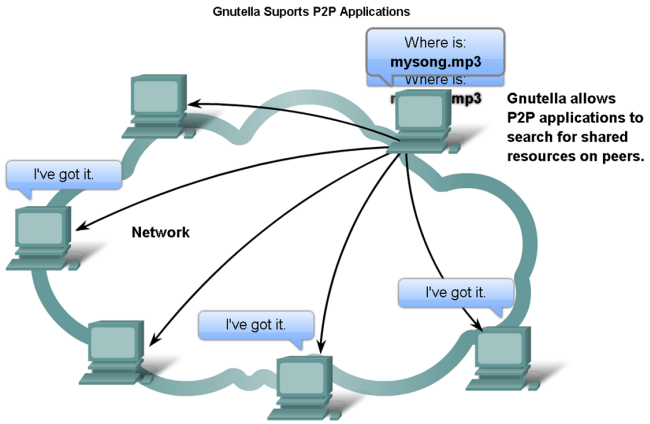


SMB is a client-server, request-response protocol. Servers can make their resources available to clients on the network.

Notes

Gnutella Protocol

- supports P2P services



Notes

Host-to-host (Transport) Layer

- parallels the functions of the OSI's Transport layer

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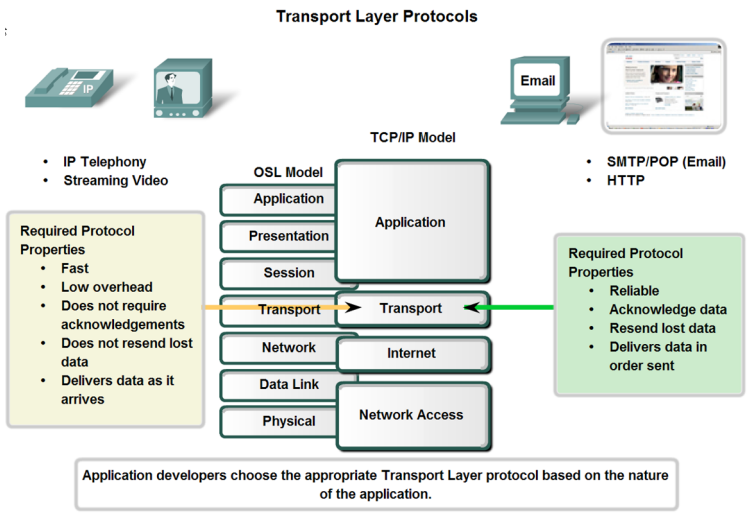
- define protocols for setting up the level of transmission service for applications.
- concerned with
  - reliable end-to-end communication
  - error-free delivery of data
  - packet sequencing

Notes

Transport Layer Role



Notes

Transport Layer Functions

- Enables multiple applications to communicate over the network at the same time on a single device

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- Ensures that, if required, all the data is received reliably and in order by the correct application
- Employs error handling mechanisms
- UDP- User Datagram protocol- an exchange of data w/o acknowledgment, sure delivery

Notes

Transport Layer Purpose

- Segmenting data & managing each piece - data must be prepared to be sent across the media in manageable pieces.

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Transport Layer Purpose

- Segmenting data & managing each piece - data must be prepared to be sent across the media in manageable pieces.
- Tracking the individual communication between applications on the source and destination hosts - maintains the multiple communication streams between these applications.

Notes

Transport Layer Purpose

- Reassembling the segments into streams of application data - At the receiving host, each piece of data will be reconstructed and directed to the appropriate application.

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Transport Layer Purpose

- Reassembling the segments into streams of application data -
  At the receiving host, each piece of data will be reconstructed and directed to the appropriate application.
- Identifying the different applications-
  assigns each application an identifier; the TCP/IP protocols call this identifier a port number.

Notes

Transport Layer Protocols

- Transmission Control Protocol (TCP)
  - Connection-oriented
  - Guaranteed Delivery
  - Supports Flow Control and Error control

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Transport Layer Protocols

- Transmission Control Protocol (TCP)
  - Connection-oriented
  - Guaranteed Delivery
  - Supports Flow Control and Error control
- User Datagram Protocol (UDP)
  - Connectionless-oriented
  - Nonguaranteed Delivery
  - No Flow Control and Error control

Notes

Internet Layer

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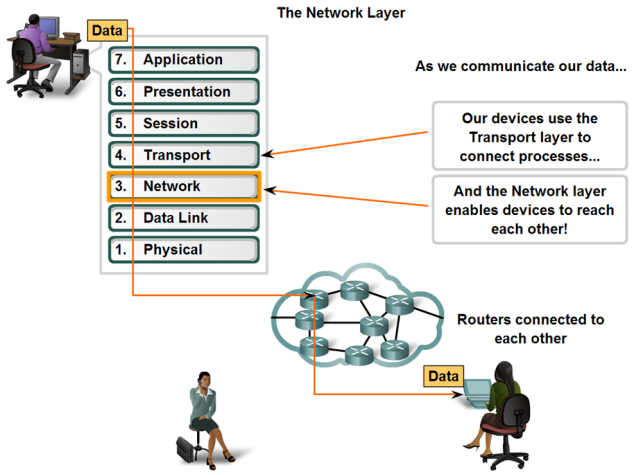
- designates the protocols relating to the logical transmission of packets over the entire network.
- concerned with
  - logical addressing, i.e. IP (Internet Protocol) address
  - routing of packets among multiple networks

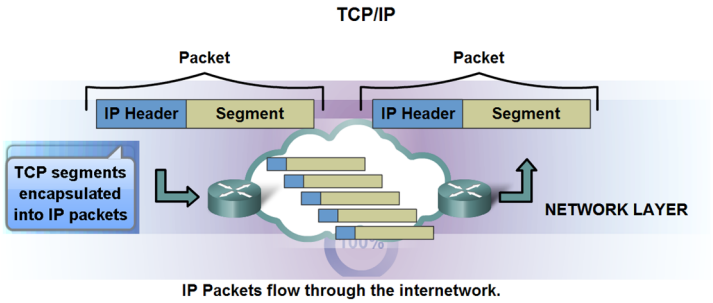
Notes

Internet Layer



Notes

Internet Protocol (IP)



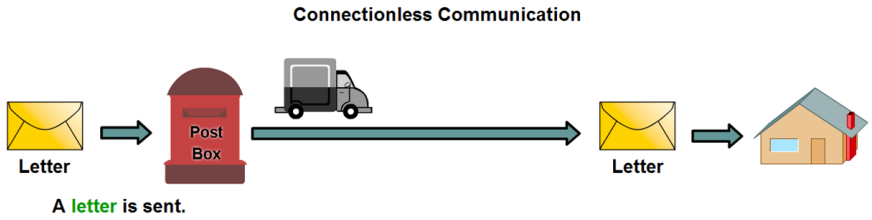
IP Packets flow through the internetwork.

- Connectionless - No connection is established before sending data packets.
- Best Effort (unreliable) - No overhead is used to guarantee packet delivery.
- Media Independent - Operates independently of the medium carrying the data.

Notes

Internet Protocol (IP)

Connectionless



The sender doesn't know:

- if the receiver is present
- if the letter arrived
- if the receiver can read the letter

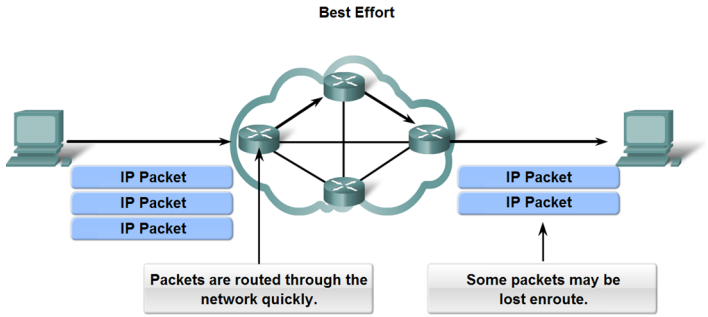
The receiver doesn't know:

- when it is coming

Notes

Internet Protocol (IP)

Unreliable Protocol



As an unreliable Network layer protocol, IP does not guarantee that all sent packets will be received.

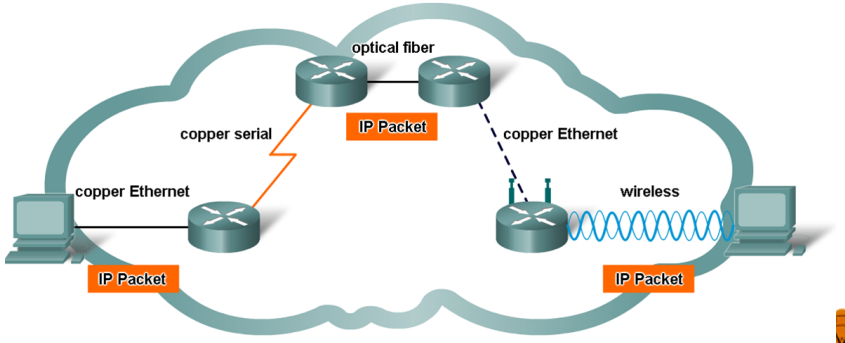
Other protocols manage the process of tracking packets and ensuring their delivery.

Notes

Internet Protocol (IP)

Media Independent

Media Independence



IP packets can travel over different media.

Notes

Internet Protocol (IP)

- Segments are encapsulated as packets

Generating IP Packets

Transport Layer Encapsulation

Segment Header	Data

Network Layer Encapsulation

IP Header	Transport Layer PDU

IP Packet

In TCP/IP based networks, the Network layer PDU is the IP packet.

Notes

Network Access Layer

- interface to the local network

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- concerned with the exchange of data between an end system (server, workstation, etc.) and the network to which it is attached.

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- concerned with the exchange of data between an end system (server, workstation, etc.) and the network to which it is attached.
- concerned with
  - hardware addressing
  - protocols for the physical transmission of data

Notes

Network Access Layer

- the source and destination physical addresses are put on the front of the package in a part called the header.

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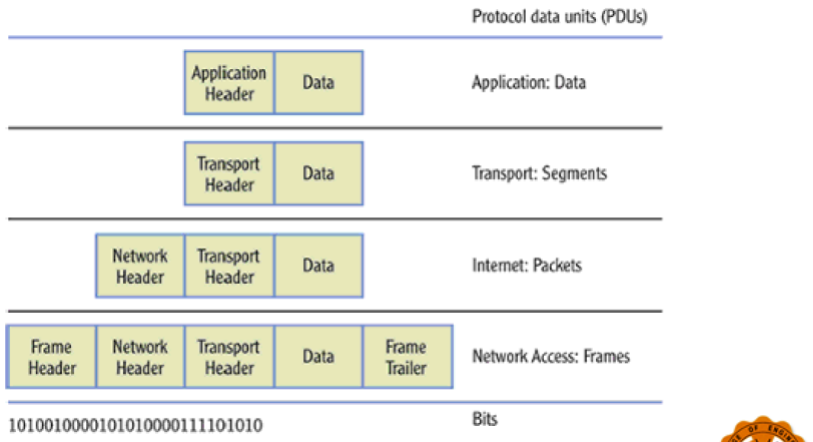
- the source and destination physical addresses are put on the front of the package in a part called the header.
- Information used to perform a frame check sequence on the message is placed at the back of the package in a section called the trailer.
- the package is converted to ones and zeros in the format required by the physical medium in use.

Notes

TCP/IP Data Encapsulation



Notes

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- Transport layer adds port number information to the data that was handed down from the Application layer.
- Internet layer adds the required logical address information to the segment.

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- Integrity means that the data has not changed even 1 bit.

Notes

TCP/IP Data Encapsulation

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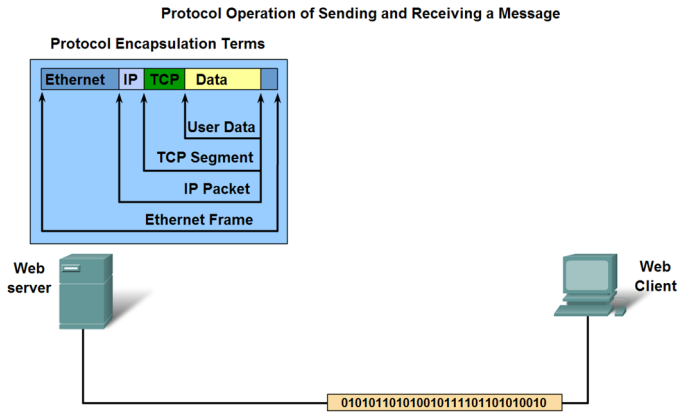
- Once the receiving device has synched up with the frame, it will start reading.

Notes

Protocol Operation of Sending and Receiving



Notes

☞Readings

In what year was it mandated that all computers connected to the ARPANET use TCP/IP?

A. 1969
B. 1974
C. 1979
D. 1983
E. None of the above

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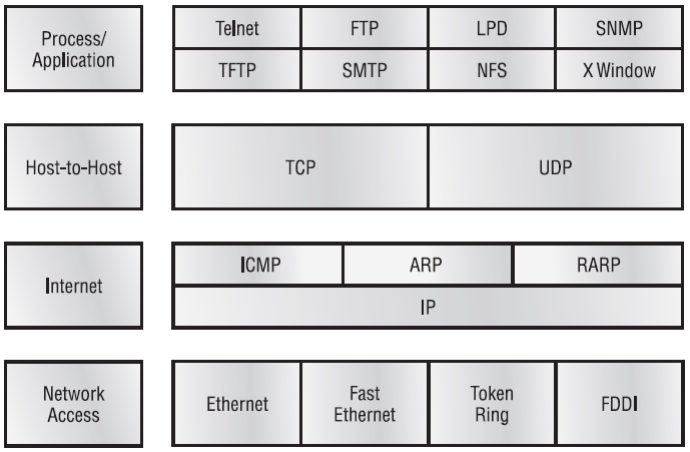
Notes

TCP/IP Protocol Suite



Notes

Application Protocols

- Telnet (Terminal emulation)
  allows a user on a remote client machine, called the Telnet client, to access the resources of another machine, the Telnet server.
- File Transfer Protocol (FTP)
  the protocol for transferring files
- Trivial File Transfer Protocol (TFTP)
  stripped-down, stock version of FTP; TFTP has no directory-browsing abilities; it can do nothing but send and receive files.

Notes

Application Protocols

- Network File System (NFS)
  allows two different types of file systems to interoperate. Ex. NT and Unix file systems
- Simple Mail Transfer Protocol (SMTP)
  answering our ubiquitous call to email, uses a spooled, or queued, method of mail delivery.
- Line Printer Daemon (LPD)
  designed for printer sharing

Notes

Application Protocols

- X Window
  defines a protocol for writing client/server applications based on a graphical user interface (GUI)
- Simple Network Management Protocol (SNMP)
  collects and manipulates valuable network information. It gathers data by polling the devices on the network from a management station at fixed or random intervals, requiring them to disclose certain information.

Notes

Application Protocols

- Domain Name Service (DNS)
  resolves hostnamesâĂŤspecifically, Internet names, such as www.dlsu.edu.ph.
- Dynamic Host Configuration Protocol (DHCP)/Bootstrap Protocol (BootP)
  assigns IP addresses to hosts. It allows easier administration and works well in small to even very large network environments.

Notes

Host-to-host (Transport) Protocols

- Transmission Control Protocol (TCP)
  a full-duplex, connection-oriented, reliable, and accurate protocol, but costly in terms of network overhead.
- User Datagram Protocol (UDP)
  a minimalist protocol mechanism with no handshaking dialogues, thus exposes any unreliability of the underlying network protocol to the user's program. There is no guarantee of delivery, ordering or duplicate protection.

Notes

Internet Protocols

- Internet Control Message Protocol (ICMP)
  a management protocol and messaging service provider for IP. Its messages are carried as IP datagrams.
- Address Resolution Protocol (ARP)
  finds the hardware address of a host from a known IP address.

Notes

Internet Protocols

- Reverse Address Resolution Protocol (RARP)
  discovers the identity of the IP address for diskless machines by sending out a packet that includes its MAC address and a request for the IP address assigned to that MAC address.
- Proxy Address Resolution Protocol (Proxy ARP)
  help machines on a subnet reach remote subnets without configuring routing or even a default gateway.

Notes

Other Terms

- De facto standard
  one that becomes the standard simply by being the method that all parties gradually choose to use over a period of time, without a formal adoption process.
- Default gateway
  This is the IP address of the nearest router in the network.

Notes

Other Terms

- IP address
  a number in a specific format that is used to identify a computer.
- ISO (International Organization for Standardization)
  is the world's largest developer of voluntary International Standards. International Standards give state of the art specifications for products, services and good practice, helping to make industry more efficient and effective.
  Note: ISO is derived from the Greek isos, meaning equal.

Notes

Other Terms

- Local vs. Remote
  If the source and destination hosts are on the same network, the destination device is considered to be on the local network.
  If the two computers are on different networks, the destination device is considered to be on a remote network.

Notes

Other Terms

- Peripherals
  are any devices that operate in conjunction with the computer yet reside outside the computer's box. Ex. display, mouse, keyboard, printer, camera, speakers, and scanners.
- Resource
  refers to anything that a user on one computer may want to access on a different computer. Ex. files, folders, printers, and scanners.
- Telecommuting
  working from another physical location, usually from home.

Notes

Other Terms

- Standard vs. Proprietary
  Proprietary refers to any process or way of doing something that works only on a single vendor's equipment while standard any process that the industry has agreed upon.

Notes

☞Understand

- How do you ensure that products from different manufacturers can work together as expected?

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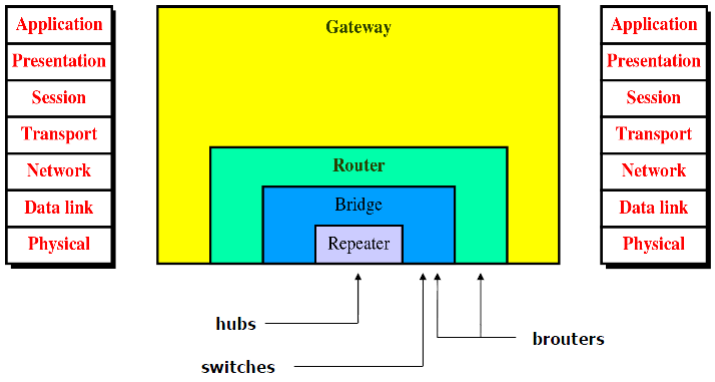
- How do you ensure that products from different manufacturers can work together as expected?
- Answer:
  Using Standards which provide guidelines to manufacturers, vendors, government agencies, and other service providers to ensure the kind of interconnectivity necessary in today's marketplace and in international communications.

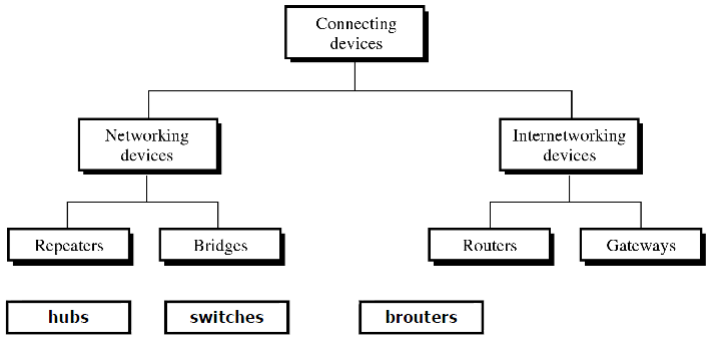
Notes

OSI Model and Networking Devices



Notes

Networking and Internetworking Devices



Notes

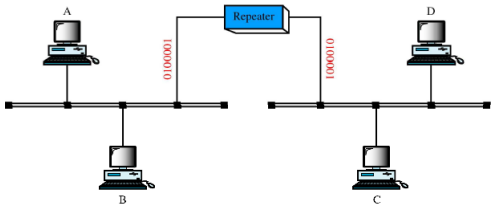
Networking and Internetworking Devices

Examples

Notes

Repeaters

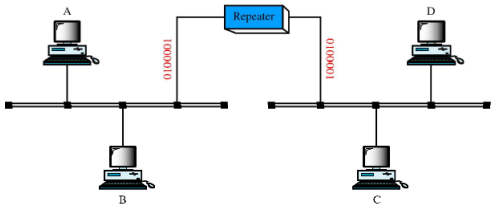
- a physical layer device used to interconnect the media segments of an extended network.



Notes

Repeaters

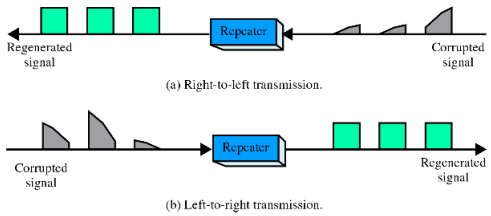
- a physical layer device used to interconnect the media segments of an extended network.
- does not actually connect two LANs; it connects two segments of the same LAN.



Notes

Repeaters

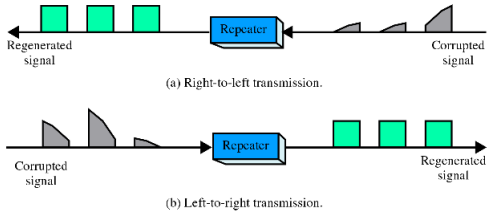
- repeaters regenerate signals corrupted primarily due to distance effects



Notes

Repeaters

- repeaters regenerate signals corrupted primarily due to distance effects



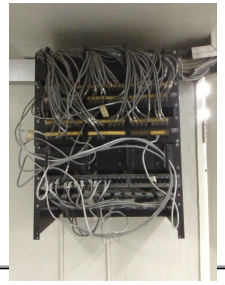
- A repeater forwards every frame; it has no filtering capability.

Notes

Hub

Multiport repeater

- a physical-layer device that connects multiple user stations, each via a dedicated cable

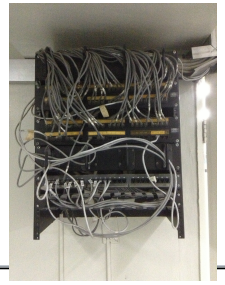


Notes

Hub

Multiport repeater

- a physical-layer device that connects multiple user stations, each via a dedicated cable
- used to create a physical star network while maintaining the logical bus or ring configuration of the LAN



Notes

Bridge

- A physical and data-link layer device that links one LAN segment to others

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Bridge

- A physical and data-link layer device that links one LAN segment to others
- Read all frames transmitted on one LAN and accept those address to any station on the other LAN

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Bridge

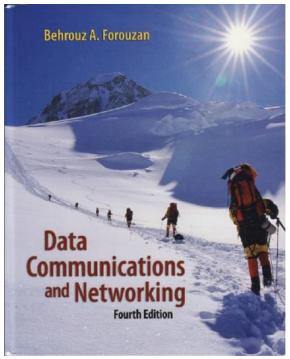
- A physical and data-link layer device that links one LAN segment to others
- Read all frames transmitted on one LAN and accept those address to any station on the other LAN
- Using MAC protocol for second LAN, retransmit each frame

Notes

References

TEXTBOOK:

- Data Communications and Networking, Behrouz Forouzan, 4th Edition, McGraw-Hill, 2007

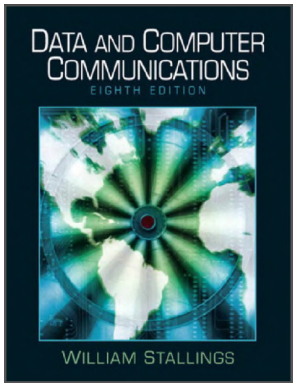


Notes

References

SECONDARY SOURCE:

- Data and Computer Communications, William Stallings, 2007

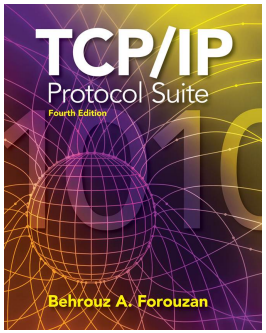


Notes

References

SECONDARY SOURCE:

- TCP/IP Protocol Suite, Behrouz Forouzan, 4th edition, 2010

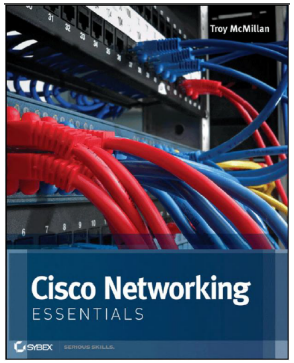


Notes

References

SECONDARY SOURCE:

- CISCO Networking Essentials, Troy McMillan, 2012

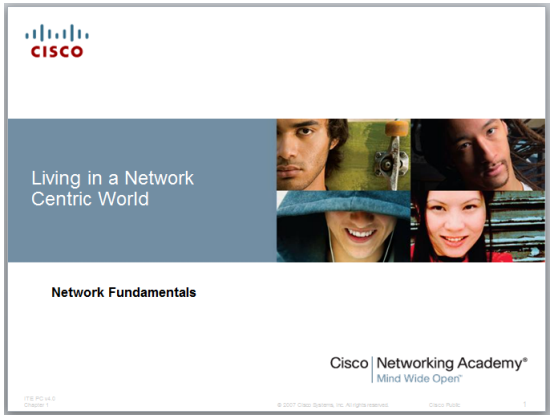


Notes

References

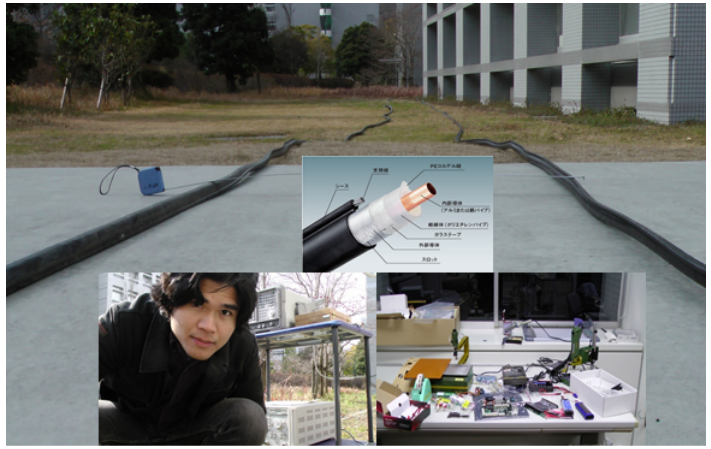
SECONDARY SOURCE:

- Network Fundamentals, Cisco Networking Academy, 2007



Notes

Thank you for your attention!



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