CCNA 1 v3.1 Module 2 Networking Fundamentals

Objectives

Upon completion of this module, the student will be able to perform tasks related to the following:	
2.1	Networking Terminology
2.2	Bandwidth
2.3	Networking Models

Data Networks

Distance Between CPUs	Location of CPUs	Name
0.1 m	Printed circuit board Personal data asst.	Motherboard Personal area network (PAN)
1.0 m	Millimeter Mainframe	Computer systems network
10 m	Room	Local area network (LAN) Your classroom
100 m	Building	Local area network (LAN) Your school
1000 m = 1 km	Campus	Local area network (LAN) Stanford University
100,000 m = 100 km	Country	Wide area network (WAN) Cisco Systems, Inc.
1,000,000 m = 1,000 km	Continent	Wide area network (WAN) Africa
10,000,000 m = 10,000 km	Planet	Wide area network (WAN) The Internet
100,000,000 m = 100,000 km	Earth-moon system	Wide area network (WAN) Earth and artificial satellites

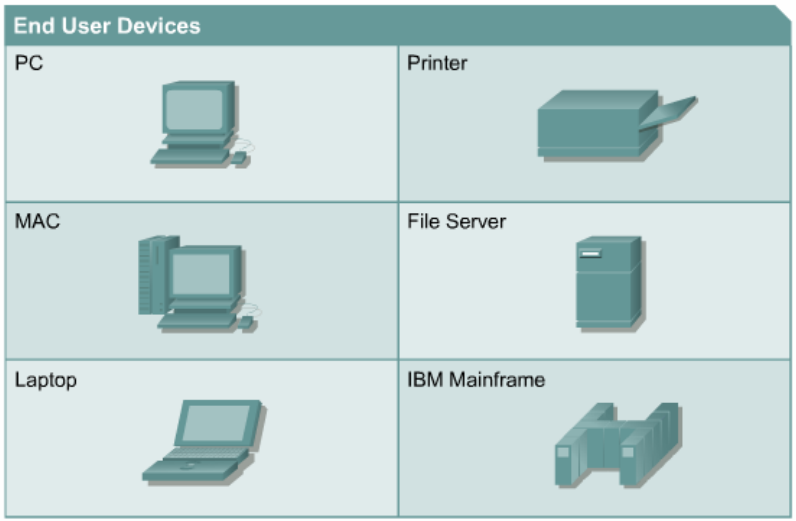
Network History

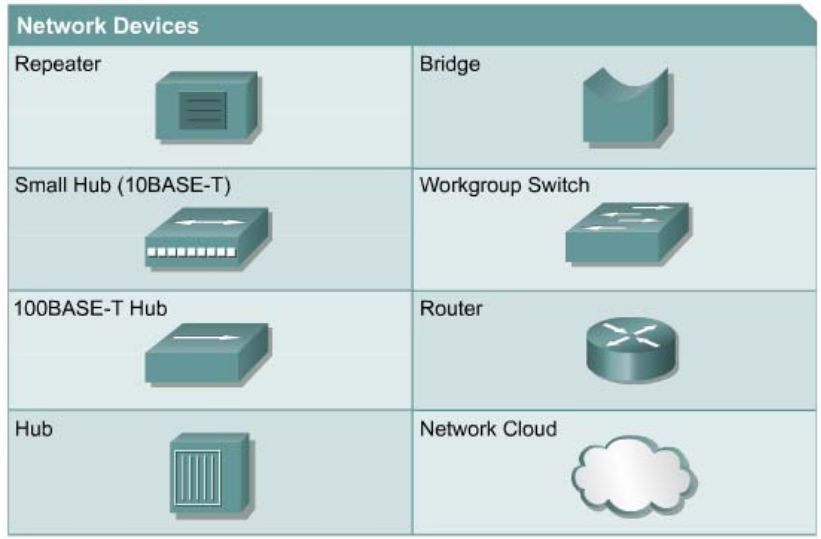
Internet Timeline	
1957	ARPA is created by DoD.
1960s	Mainframe Computing
1962	Paul Baran at RAND works on "packet switching" networks
1967	Larry Roberts publishes first paper on ARPANET
1969	ARPANET established at UCLA, UCSB, U-Utah, and Stanford
1970s	Widespread use of digital integrated circuits; advent of digital personal computers
1970	ALOHANET is developed by University of Hawaii.
1972	Ray Tomlinson creates email program to send messages
1973	Bob Kahn and Vint Cerf begin work on what later becomes TCP/IP.The ARPANET goes international with connections to University College in London, England and the Royal Radar Establishment in Norway.
1974	BBN opens Telnet, the first commercial version of the ARPANET.
1980s	Widespread use of personal computers and Unix-based mini-computers
1981	The term Internet is assigned to a connected set of networks
1982	The term "Internet" is used for the first time.
1982	ISO releases OSI Model and protocols; the protocols die but the model is very influential

Network History continued

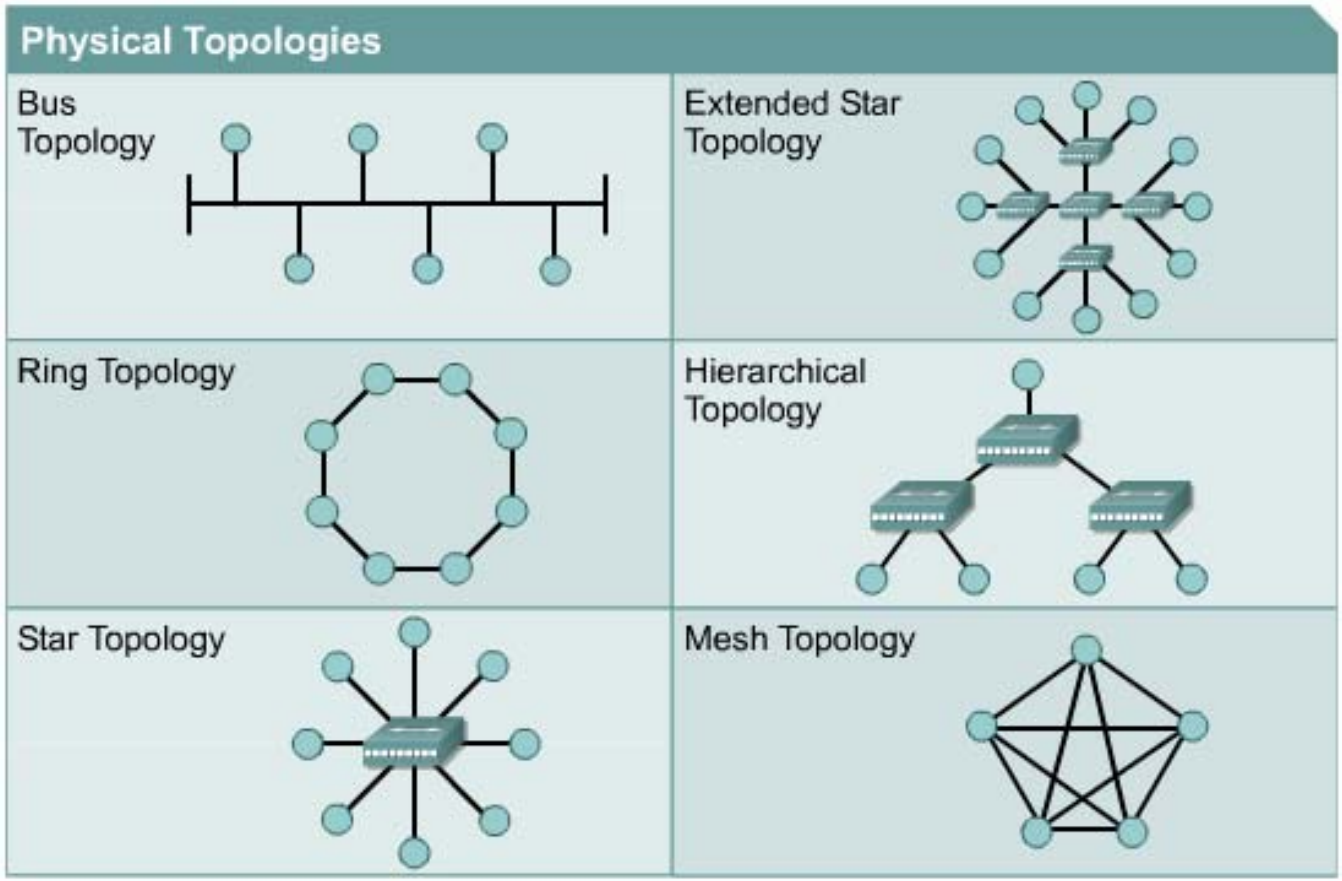
1987	The number of Internet hosts exceeds 10,000.
1988	Computer Emergency Response Team (CERT) is formed by DARPA.
1989	The number of Internet hosts exceeds 100,000.
1990	ARPANET becomes the Internet.
1991	The World Wide Web (WWW) is born. Tim Berners-Lee develops code for WWW.
1992	Internet Society (ISOC) is chartered. Number of Internet hosts breaks 1,000,000.
1993	Mosaic, the first graphics-based Web browser, becomes available.
1994	Netscape Navigator introduced
1996	The number of Internet hosts exceeds 10 million. The Internet covers the globe.
1997	The American Registry for Internet Numbers (ARIN) is established. Internet 2 comes online.
Late 1990's til present	Internet users doubling every 6 months (exponential growth)
1998	Cisco hits 70% of sales via internet, Networking Academies launched
1999	Internet 2 backbone network deploys IPv6. Major corporations race toward the video, voice and data convergence
2001	The number of Internet host exceeds 110 million.

Networking Devices

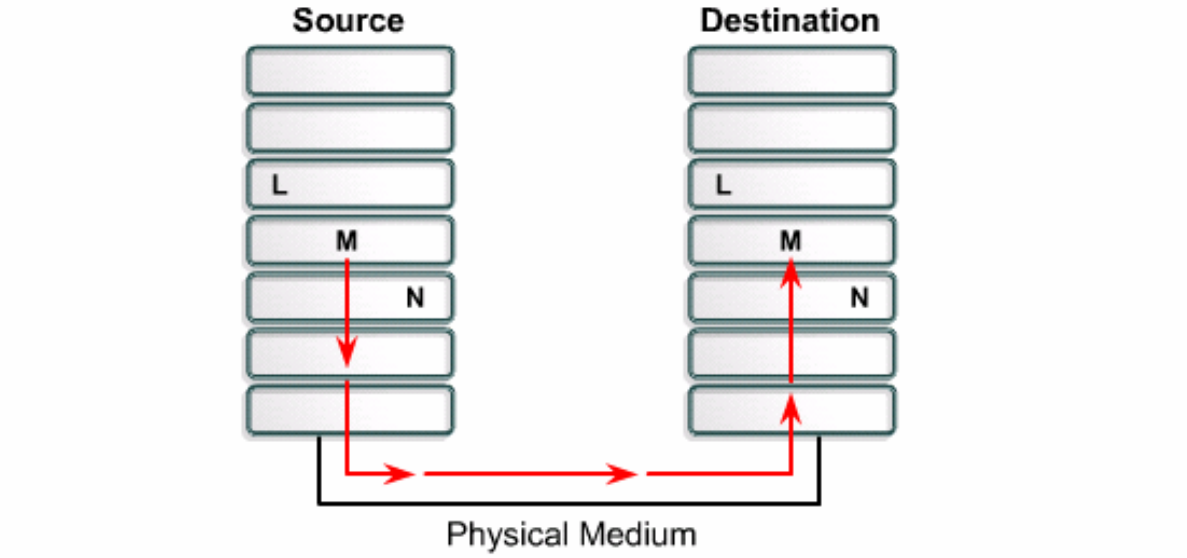




Network Topology



Network Protocols



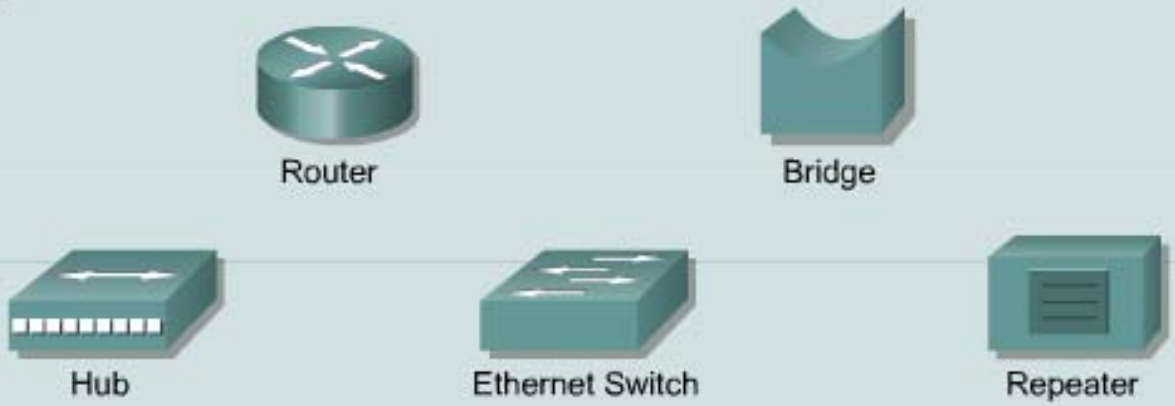
L, M, N	Layers in our model of computer communications
Msource, Mdestination	Peer layers
→	Peer to peer communications
M layer Protocol	The rules by which Msource communicates with Mdestination

Local-area Networks (LANs)

LANS are designed to:

- Operate within a limited geographic area
- Allow multi-access to high-bandwidth media
- Control the network privately under local administration
- Provide full-time connectivity to local services
- Connect physically adjacent devices

Using:



Wide-area Networks (WANs)

WANS are designed to:

- Operate over a large geographical area
- Allow access over serial interfaces operating at lower speeds
- Provide full-time and part-time connectivity
- Connect devices separated over wide, even global areas

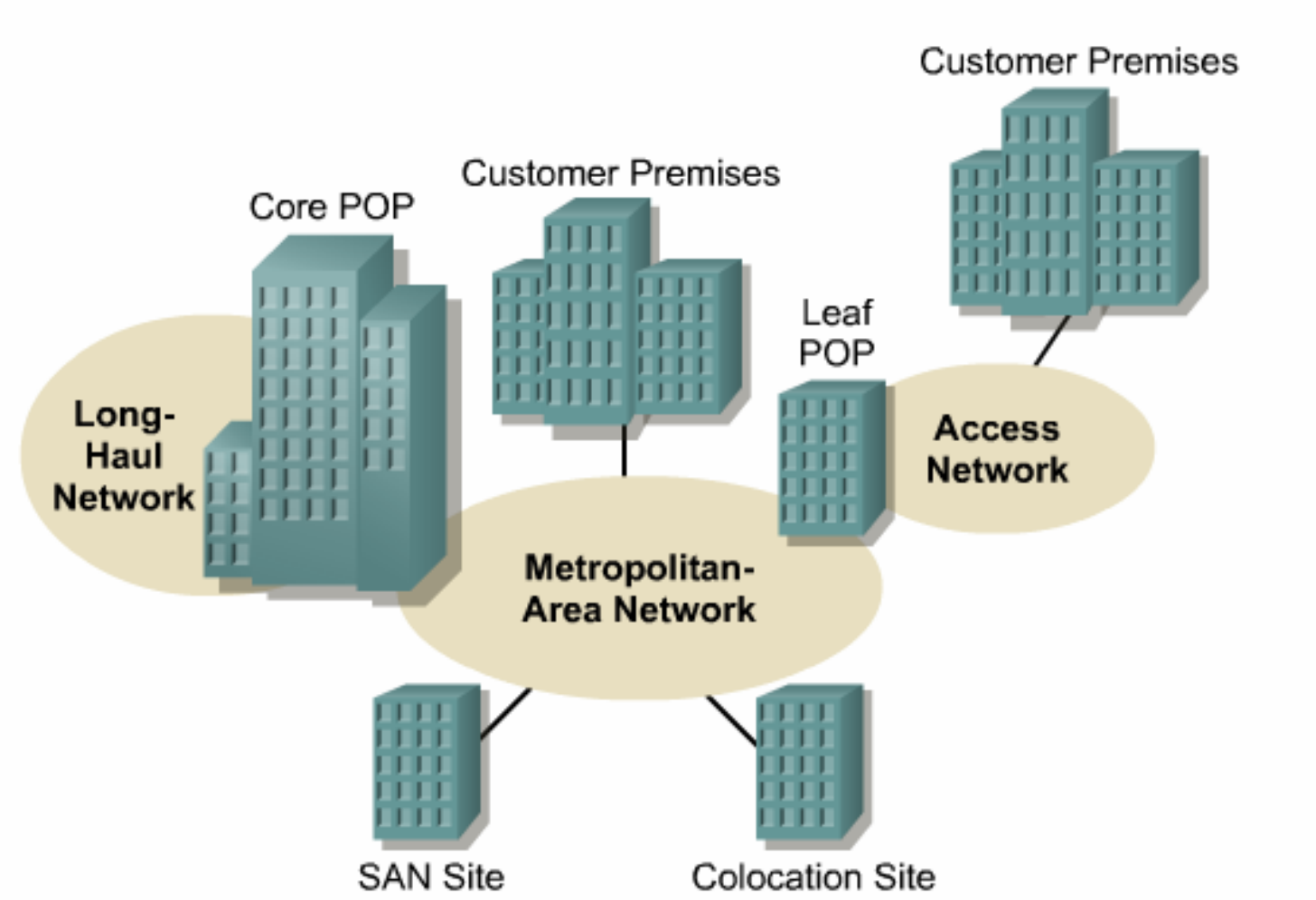
Using:

Router

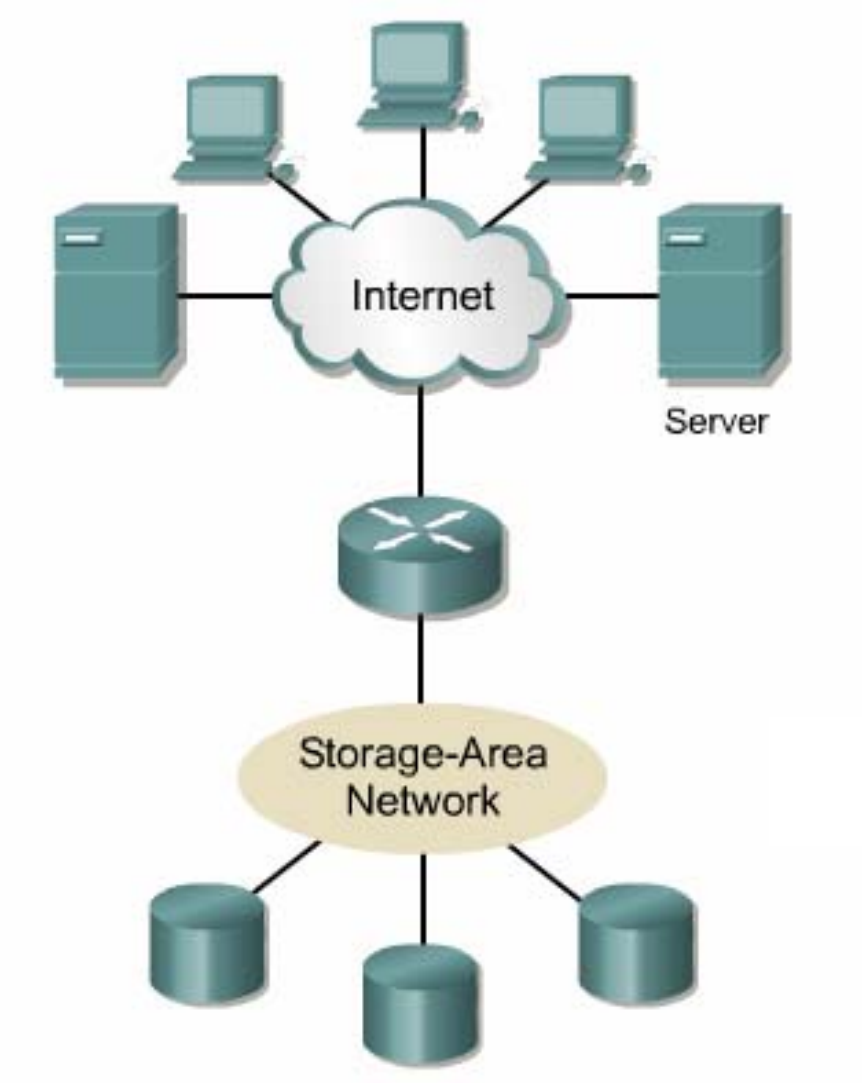
Communication Server

Modem CSU/DSU TA/NT1

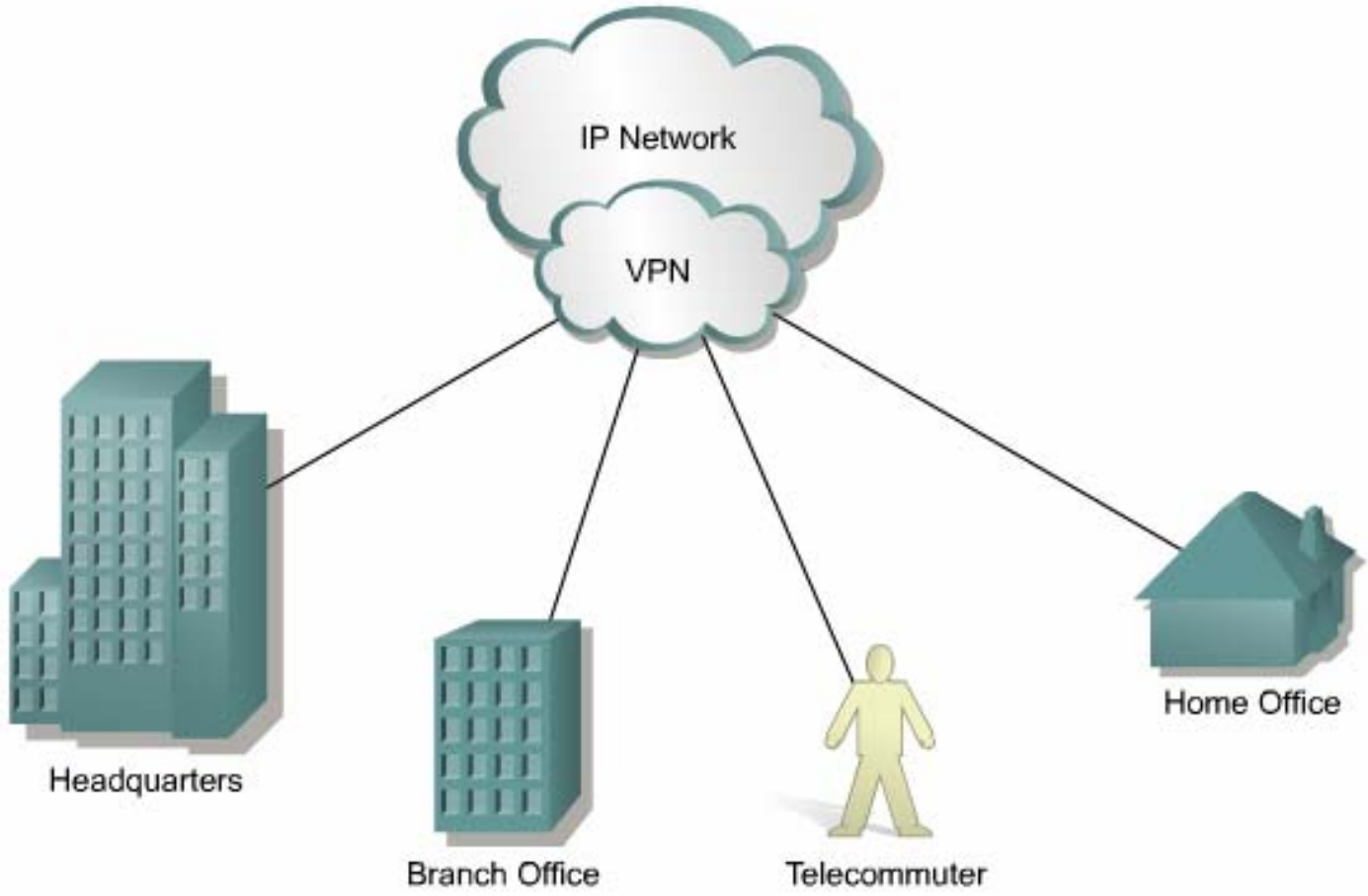
Metropolitan-Area Network (MANs)



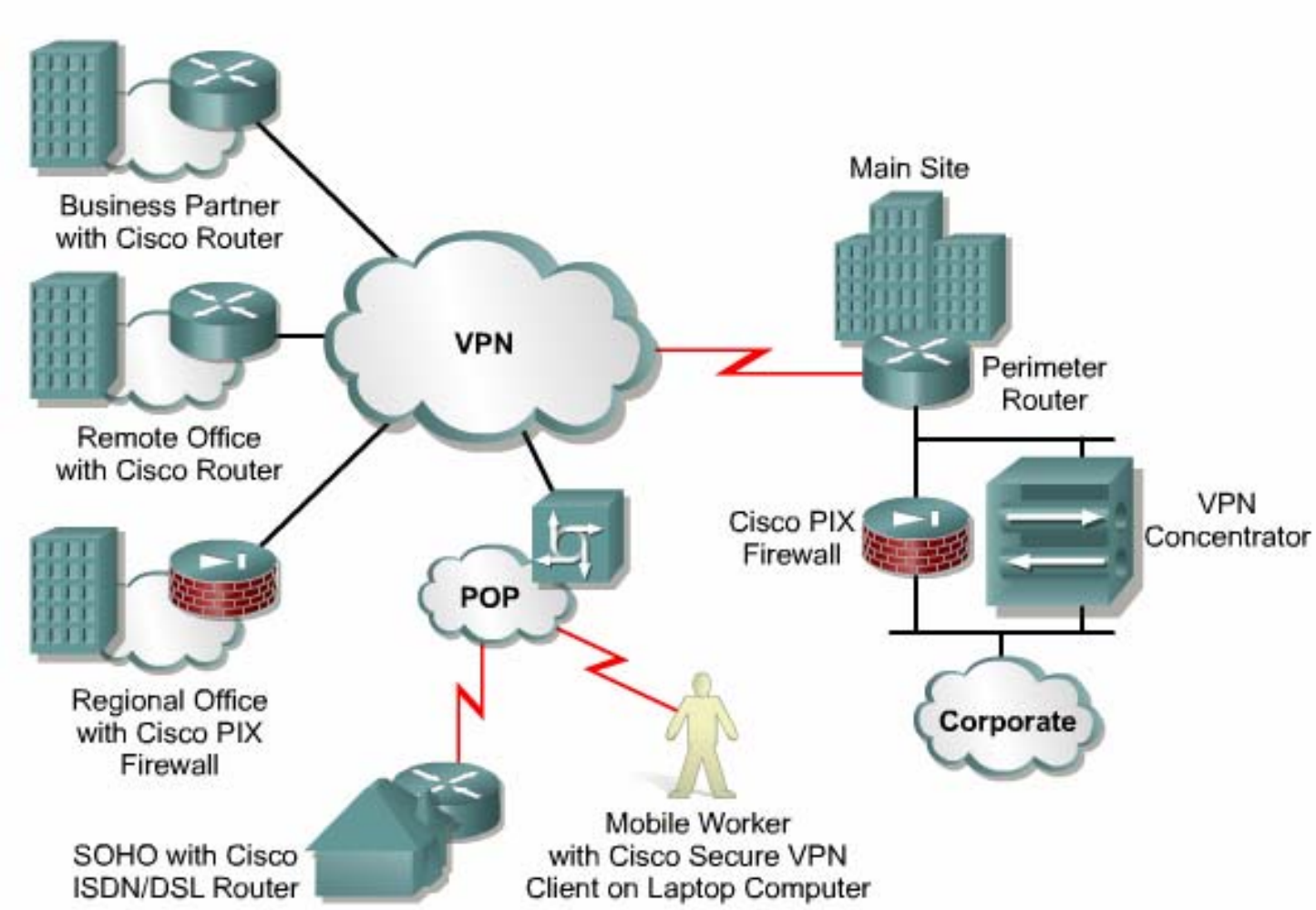
Storage-Area Networks (SANS)



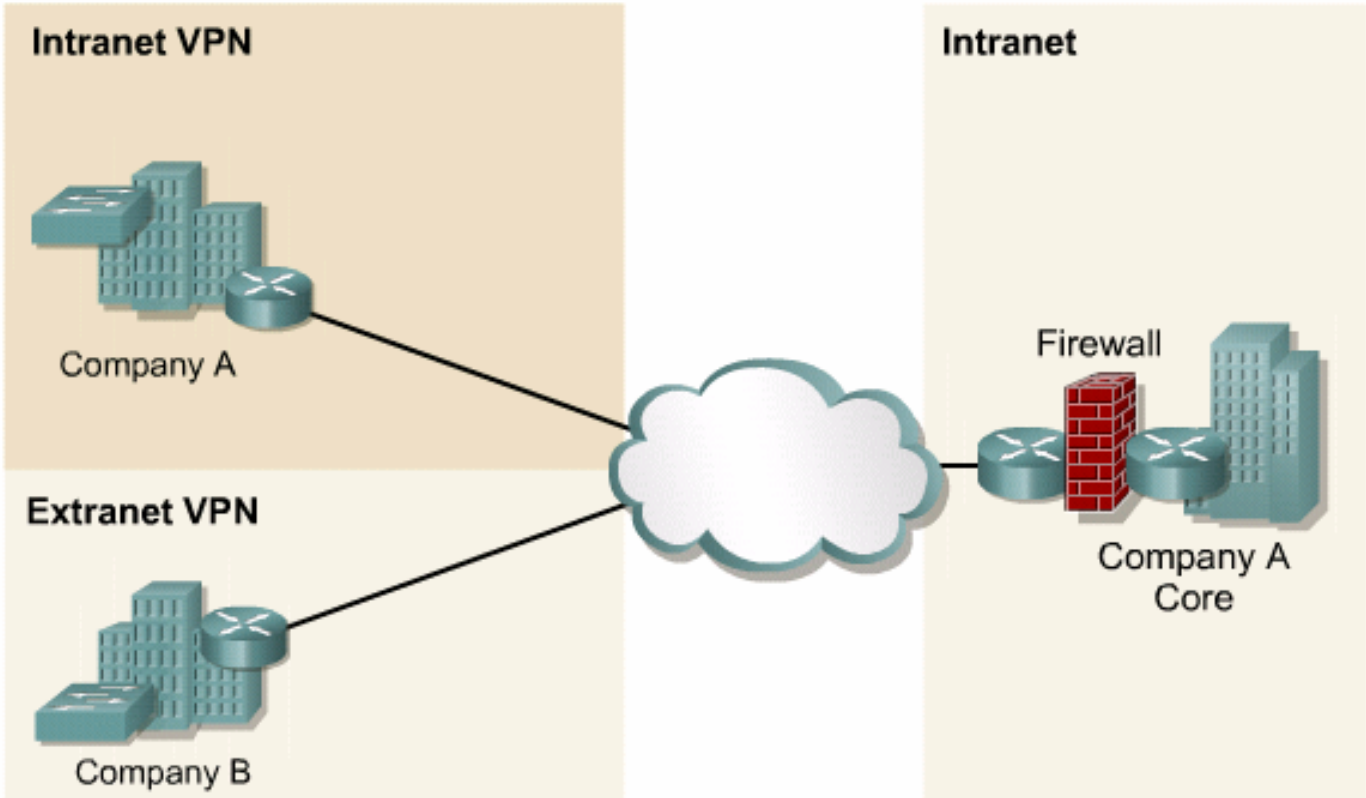
Virtual Private Networks (VPNs)



Benefits of VPNs



Intranet and Extranet VPN

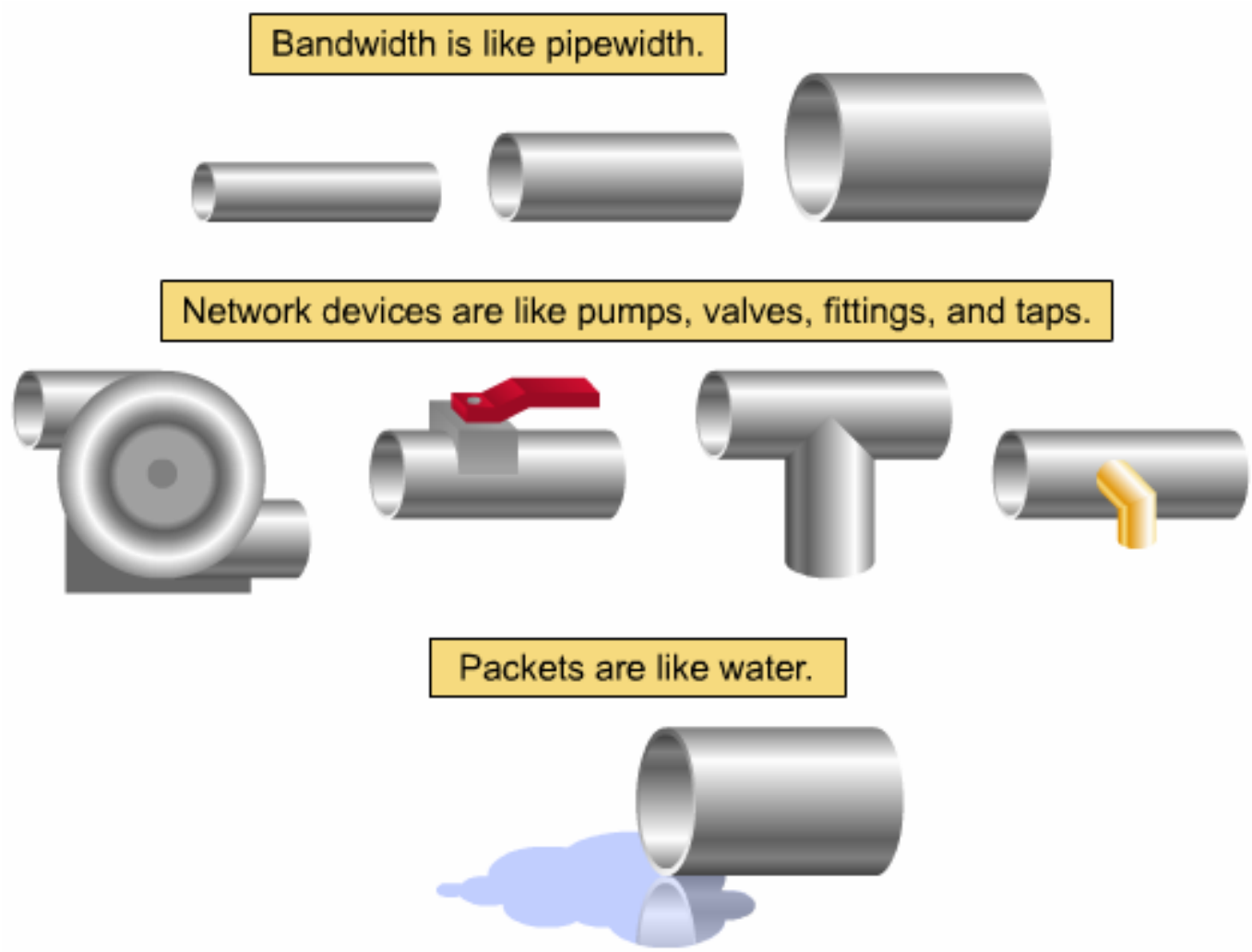


Importance of Bandwidth

Why bandwidth is important:

- Bandwidth is limited by physics and technology
- Bandwidth is not free
- Bandwidth requirements are growing at a rapid rate
- Bandwidth is critical to network performance

Bandwidth Pipe Analogy

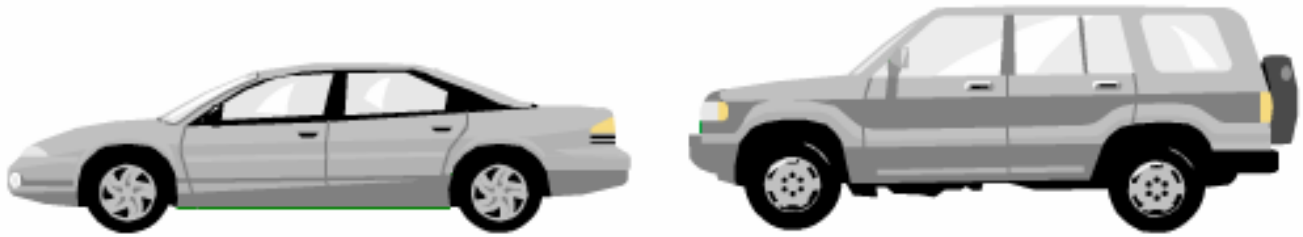


Bandwidth Highway Analogy

Bandwidth is like the number of lanes.

Network devices are like on-ramps, traffic signals, signs, and maps.

Packets are like vehicles.



Bandwidth Measurements

Unit of Bandwidth	Abbreviation	Equivalence
Bits per second	bps	1 bps = fundamental unit of bandwidth
Kilobits per second	kbps	1 kbps = ~1,000 bps = 10^3 bps
Megabits per second	Mbps	1 Mbps = ~1,000,000 bps = 10^6 bps
Gigabits per second	Gbps	1 Gbps = ~1,000,000,000 bps = 10^9 bps
Terabits per second	Tbps	1 Tbps = ~1,000,000,000,000 bps = 10^{12} bps

Bandwidth Limitations

Some Typical Media	Bandwidth	Max. Physical Distance
50-Ohm Coaxial Cable (Ethernet 10BASE2, ThinNet)	10-100 Mbps	185m
50-Ohm Coaxial Cable (Ethernet 10BASE5, ThickNet)	10-100 Mbps	500m
Category 5 Unshielded Twisted Pair (UTP) (Ethernet 10BASE-T)	10 Mbps	100m
Category 5 Unshielded Twisted Pair (UTP) (Ethernet 100BASE-TX)(Fast Ethernet)	100 Mbps	100m
Multimode (62.5/125µm) Optical Fiber 100BASE-FX	100 Mbps	2000m
Singlemode (9/125µm core) Optical Fiber 1000BASE-LX	1000 Mbps (1.000 Gbps)	3000m
Wireless	11 Mbps	a few 100meters

Bandwidth Throughput

Throughput ≤ Digital Bandwidth of a Medium

- PC (client)
- The server
- Other users on the LAN
- Routing within the "Cloud"
- The design (topology) of all networks involved
- Type of data being transferred
- Time of day

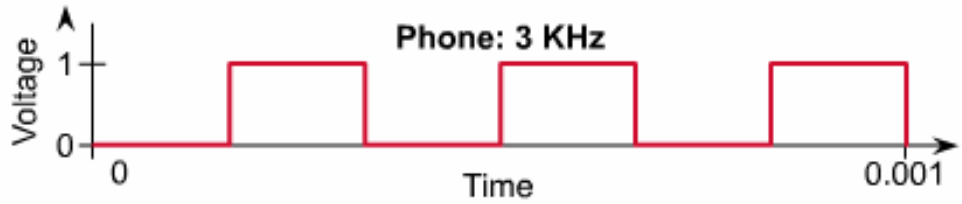
Digital Transfer Calculation

Best Download	Typical Download
$T = \frac{S}{BW}$	$T = \frac{S}{P}$

BW	Maximum theoretical bandwidth of the "slowest link" between the source host and the destination host (measured in bits per second).
P	Actual throughput at the moment of transter (measured in bits per second).
T	Time for file transfer to occur (measured in seconds).
S	File size in bits.

Digital versus Analog

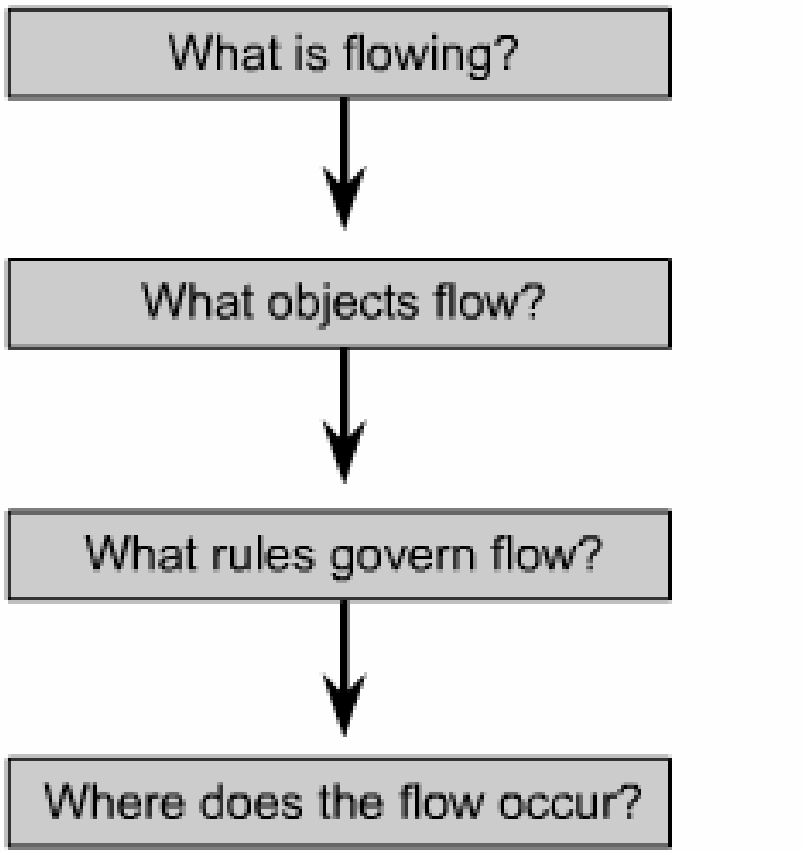
Bandwidth (digital) is like analog bandwidth.



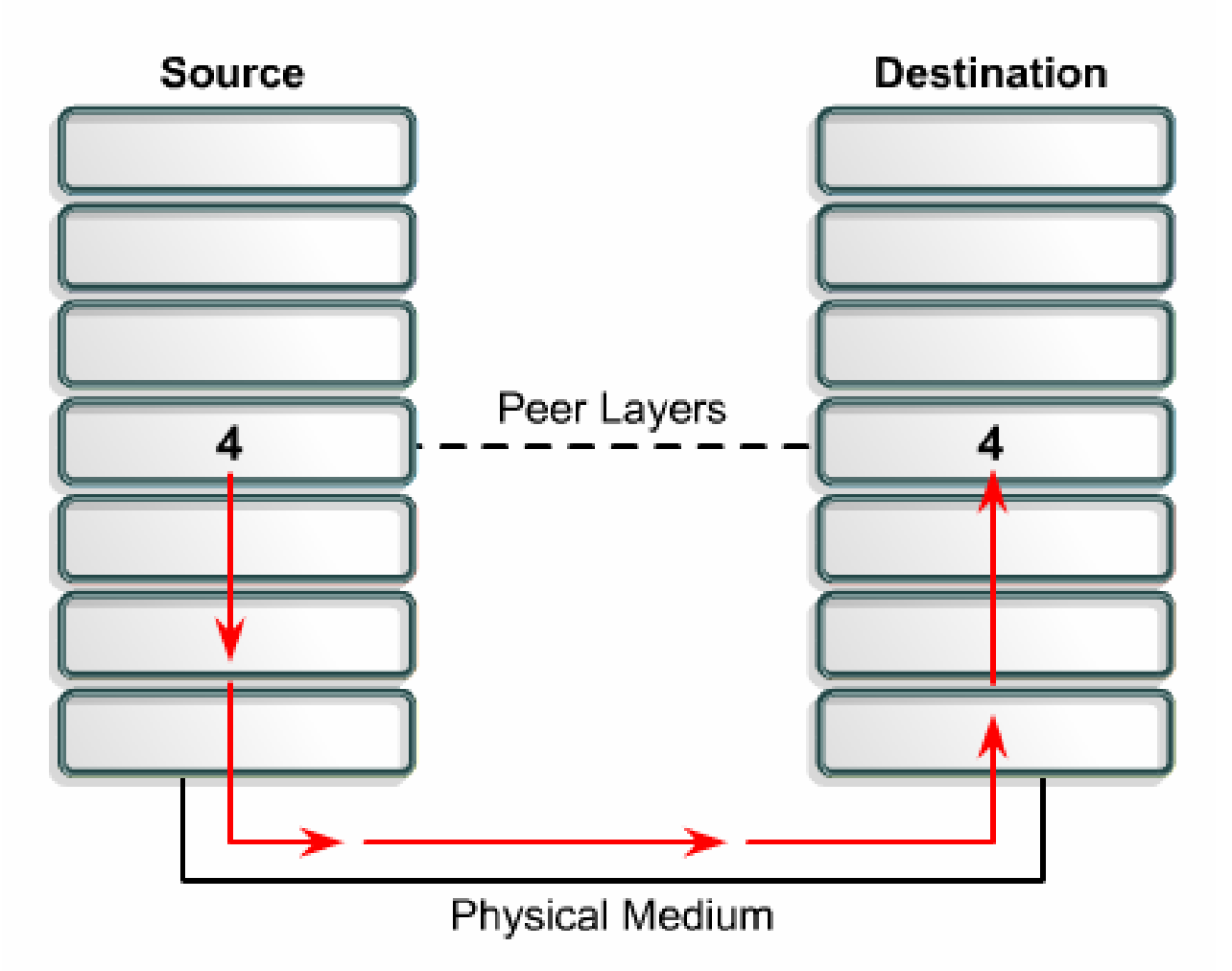
Network devices are like phones, AM/FM radios, and CD ROM players.

Packets are like music.

Using Layers to Analyze Problems



Using Layers to Describe Data Communication

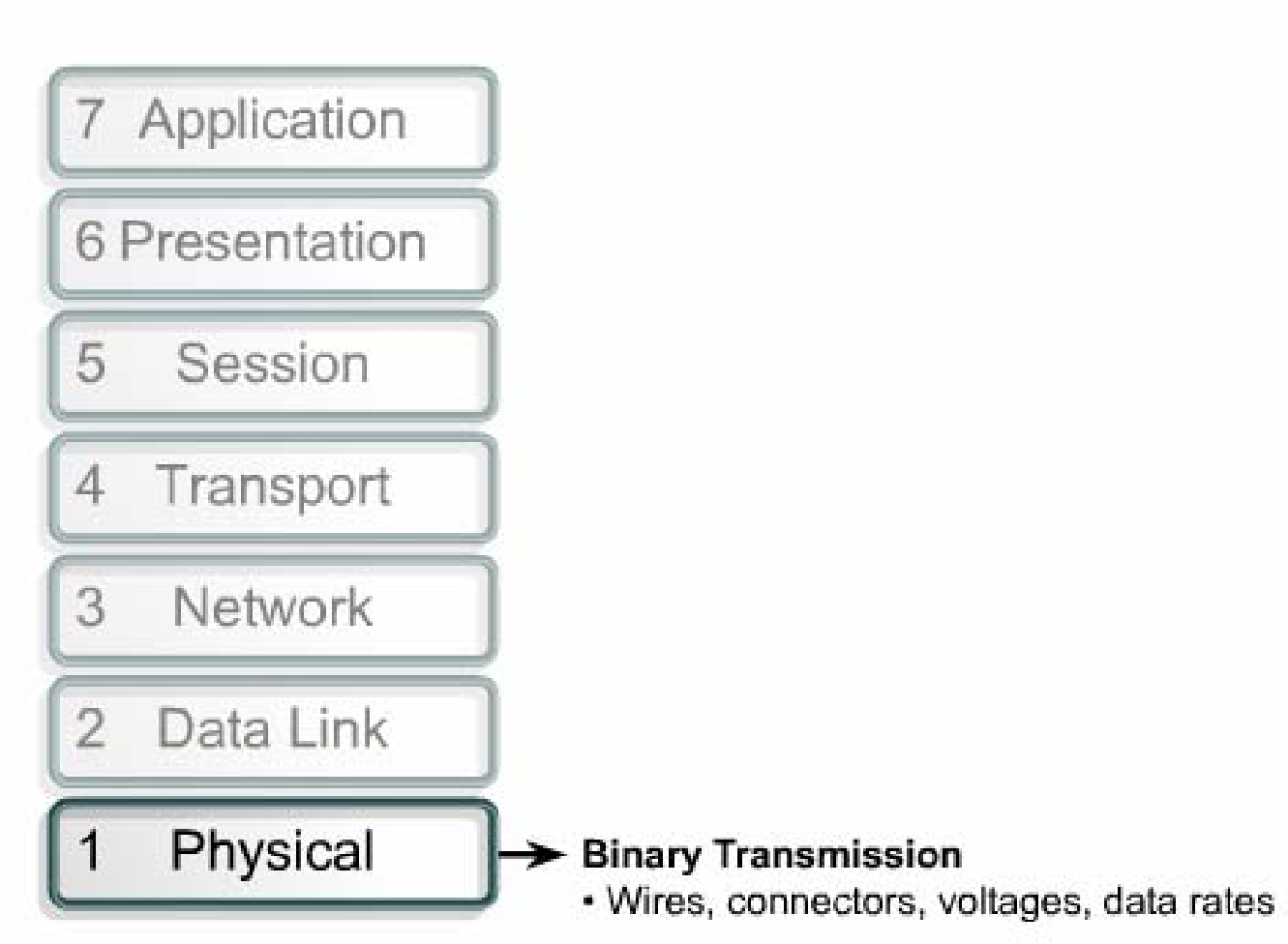


OSI Model

Benefits of the OSI Model:

- Reduces complexity
- Standardizes interfaces
- Facilitates modular engineering
- Ensures interoperable technology
- Accelerates evolution
- Simplifies teaching and learning

OSI Layers



OSI Layers

Direct Link Control, Access to Media

- Provides connectivity and path selection between two host
- Provides Logical address
- No error correction, best effort delivery.

OSI Layers

Network Address and Best Path Determination

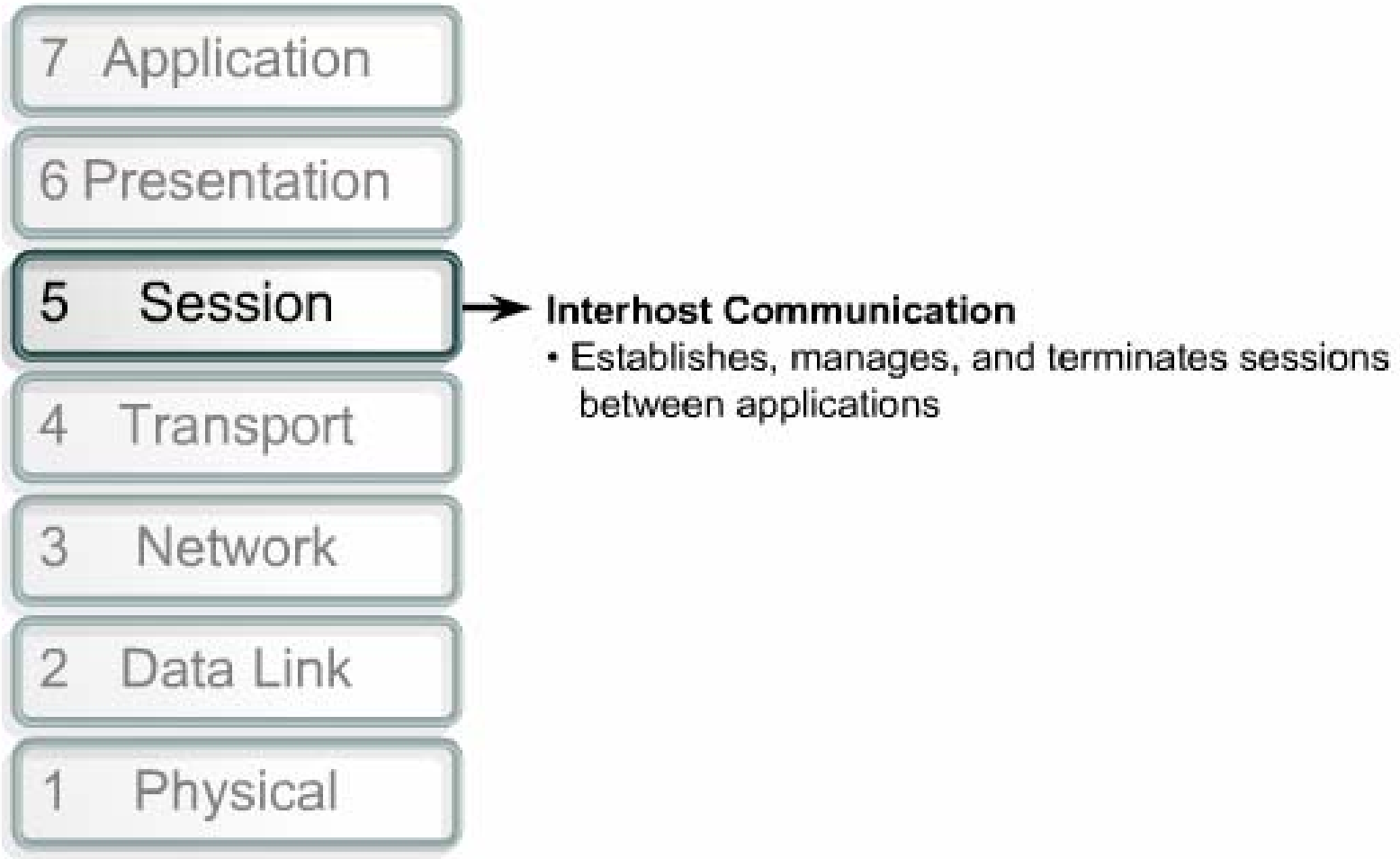
- Provides reliable transfer of data across media
- Physical addressing, network topology, error notification, flow control

OSI Layers

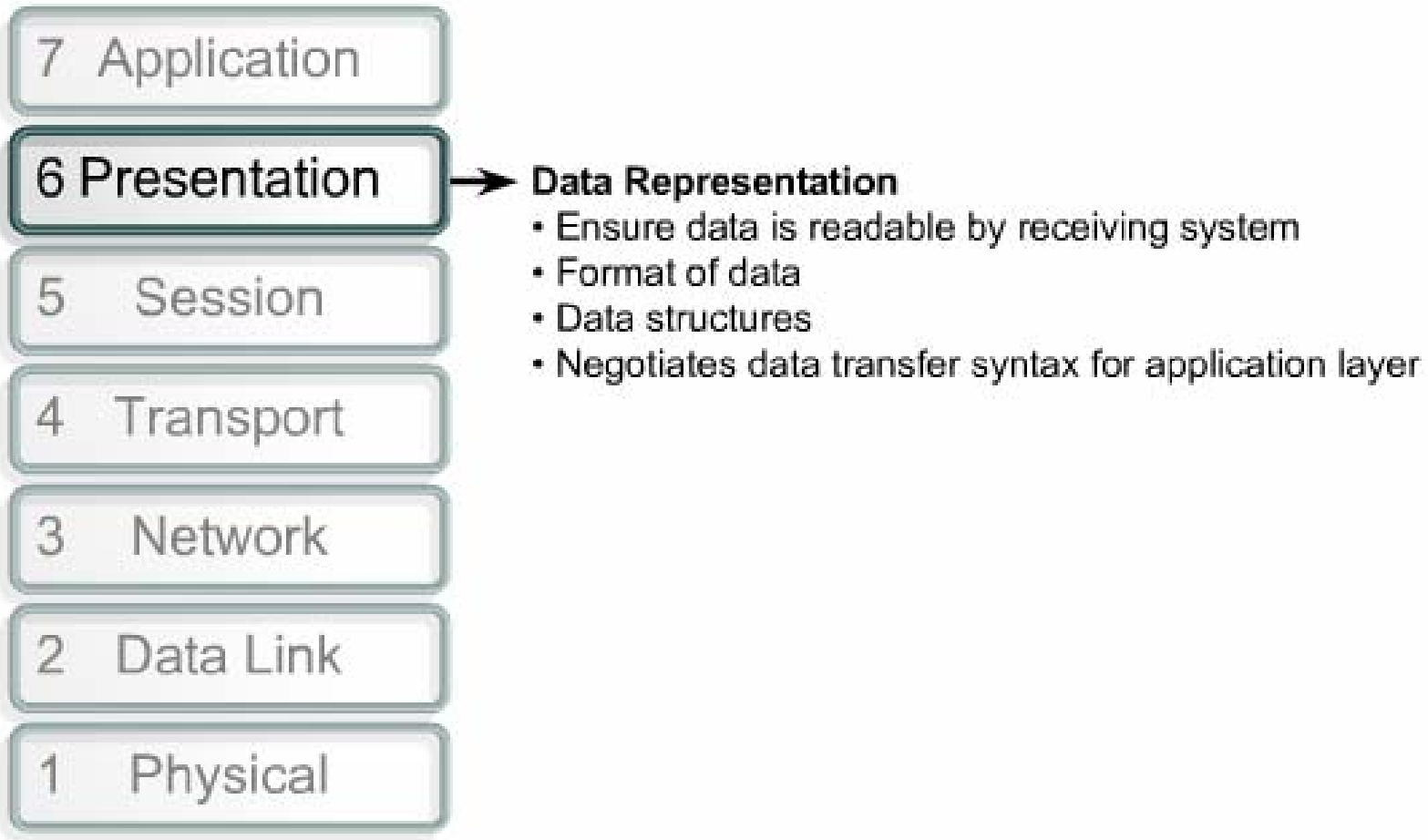
End-to-end Connections

- Concerned with transportation issues between hosts
- Data transport reliability
- Establish, maintain, terminate virtual circuits
- Fault detection and recovery information flow control

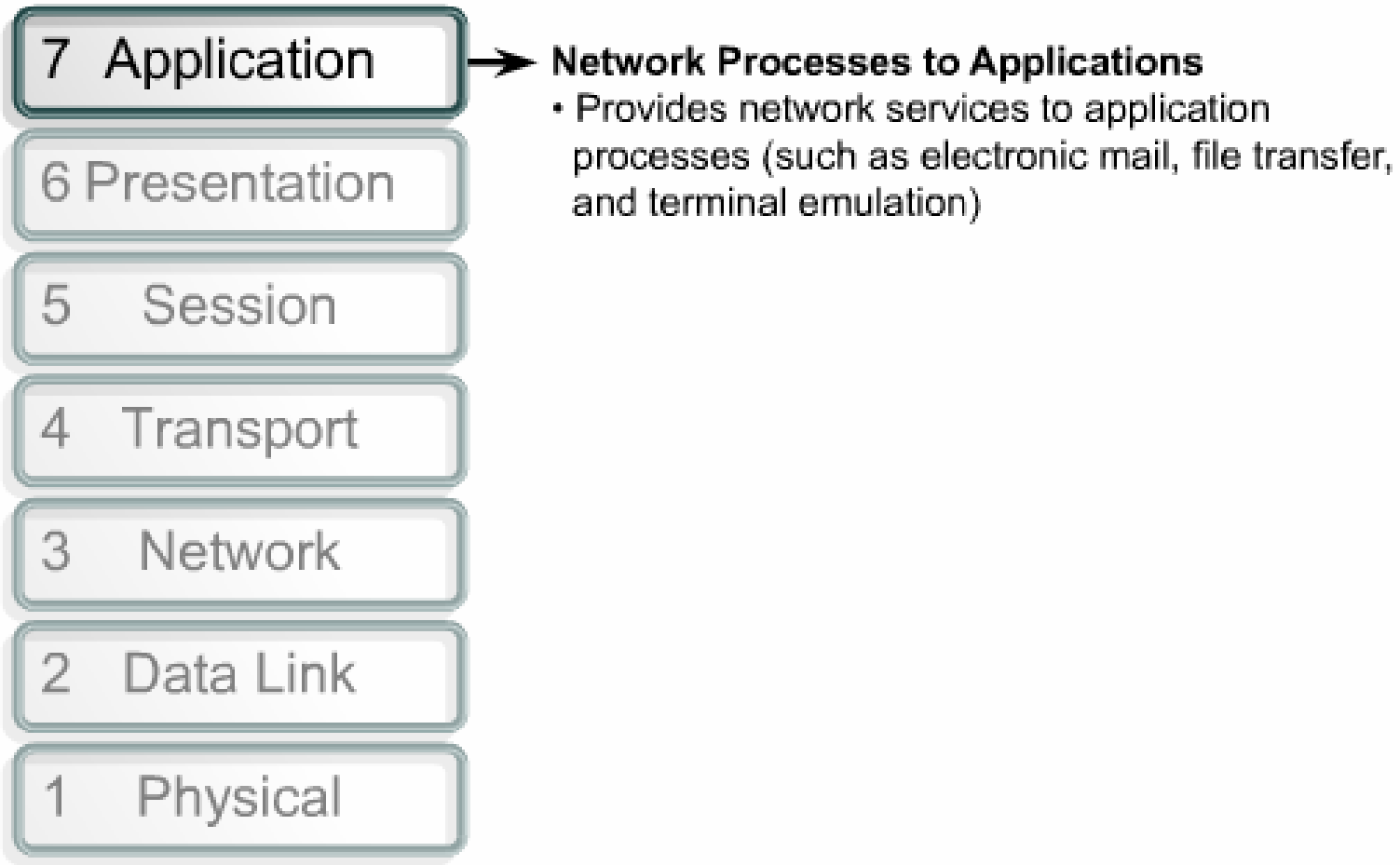
OSI Layers



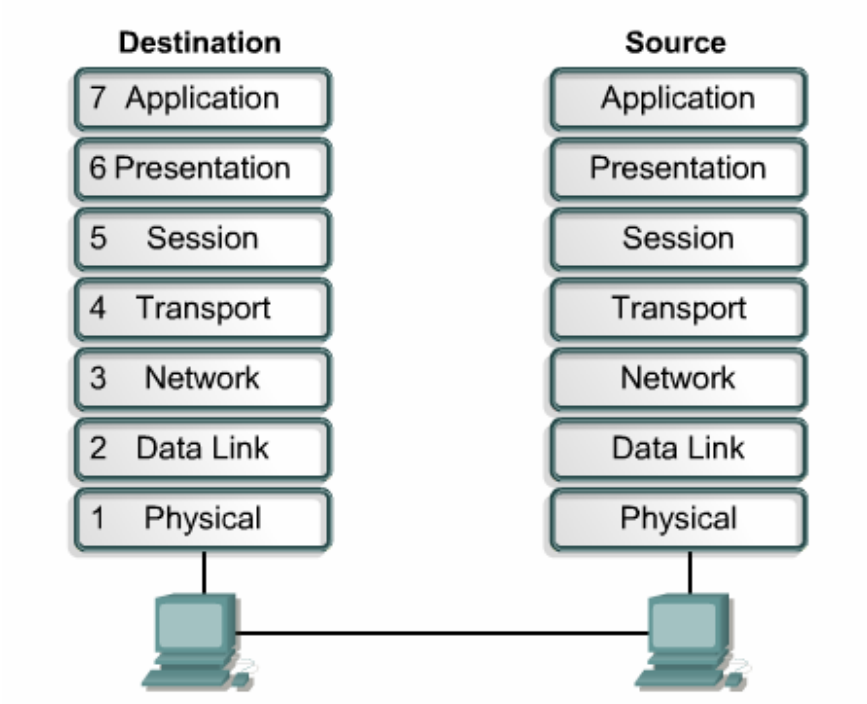
OSI Layers

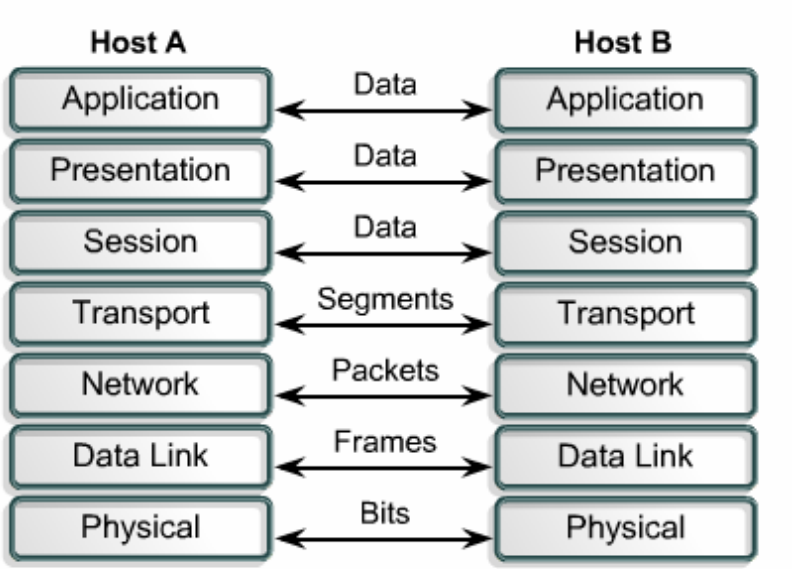


OSI Layers

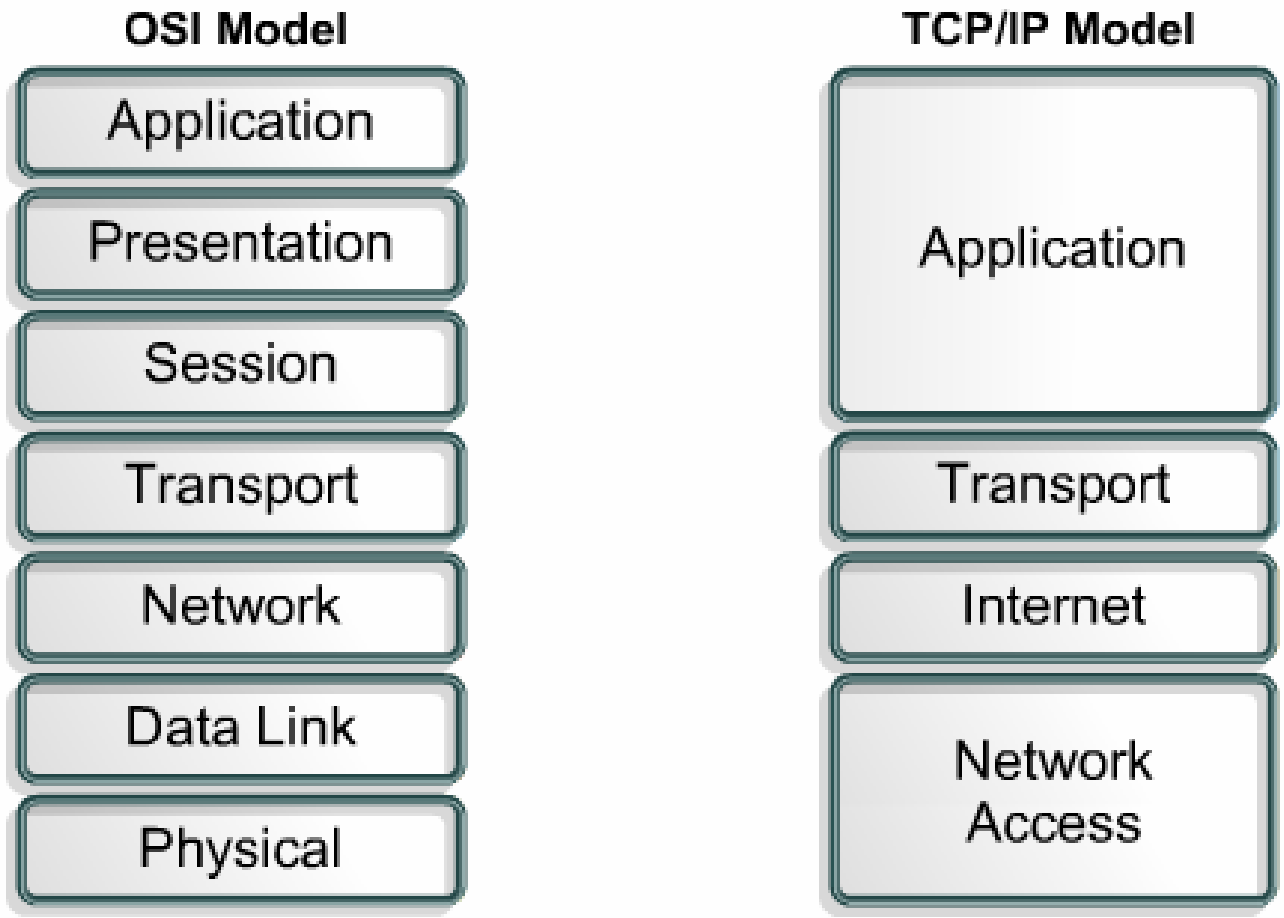


Peer-to-Peer Communication

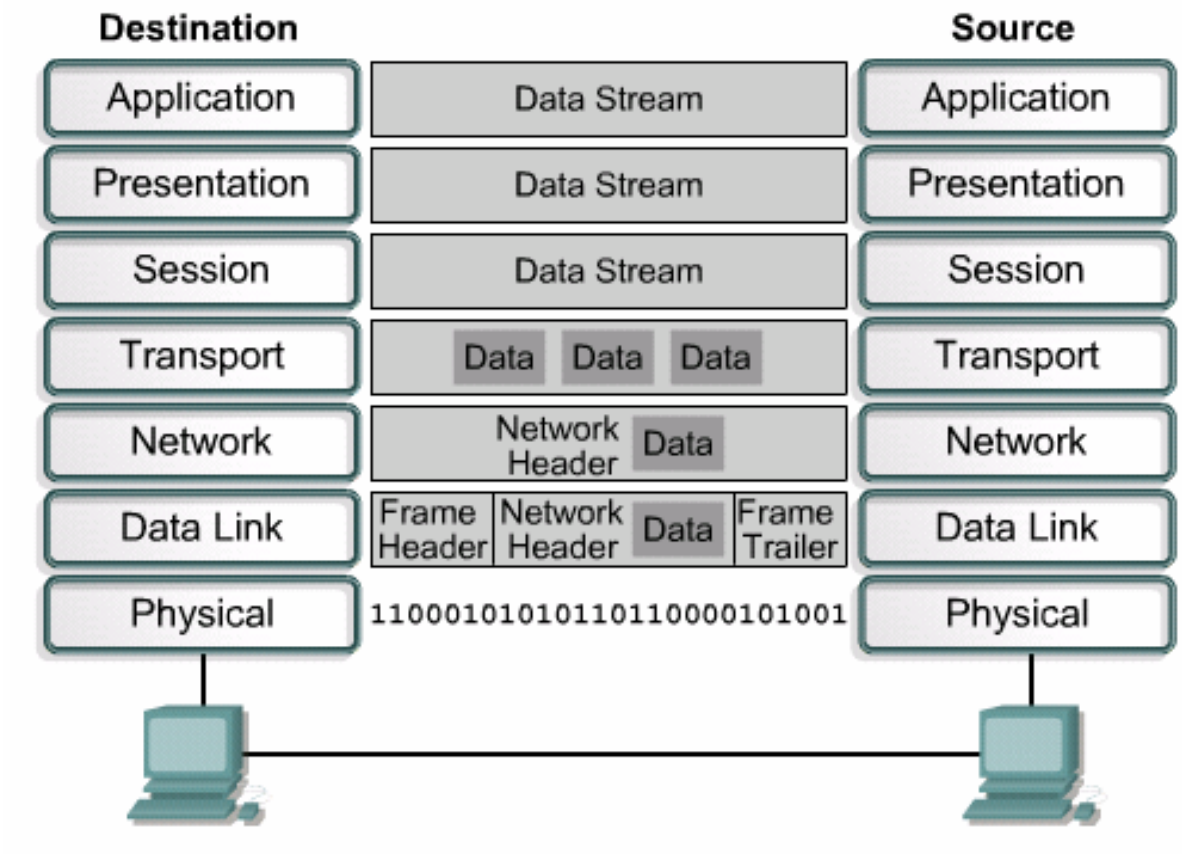




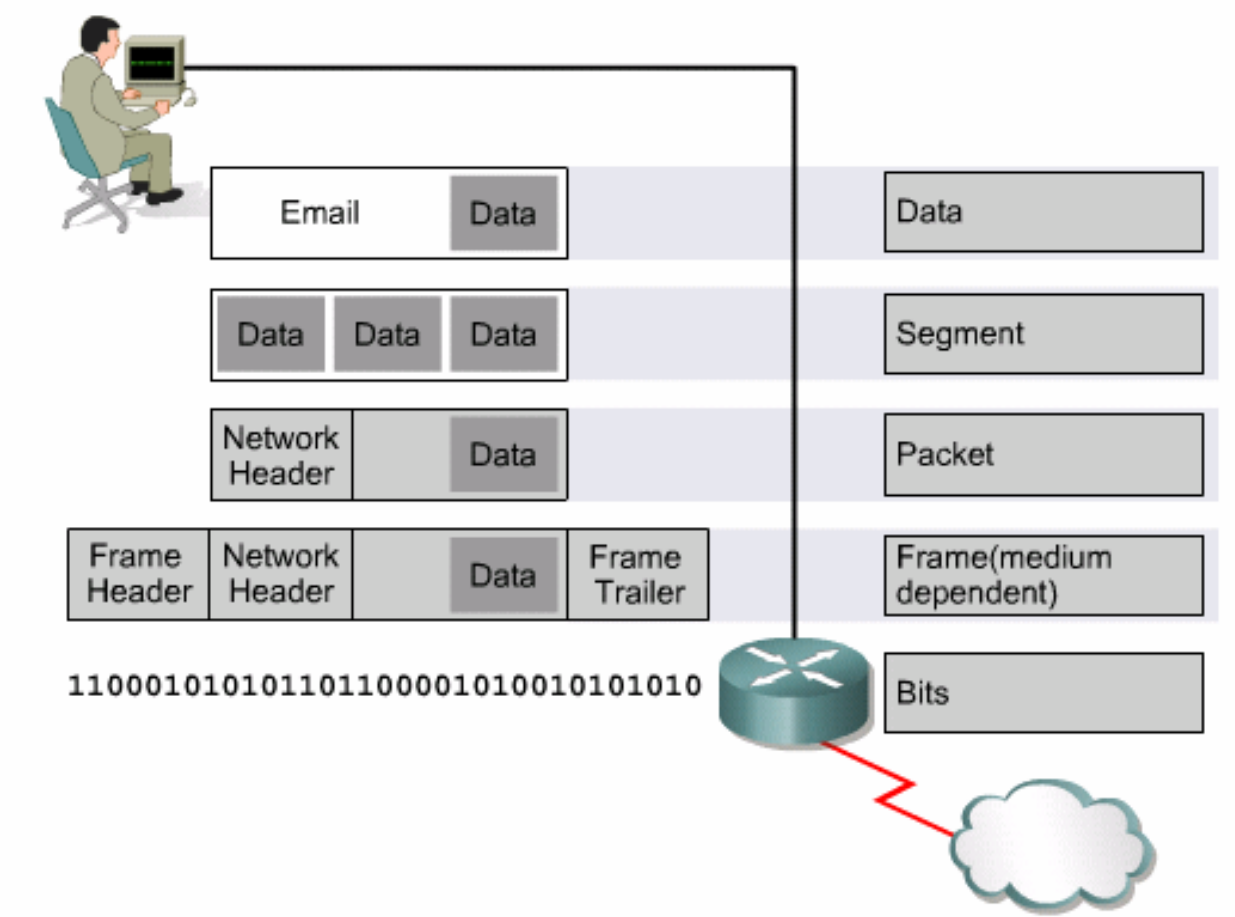
TCP/IP Model



Encapsulation



Names for Data at Each Layer



Summary

Summary

- NICs, repeaters, hubs, bridges, switches, and routers are common networking devices
- Some of the common network types are: LANs, WANs, MANs, SANs, and VPNs
- Bandwidth is defined as the amount of information that can flow through a network connection in a given period of time
- Two of the most known networking models are: OSI reference model and TCP/IP model