

CCNA: Cisco Certified Network Associate Study Guide

CHAPTER 1: Internetworking

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Network

Hardware	Software
Personal computers - Laptops	Standard Protocols <ul style="list-style-type: none">• OSI ISO Model (7 Layers)• TCP/IP model• Cisco Hierarchical model
Cables (Twisted pairs, Coaxial Cable, Fiber cable, ..)	
Routers, switches, hub, bridge	

Network Types

- Personal Area Network.
- Local Area Network (LAN).
- Metropolitan Area Network (MAN).
- Wider Area Network (WAN).
- Internetwork.



Why Network ?

1. Resource Sharing

- Hardware (ex: printers, pcs, ..)
- Software: Files(Audio videos, Image)

2. Video Conferences.

3. VOIP Applications.

4. E-Commerce

5. E-Learning

6. Online Games

7. Chatting Applications

8. Mailing

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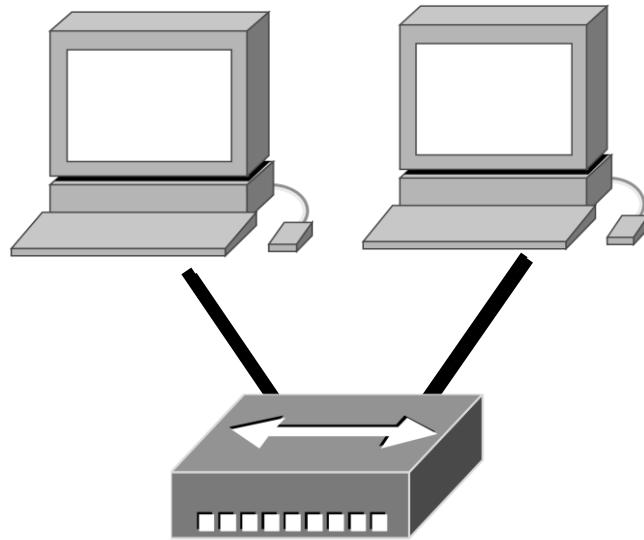
The CCNA exam topics covered in this chapter include the following:

Technology

- Describe network communications using layered models
- Compare and contrast key characteristics of LAN environments
- Describe the components of network devices
- Evaluate rules for packet control



The Basic Network



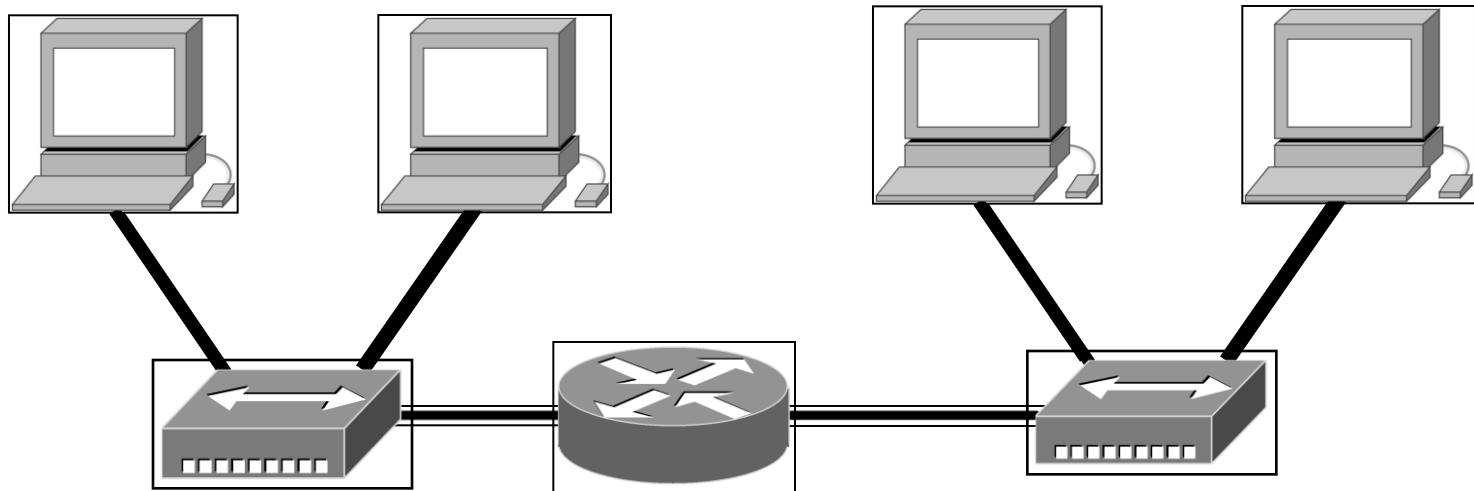
Hub Characteristics:

1. One Board cast domain.
2. One Collision Domain.
3. It does not examine the traffic (Not smart device).
4. Repeat the digital signal
5. It is Physical Layer device.

The basic network allows devices to share information

The term “Computer Language” refers to Binary code (0’s or 1’s)

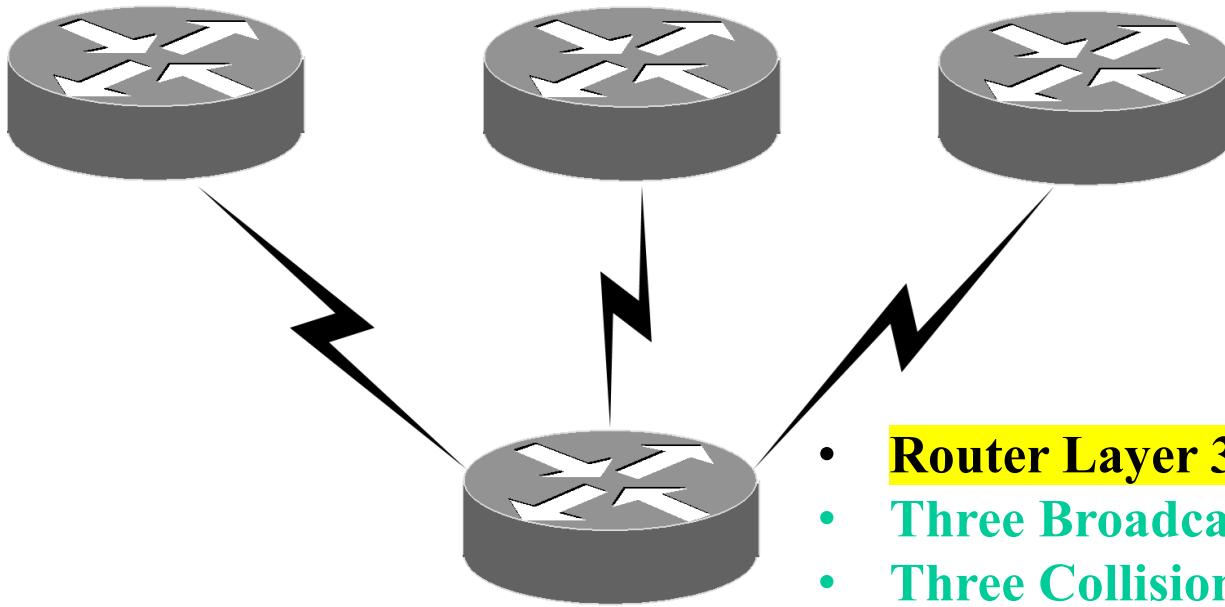
The Basic Internetwork



A router creates an
internetwork

- Two Broadcast domain
- Two Collision domain

Routing Protocols



- Router Layer 3 Device
- Three Broadcast domain
- Three Collision domain

When you have more then one router, a routing protocol is used to share network information between the routers.

Internetworking Basics

Possible causes of LAN traffic congestion:

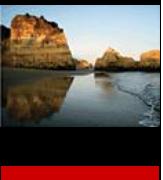
- Too many hosts in the broadcast domain
- Broadcast storms
- Multicasting
- Low Bandwidth



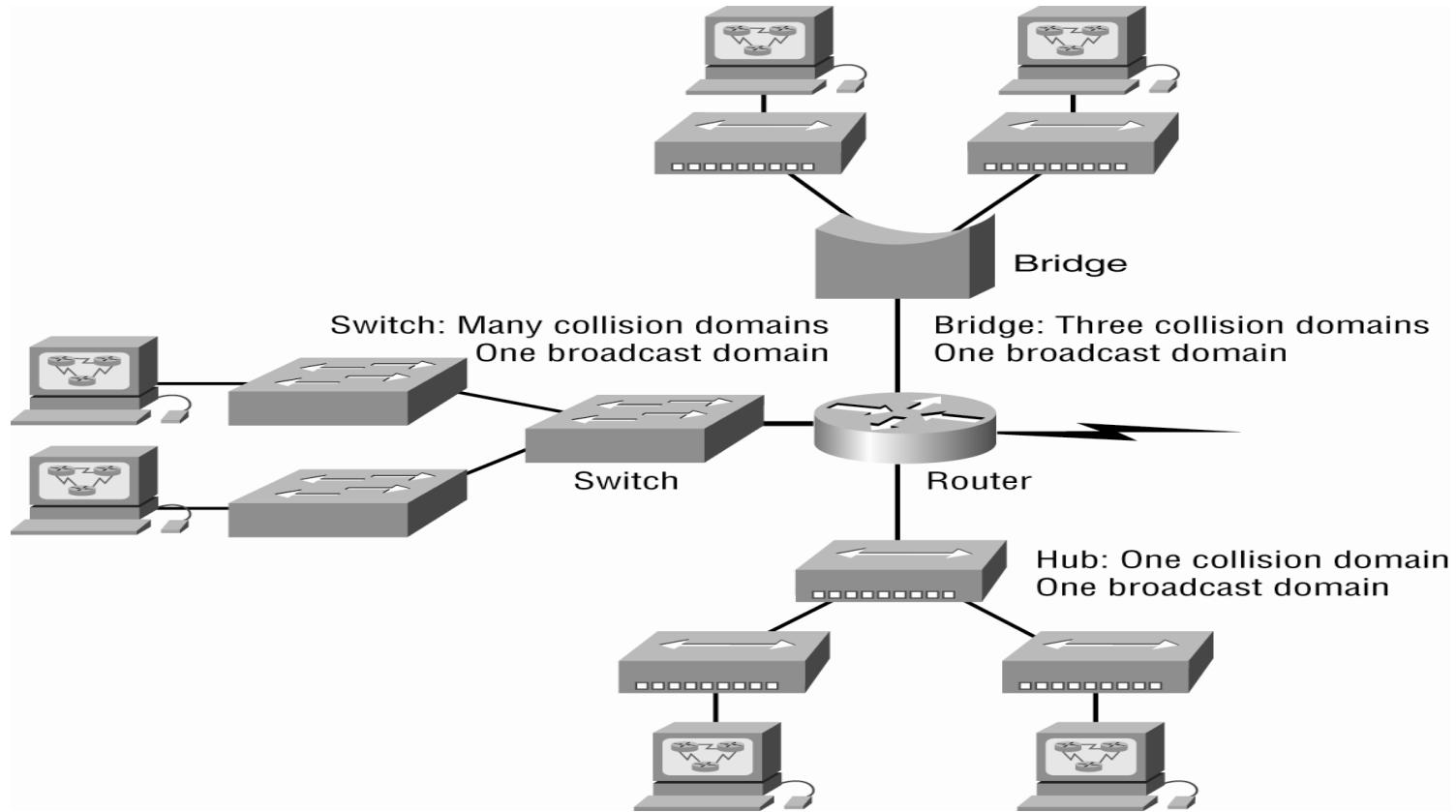
Internetworking Basics

Advantages of using routers in your network:

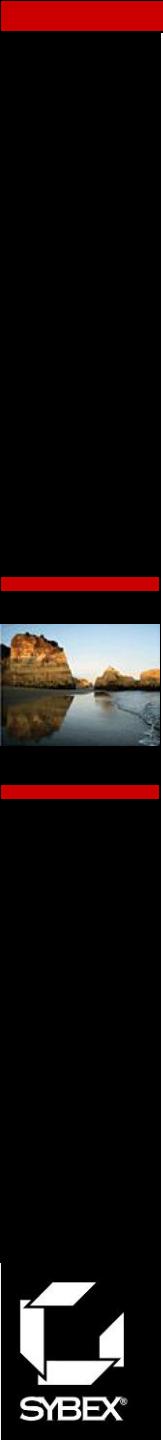
- **Routers** don't forward broadcasts by default.
- **Routers** can filter the network based on layer-3 (Network layer) information (i.e., IP address).



Internetworking Basics



Broadcast domains ??
Collision Domains ??



Internetworking Models

- **The OSI Reference Model**
 - It describes how data and network information are communicated from an application on one computer, through the network media, to an application on another computer
- **The Layered Approach**

Advantages of OSI layered model

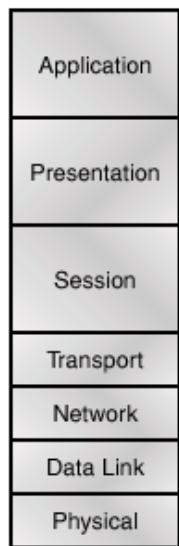
- Allows multiple-vendor development through standardization of network components
- It divides the network communication process into smaller and simpler components, and thus aiding component development, design, and troubleshooting.
- Allows various types of network hardware and software to communicate.
- Prevents changes in one layer from affecting other layers, so it does not hamper development.

The OSI Reference Model

OSI Reference Model's Seven Layers

	Layers	Main Functions	Protocols
7	Application Layer	File, Print, Message, database, and application service	Http, Https, SMTP, FTP, TFTP
6	Presentation Layer	Data encryption, compression, data format, and transport service	
5	Session layer	Dialog Control	
4	Transport Layer	End to End Connection	TCP and UDP
3	Network Layer	Routing	Ip protocol, and Routing Protocols RIP, EIGRP, OSPF
2	Data Link Layer	Framing	
1	Physical Layer	Physical Technology	

The OSI Reference Model

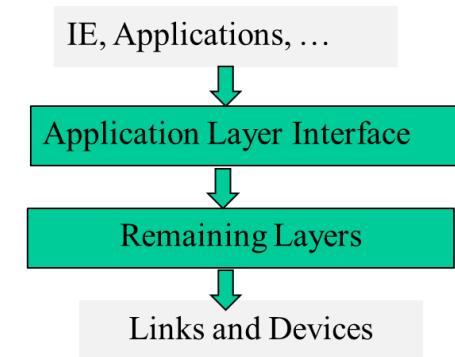


- Provides a user interface
- Presents data
- Handles processing such as encryption
- Keeps different applications' data separate

- **Network devices that operate at all seven layers:**
 - Network Management stations (NMS)
 - Web and Application servers
 - Gateways (not default gateways)
 - Network hosts

Application Layer Functions

- It marks the spot where actually communicate to the computer.
- It is responsible for identifying and establishing the availability of the intended communication partner, and determining whether sufficient resources for the intended communication exist



IE isn't in the application Layer, but it call application layer functions

Internet Applications

- Used among organizations to share information.

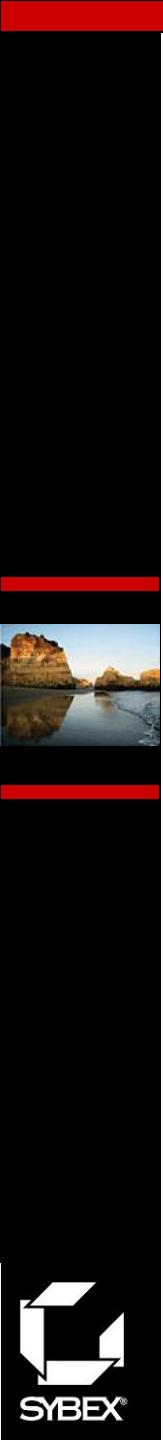
Internet Applications	Function
World Wide Web (WWW)	Connecting large number of servers that have large number of applications
Email Gateways	Transfer emails among email applications
Electronic data interchange	Accounting, shipping/ receiving , and order. Inventory tracking
Internet Navigation Tracking	For navigation, ex: Gopher, WAIS
Financial Transaction Services	Credit data, Market trading, gather and sell information

Presentation Layer Functions

- It presents data to the application layer and is responsible for data translation and code formatting.
- The presentation layer ensures that the data transferred from the application layer of one system can be read by the application layer of another one.
- Tasks like data compression, decompression, and decryption with this layer and multi-media operation too.

Presentation Layer Data Format

Data	Format	Extension
Text	Rich text format	RTF
Music	Music Instrumentation Digital Interface	MIDI
Video	Moving Picture Expert group	MPEG
Image	Joint photographic Expert group	JPEG
	Tagged Image File Format	TIFF
	Picture Format	PICT



Session Layer

- It is responsible for setting up, managing and then tearing down session between presentation entities.
- This layer also provides dialogue control system between devices or nodes.

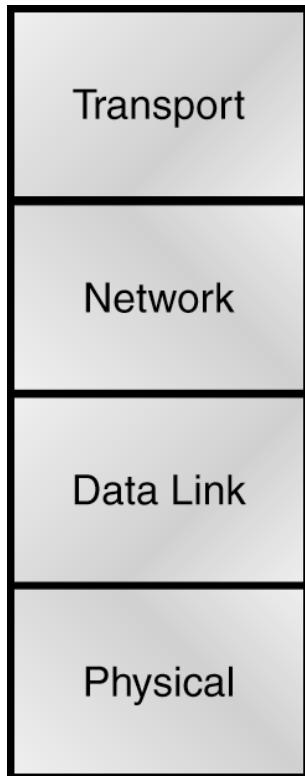
Session Layer Protocols

Protocol Name	Function
Network File System (NFS)	<ul style="list-style-type: none">• Developed by SUN• To access remote resources.• Transparent Access (without complexity)• Used by TCP/IP and Unix stations
Structured Query Language (SQL)	Developed by IBM Access Databases locally or remotely
Remote Procedure Call (RPC)	Client / Server Redirection Tool Implementation on client machine Execution on the server side
X Window	Connecting Smart devices such as remote Unix machines
Apple talk session Protocol (ASP)	Connecting apple talk clients to servers
Digital Network Architecture Session Control Protocol (DNASCSP)	



The OSI Reference Model

The Lower Layers



- Provides reliable or unreliable delivery
- Performs error correction before retransmit
- Provides logical addressing, which routers use for path determination
- Combines packets into bytes and bytes into frames
- Provides access to media using MAC address
- Performs error detection not correction
- Moves bits between devices
- Specifies voltage, wire speed, and pin-out cables

Transport Layer

- It segments and reassembles data into data streams
- They provide end-to-end transport service and can establish a logical connection between the sending host and the destination host.
- It sequences each segment.
- Uses acknowledgement and flow control.



Protocols of Transport layer

Protocol Name	Functions
Transmission Control Protocol (TCP)	<ul style="list-style-type: none">• Reliable Service• Connection Oriented<ul style="list-style-type: none">1. Circuit Switching2. Flow control management of transmitted data.<ul style="list-style-type: none">➢ It prevents a sending host on one side of the connection from overflowing the buffers in the receiving host.➢ Types of Flow Control:<ul style="list-style-type: none">➢ Buffering:➢ Windowing, and➢ Congestion Avoidance.3. Sequencing of each segment to ensure its arrival with a proper order4. Acknowledgment of transmitted data.
User Datagram Protocol (UDP)	<ul style="list-style-type: none">• Unreliable Service• Connectionless<ul style="list-style-type: none">• Packet Switching , No Flow control, No Sequencing , and No Acknowledgment



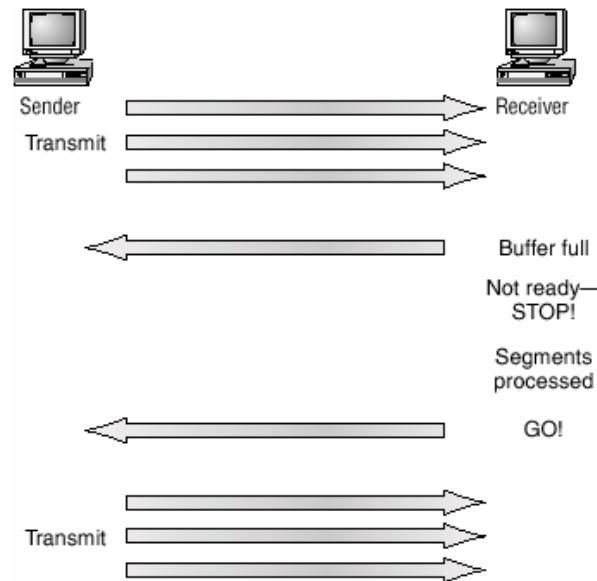
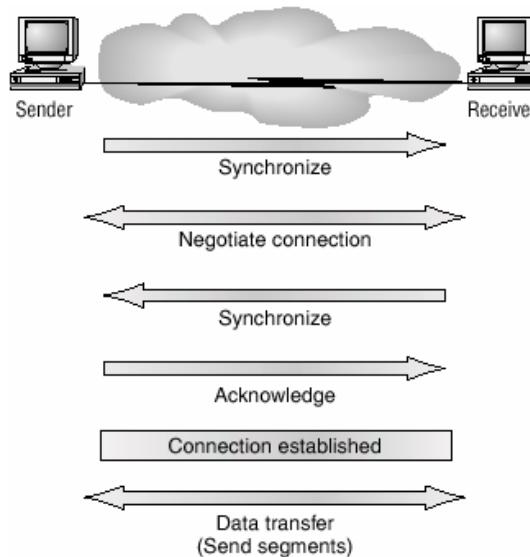
Types of flow control

Flow Control Type	Function	
Buffering	<p>The destination has a buffer of limited size,</p> <p>If the buffer is full it send stop signal to the source,</p> <p>Go signal to ask the source for sending data again</p> <p>Not Ready Signal: Buffer Full Go: Ready to receive ; buffer free</p>	
Windowing	<ul style="list-style-type: none"> • Window size =10 • It means that the sender transmits 10 frames without receiving acknowledge. • Acknowledge after sending 10 frames. 	

The OSI Reference Model

The Transport Layer

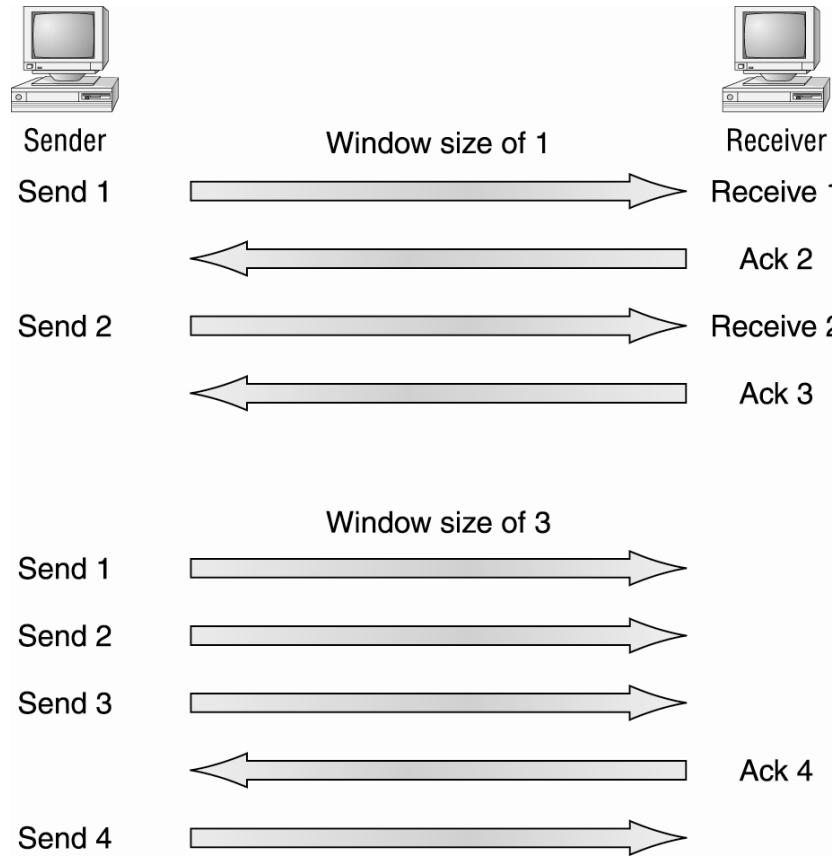
- Flow Control
- Connection-Oriented Communication
- Acknowledgements



Three-way Handshake

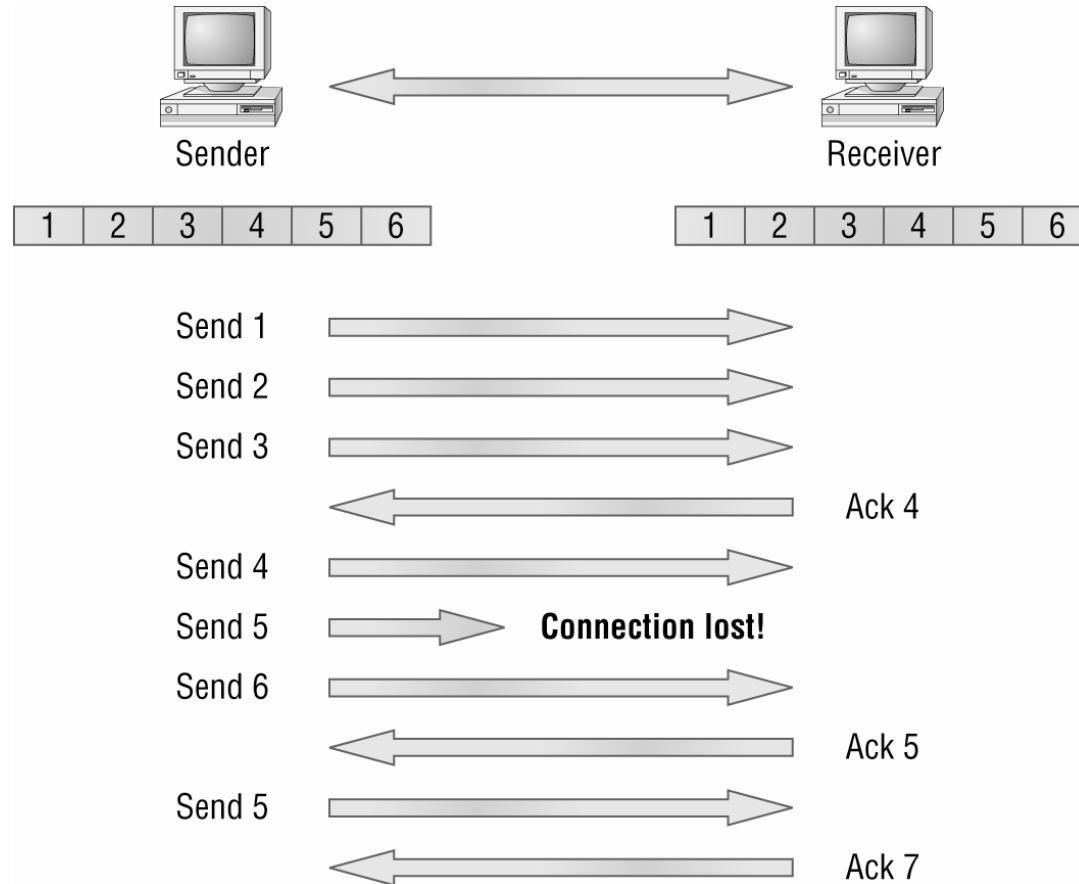


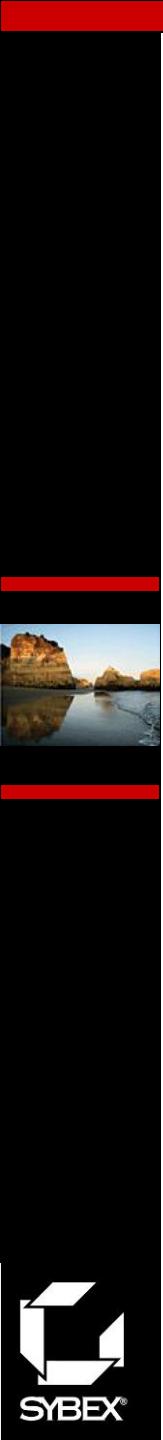
The OSI Reference Model



The OSI Reference Model

The Transport Layer (Windowing)





Network Layer

- It manages devices addressing
- It tracks the location of devices on the network and determine the best way to move data.
- Routers provide the routing services within an internetwork.

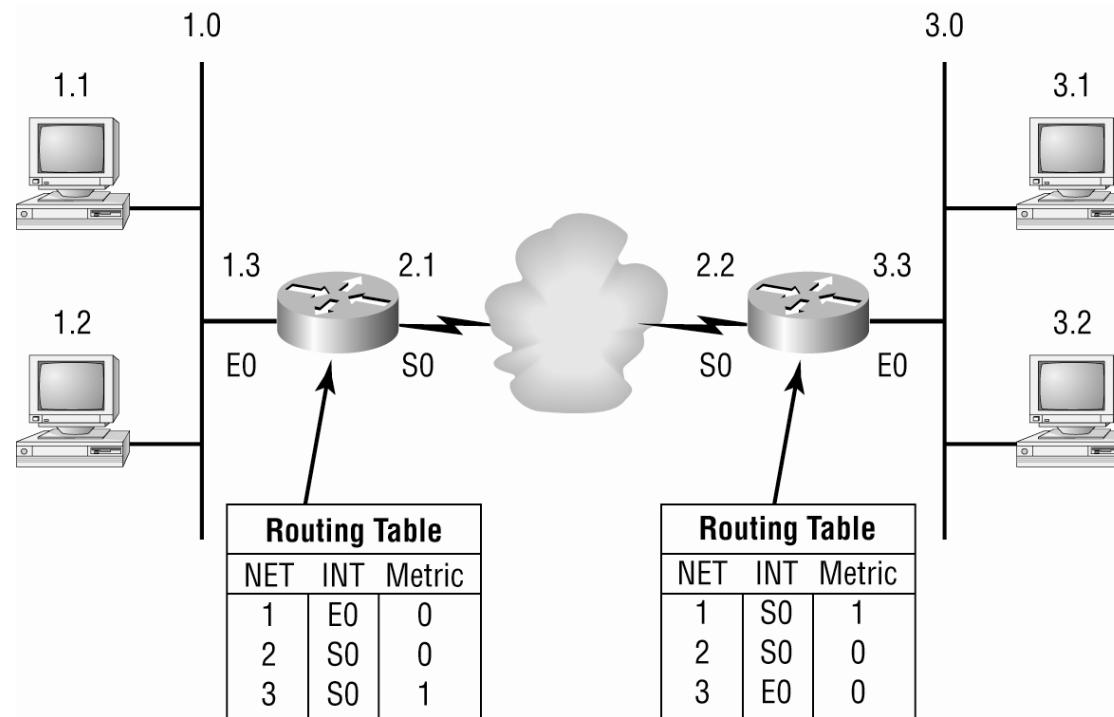
Types of packets at Network Layer

Data Packets	Route Update Packets
<ul style="list-style-type: none">It used to transport user data through the internetwork. <p>Routed Protocols:</p> <ul style="list-style-type: none">Protocols used to support data trafficExample: IP protocols and IPX	<ul style="list-style-type: none">It is used to update neighboring routers about the networks connected to all routers within the internetwork. <p>Routing Protocols</p> <ul style="list-style-type: none">Protocols that send route update packetsExamples: RIP, EIGR, OSPFRouting Table information<ol style="list-style-type: none">Network AddressThe Exit interfaceMetricsThe distance to the remote network<ul style="list-style-type: none">Hop CountBandwidthDelay of LinesTick Count



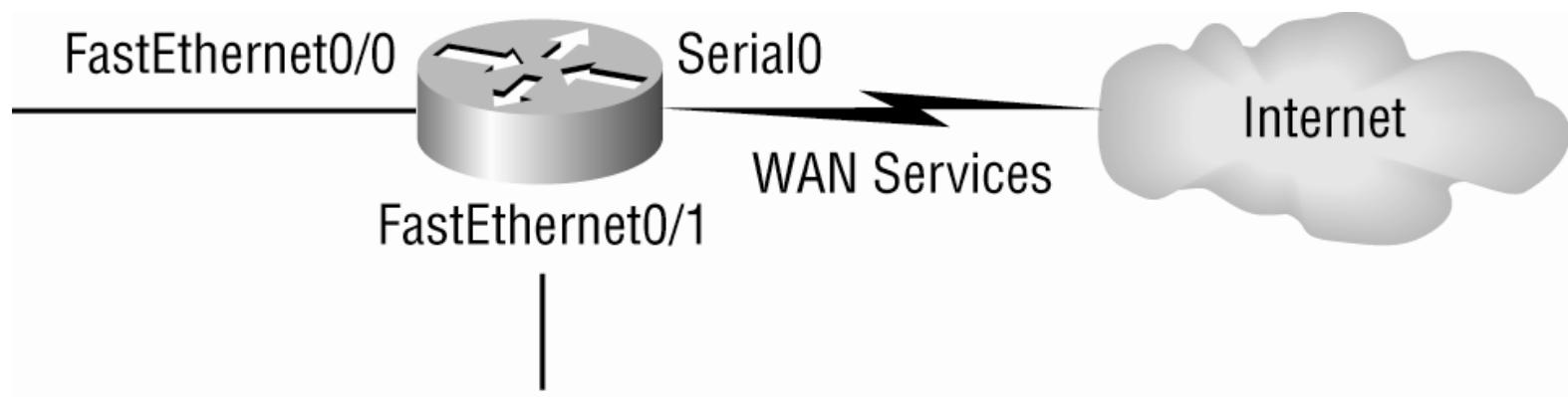
The OSI Reference Model

The Network Layer



The OSI Reference Model

The Network Layer



- Each router interface is broadcast domain.
- Routers break up broadcast domains by default and provide WAN services

The Data Link Layer

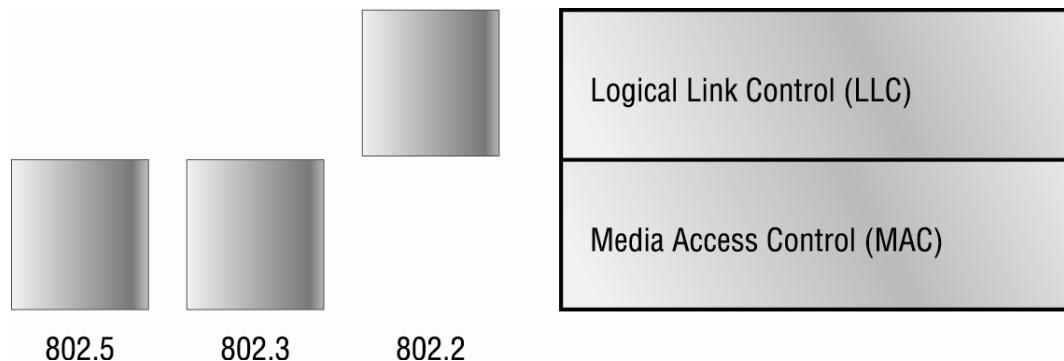
- It provides the physical transmission of the data and handles error notification, network topology, and flow control
- The data link layer will ensure that messages are delivered to the proper device on a LAN using hardware address (MAC Address).
- It translates messages from the network layer into bits for the physical layer to transmit.
- Framing & Flow Control
- Error Control (Error Detection and Error Detection and Correction)



The OSI Reference Model

The IEEE Data Link Layer has two sublayers:

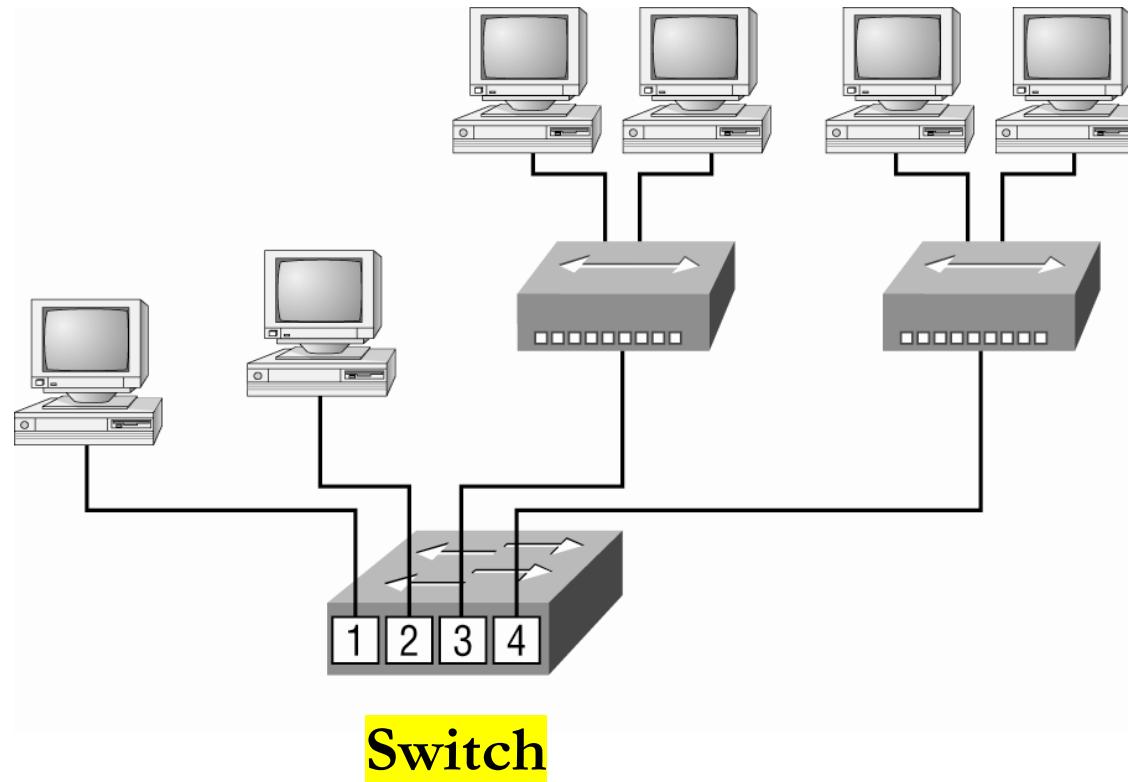
- Media Access Control (MAC) 802.3
- Logical Link Control (LLC) 802.2



IEEE Ethernet Data Link Layer

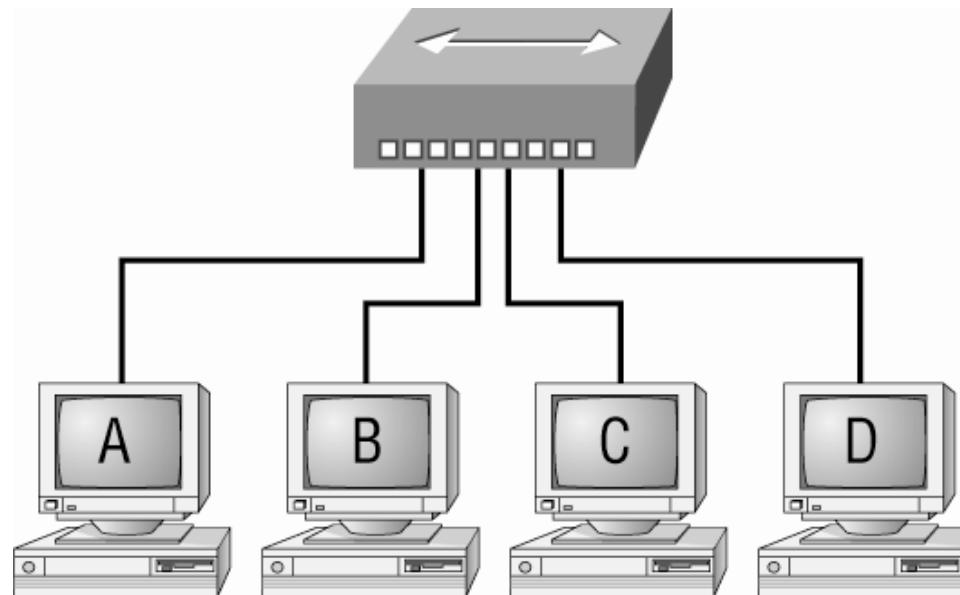
•Media Access Control (MAC) 802.3	Logical Link Control (LLC) 802.2
<ul style="list-style-type: none">• Defines how packets are placed on the media.• Contention Control (FCFS, ALOHA)• Use Physical Address (MAC)• Error Notification• Order Delivery of Frames	<ul style="list-style-type: none">• It tells the Data Link Layer what to do with the Packet once the frame is received.• It provides flow control and sequencing of control bits

Switching (LAN Segmentation)



- Layer 2 Device
- Each segment has its own collision domain.
- All segments are in the same broadcast domain.

Hubs



Hub Characteristic

- All devices in the same collision domain
- All devices in the same broadcast domain
- Devices share the same bandwidth
- Layer 1 Device

The OSI Reference Model

The Physical Layer

- Sends and receives bits; 1's & 0's.
- It uses bit timing rules (clocking schemes) to encode data into a digital signals.
- It communicates with various types of actual media
- Specify electrical, mechanical, procedural, and functional requirements
- DTE/DCE interfaces identified
- Hubs (Multi-port repeaters)



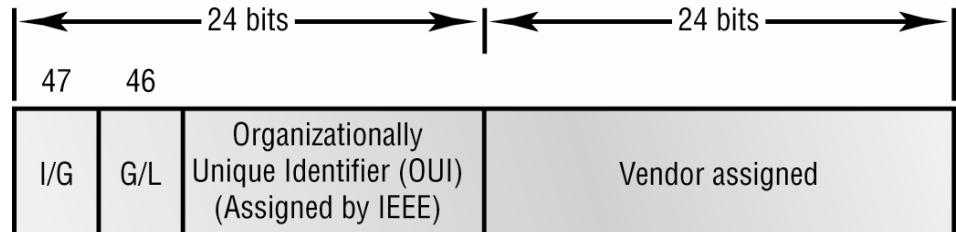
Ethernet Networking

- A connection media access method that allows all hosts on a network to share the same bandwidth
 - (Uses Data Link & Physical Layer specifications)
- CSMA/CD
- Half Duplex
- Full Duplex

Ethernet Networking

Ethernet at the Data Link Layer

- Ethernet addressing = Hardware or MAC
- Framing
 - Types of Ethernet frames:
 - Ethernet II
 - IEEE 802.3
 - IEEE 802.2
 - SNAP



Ethernet Frames

Ethernet_II

Preamble 8 bytes	DA 6 bytes	SA 6 bytes	Type 2 bytes	Data	FCS 4 bytes
---------------------	---------------	---------------	-----------------	------	----------------

802.3_Ethernet

Preamble 8 bytes	DA 6 bytes	SA 6 bytes	Length 2 bytes	Data	FCS
---------------------	---------------	---------------	-------------------	------	-----

Ethernet Networking

Ethernet Frames

802.2 (SNAP)

1	1	1 or 2	3	2	Variable
Dest SAP AA	Source SAP AA	Ctrl 03	OUI ID	Type	Data

802.2 (SAP)

1	1	1 or 2	Variable
Dest SAP	Source SAP	Ctrl	Data

Ethernet Networking

Ethernet at the Physical Layer

The Expanded IEEE Ethernet 802.3 Standards

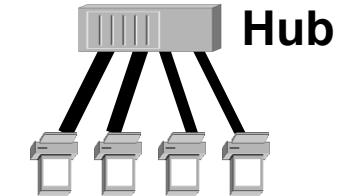
- 100BaseTX
- 100BaseFX
- 1000BaseCX
- 1000BaseT
- 1000BaseSX
- 1000BaseLX

Data Link (MAC layer)		Ethernet	802.3						
Physical			10Base2	10Base5	10BaseT	10BaseF	100BaseTX	100BaseFX	100BaseT4

Duplex Overview

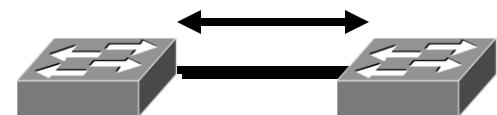
802.3 Half duplex (CSMA/CD)

- Unidirectional data flow
- Higher potential for collision
- Hubs connectivity
- One wire pair
- Shared collision domain
- Lower Effective Throughput



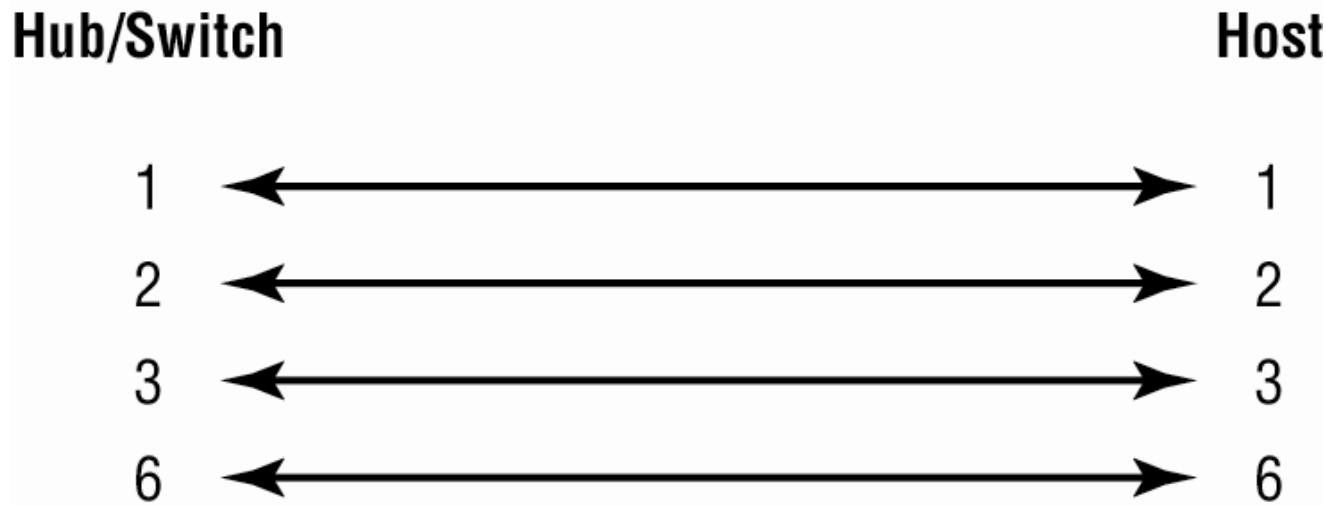
Full duplex

- Point-to-point only
- Attached to dedicated switched port
- Requires full-duplex support on both ends
- Collision free
- Collision detect circuit disabled
- Two wire pair



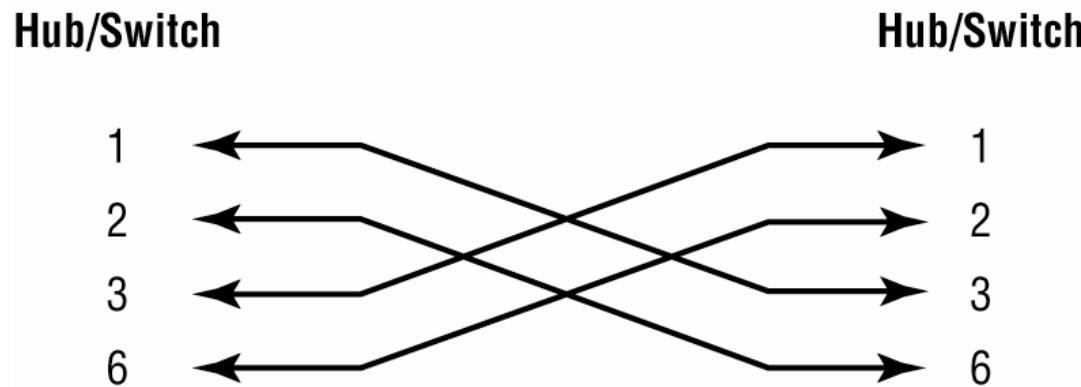
Ethernet Cabling

Straight-Through Cable



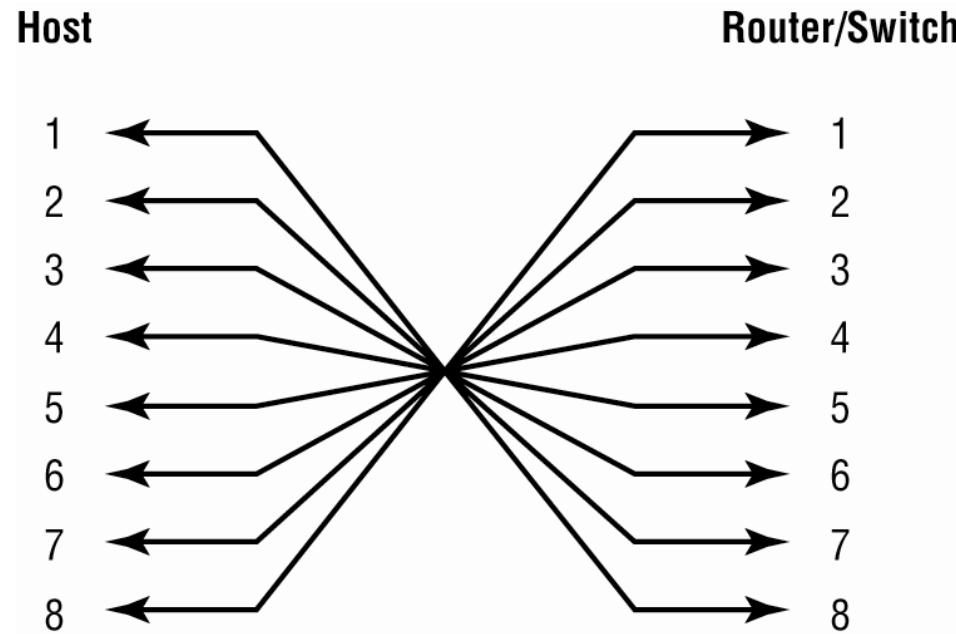
Ethernet Cabling

Crossover Cable

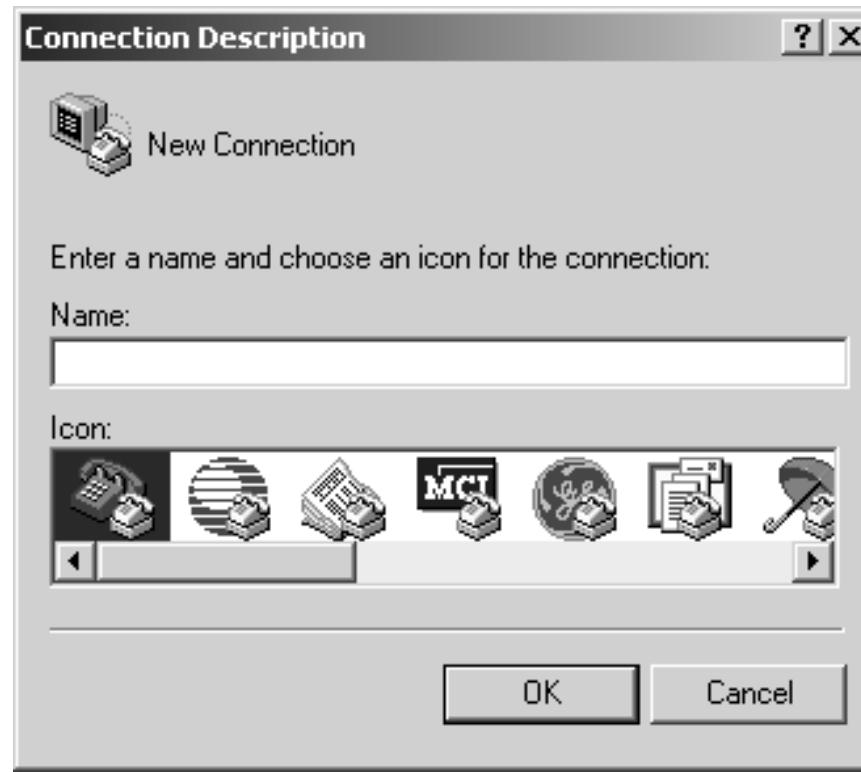


Ethernet Cabling

Rolled Cable



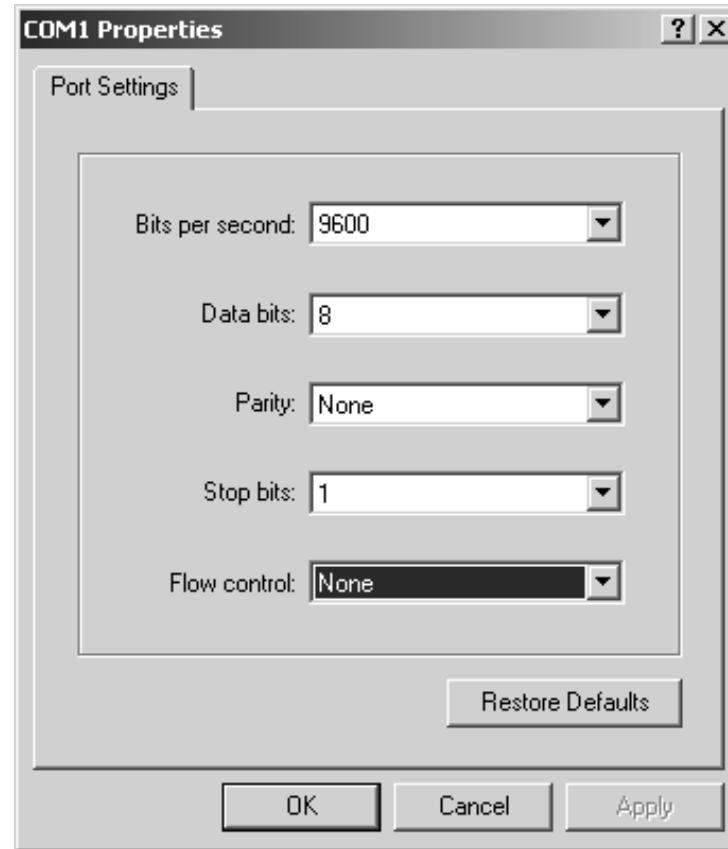
HyperTerminal



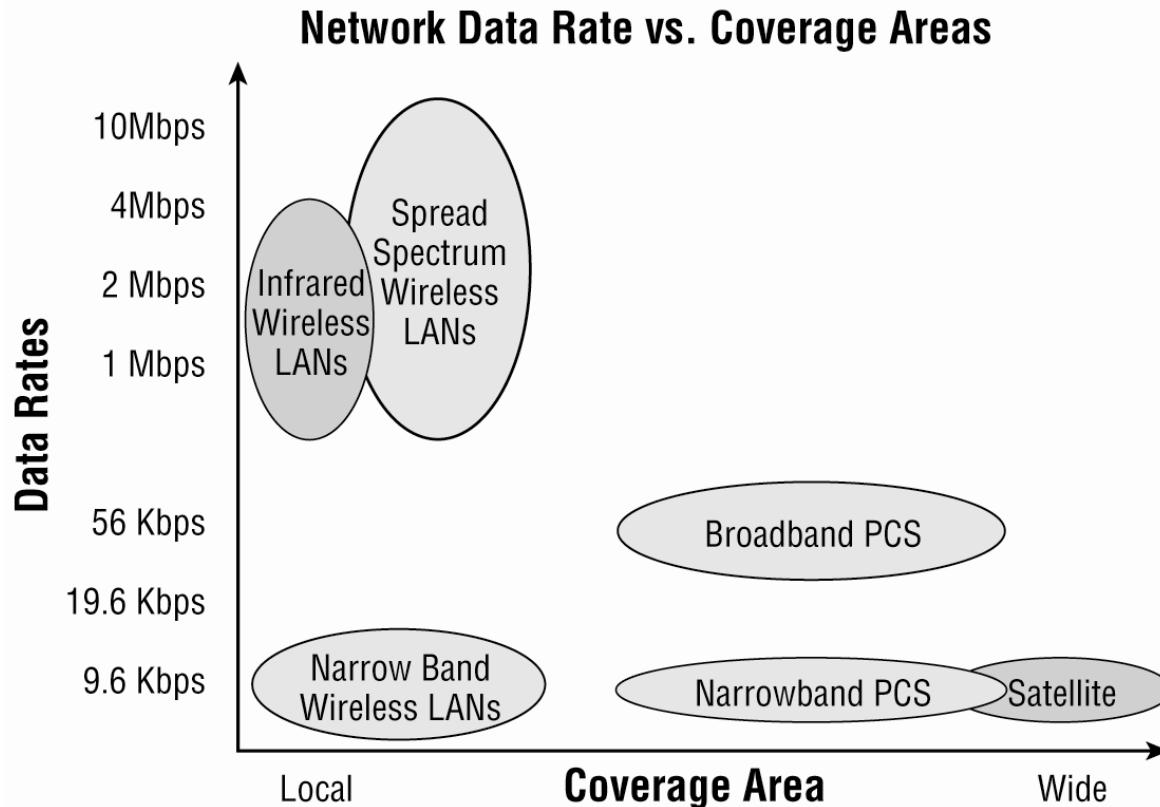
HyperTerminal



Console HyperTerminal Settings



Wireless Networking

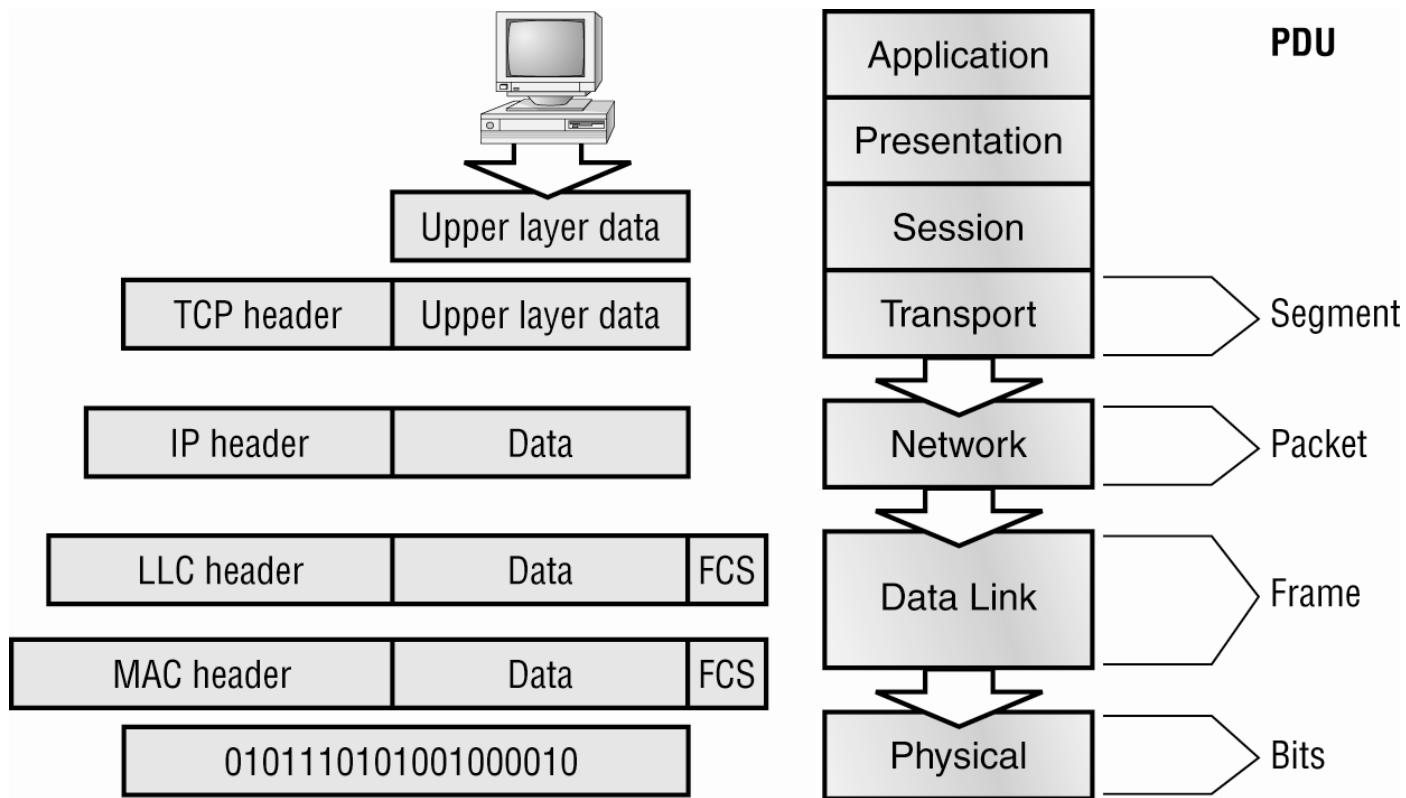


Wireless Networking

Wireless Network Types

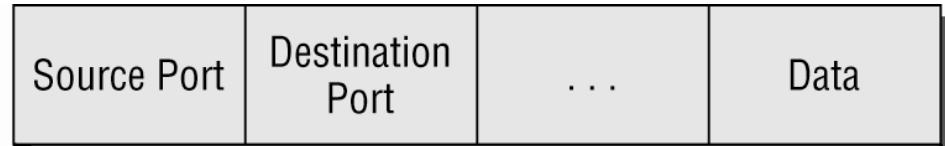
- Narrowband Wireless LANs
- Personal Communication Services (PCS)
- Narrowband PCS
- Broadband PCS
- Satellite
- Infrared Wireless LANs
- Spread Spectrum Wireless LANs

Data Encapsulation



Data Encapsulation

Segment



Packet



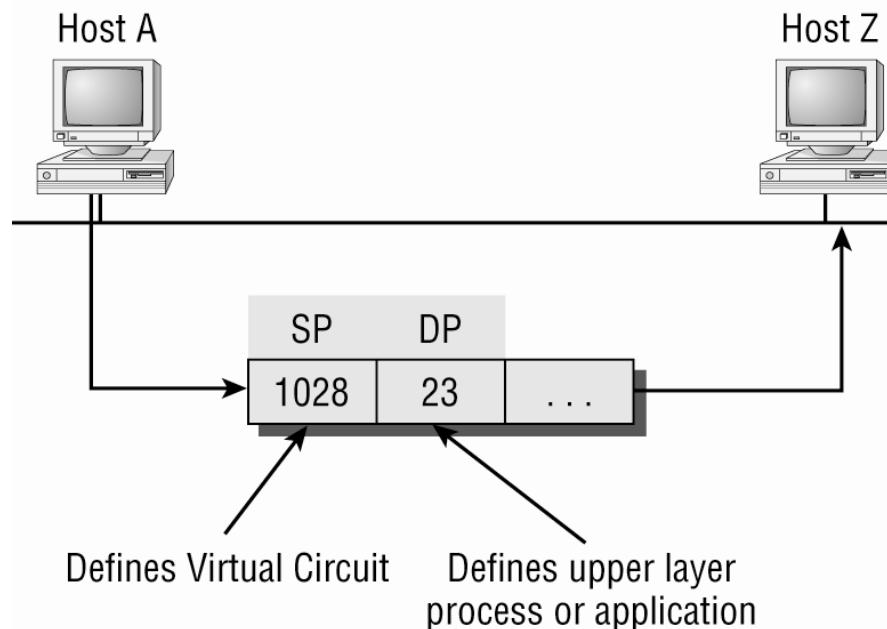
Frame

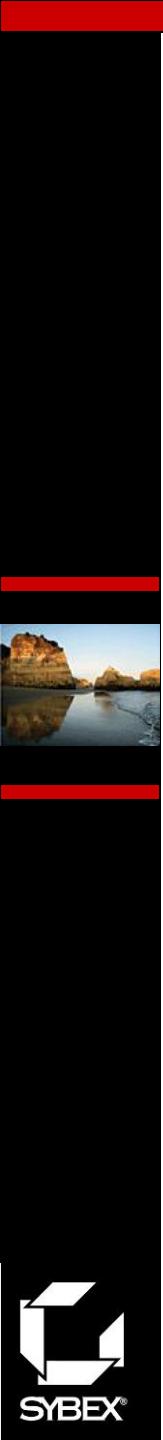


Bit

1011011100011110000

Port Numbers at the Transport Layer





Network Devices

- Routers
- Switches
- Hub (deprecated)
- Smart Hub Like Switch
- Bridges

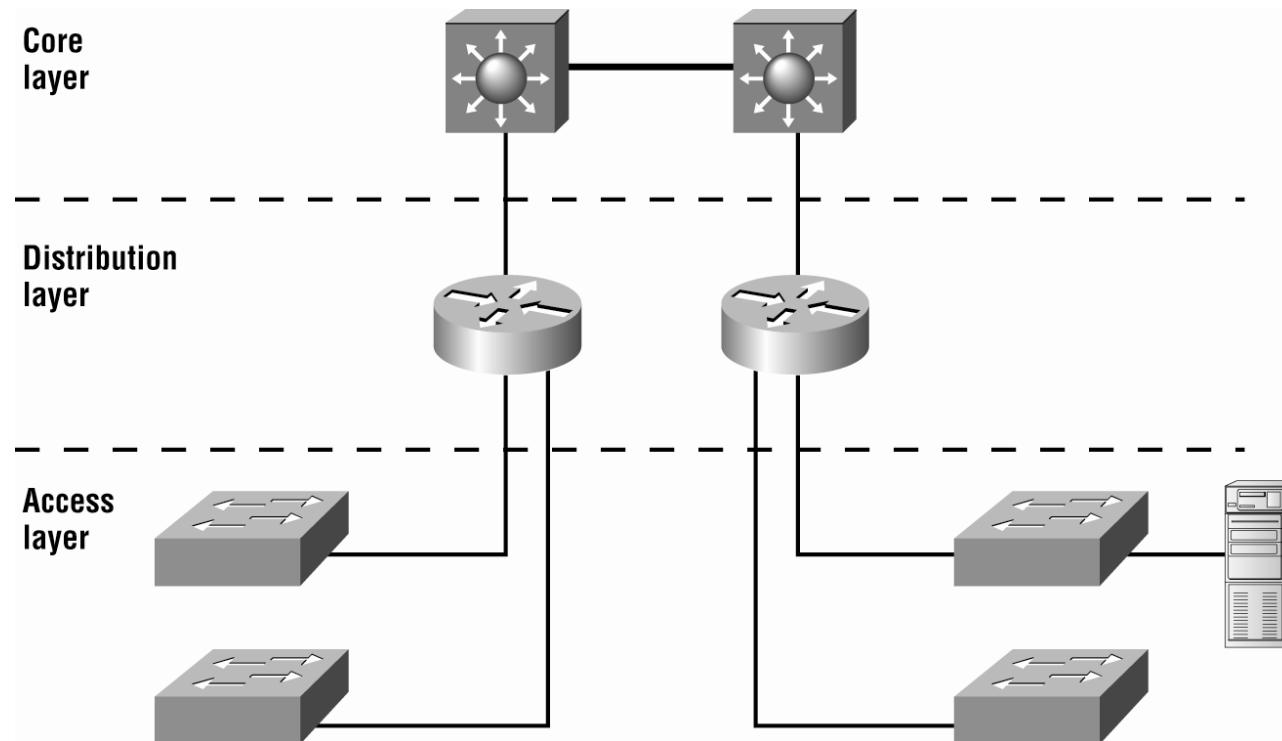
Reasons of LAN Congestion

- Two many host in a broadcast domain
- Broadcast storms
- Multicasting
- Low bandwidth
- Adding Hups for connecting networks
- A large amount of ARP or IPX for traffic.

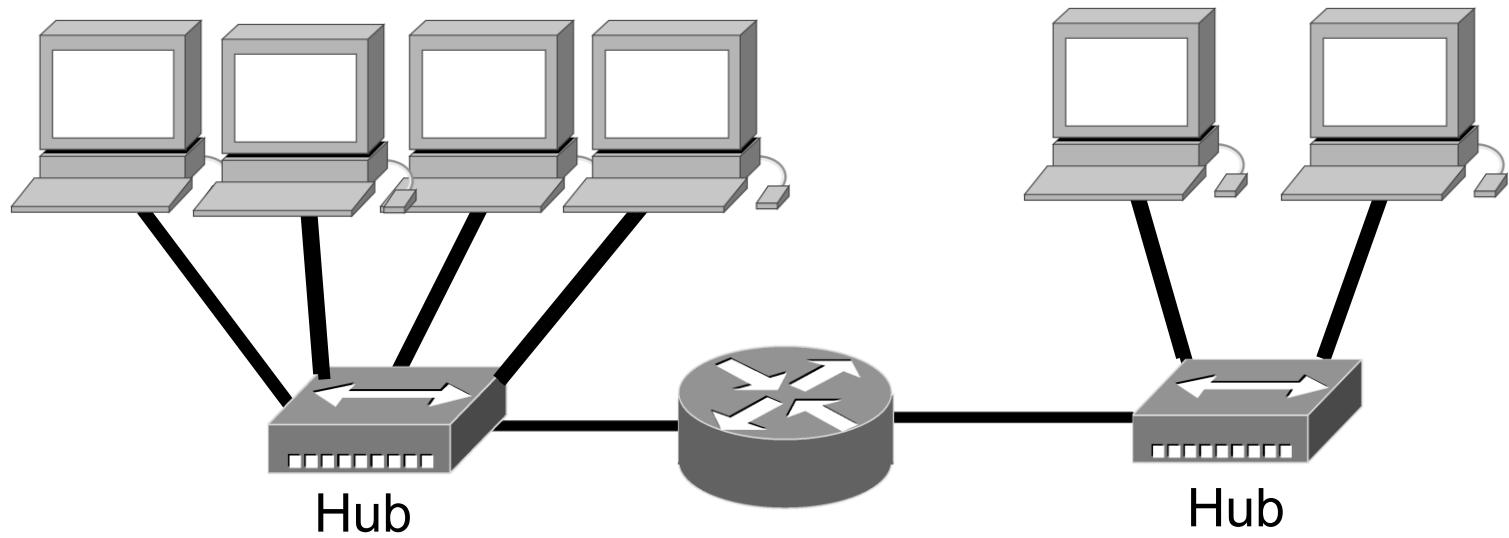


Device	Function
Router (Layer 3) 	<ul style="list-style-type: none"> Routers by default will not forward broadcast or multi-cast. Routers uses a logical address (IP) to determine the next hop router to forward the packet to. Routers can access lists created by administrator to enter control security on the types of packets that are allowed to enter or exit the interface. Routers uses Routing Tables to make path selection to forward packets, Routers connects VLAN , LANs, MANs and WANs Router Functions: Packet Switching, Packet Filtering, Internetwork Communication, Path Selection Routers break up broad cast domains and collision domains. (N)
Switch (Layer 2) 	<ul style="list-style-type: none"> Switches routes frames from port to another. It breaks up collision domains one for each switch port. (N collision Domains) It only has one broad cast domain, They deal only with LANs & Has a filtering Table.
Hup (Layer 1)	<ul style="list-style-type: none"> One Collision Domain. One Broad Cast Domain. Used in LAN. & It is used for Individual devices Does not examine Traffic.
Bridge	<ul style="list-style-type: none"> Do the same as Switches Increases the number of collision Domains in the network. It provides more bandwidth for the users. It has two or four ports. One Broad cast Domain

The Cisco Three-Layer Hierarchical Model

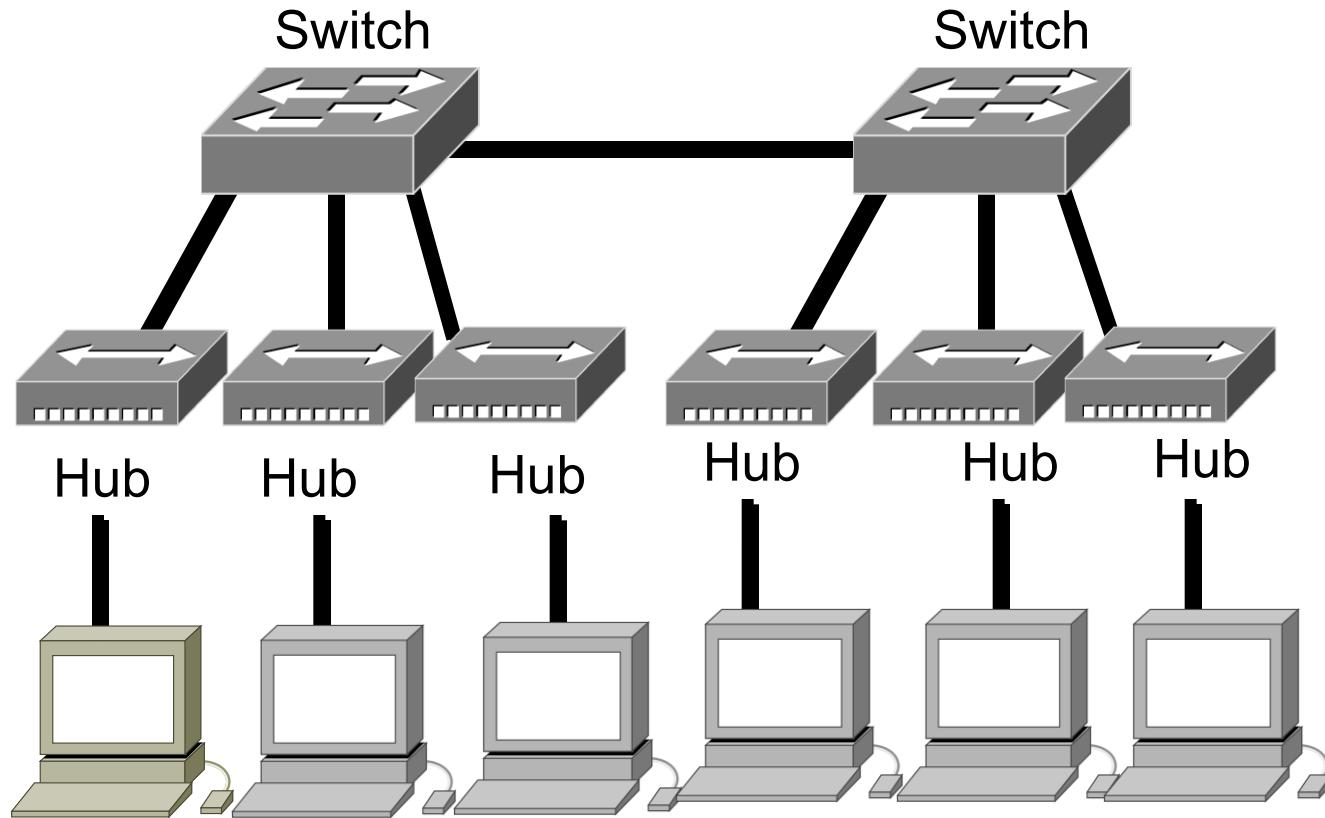


How many collision domains are shown?



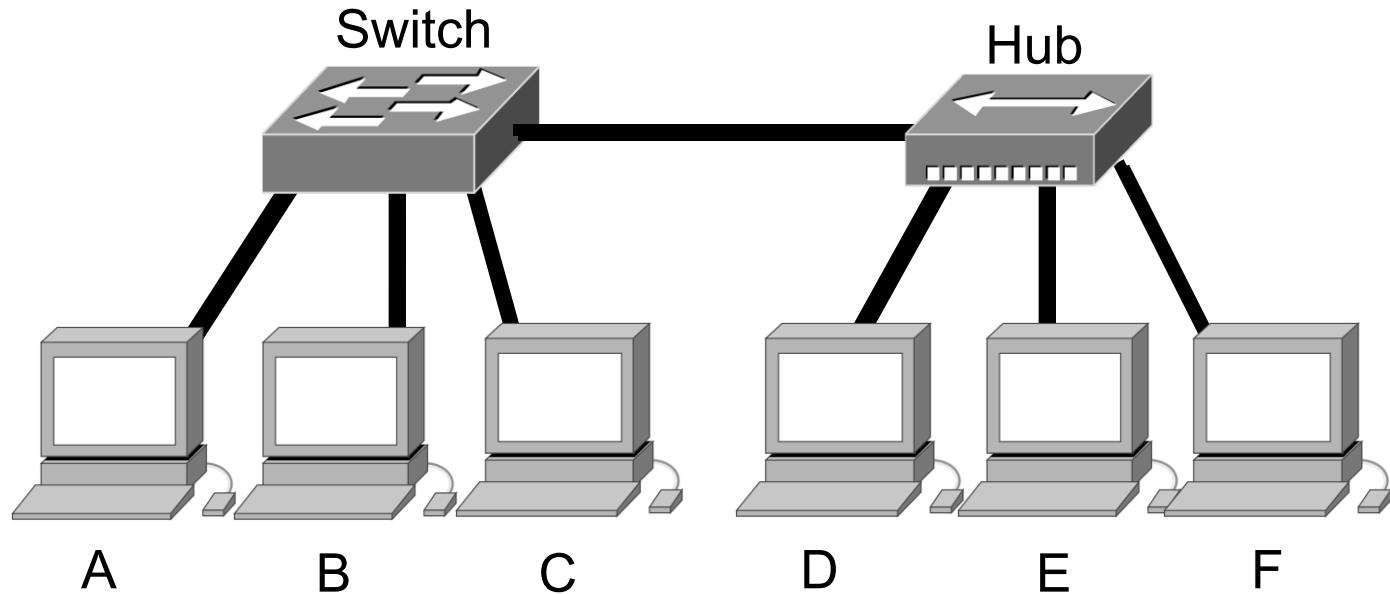
How many broadcast domains are shown?

How many broadcast domains are shown?



How many collision domains are shown?

Which of the hosts can transmit simultaneously without causing collisions?



How many collision and broadcast domains are shown?