

Data Communications and Network Topologies

Presented By
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History of Communication

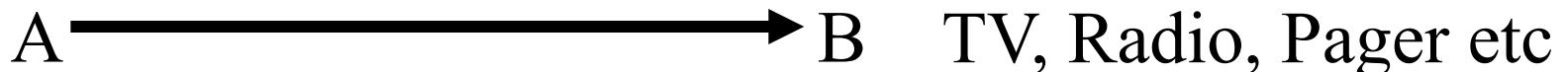
- 1837 Telegram(5km) Samuel F.B. Morse
- 1844 Telegram Washington<->Baltimore (64 km)
- 1850 Submarine Telegram Dover<->Calais
- 1876 Telephone Alexander G.Bell
- 1878 Telephone Service (Boston U.S.)
- 1895 Wireless Telegraphy G.Marconi PAT.7777 1901
- 1899 Wireless Telegraphy The Strait of Dover
- 1901 Wireless Telegraphy The Atlantic Ocean
- 1912 CQD from Titanic “All Station , Distress!”
- 1922 BBC Radio (AM)
- 1925 JOAK in Japan

History of Communication(2)

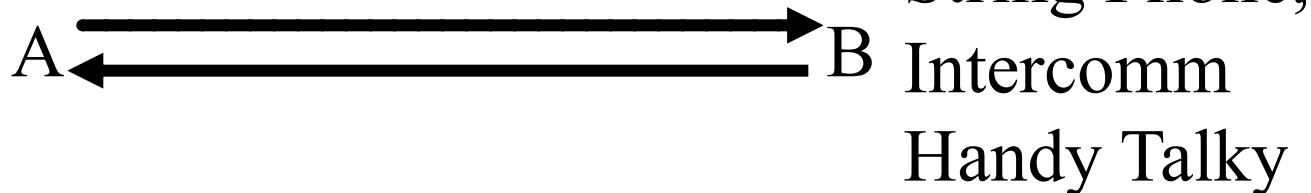
- 1953 TV
- 1960 Color TV
- 1960 Satellite Communication
- 1969 FM Radio
- 1969 ARPANET(Advanced Research Projects Agency NETwork) DOD of U.S.
- 1979 Mobile Phone (1G)
- 1982 Internet TCP/IP
- 1993 Mobile Phone (2G)
- 1986 Broadcasting Satellite
- 2001 Mobile Phone (3G)
- 2003 Terrestrial Digital Broadcasting in Japan

Transmission Style

- Simplex



- Half-Duplex



- Full-Duplex

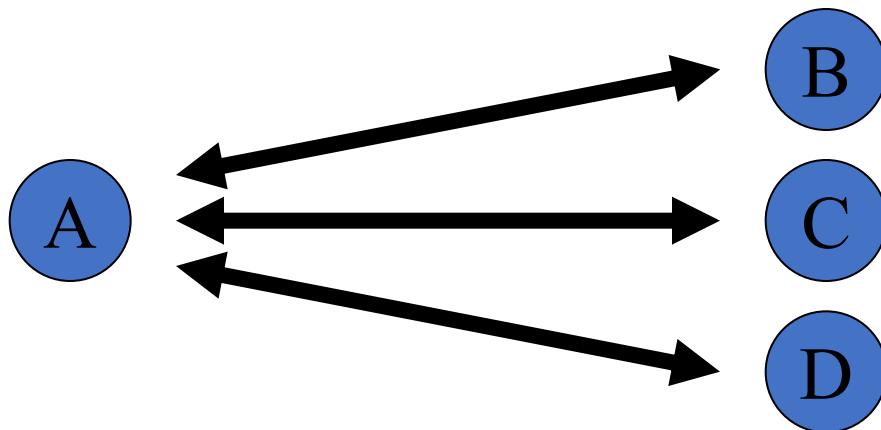


Network Topology



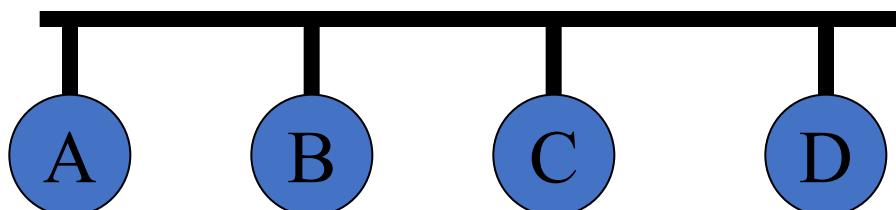
Point to Point
Connection

Personal Phone



Point to Multipoint
Connection

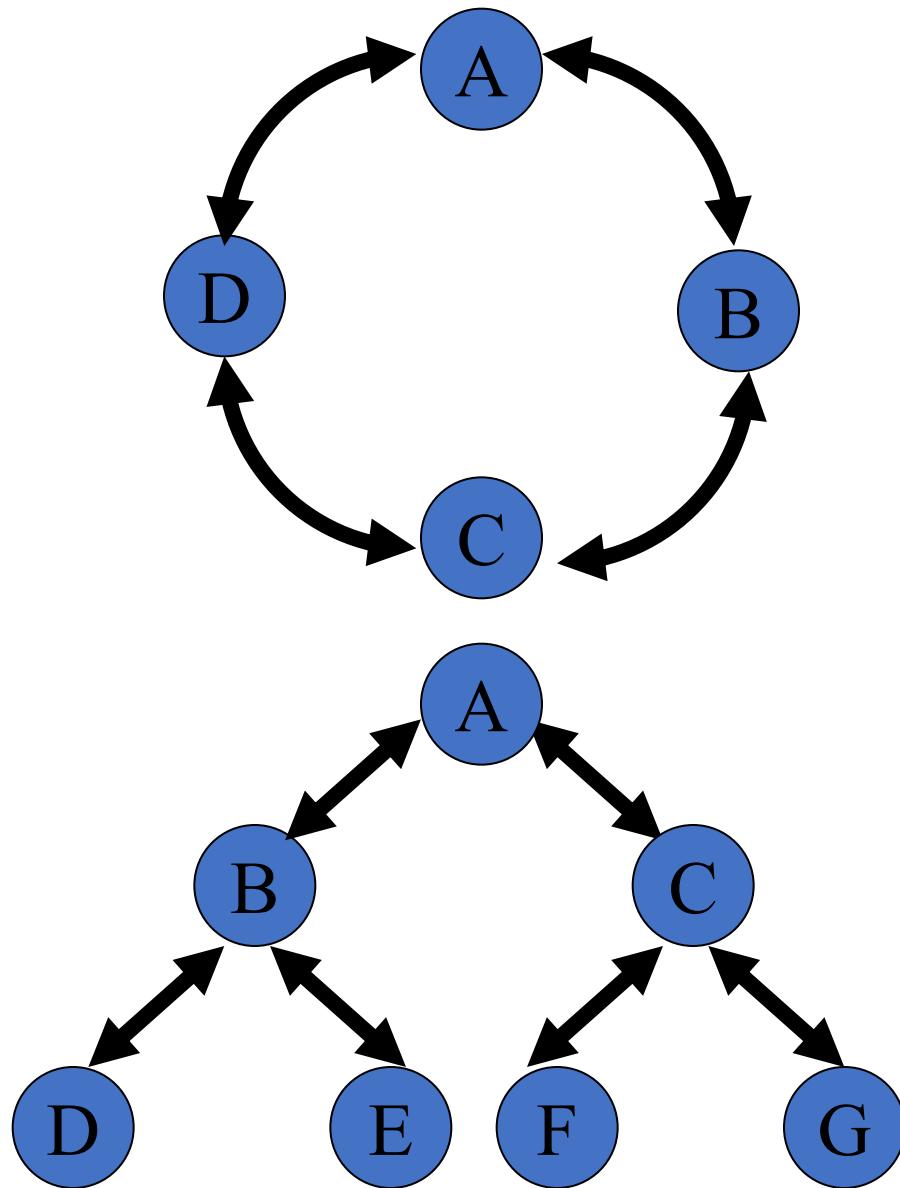
Broadcasting(Radio, TV)
Air Interface



Bus Connection

LAN(Local Area Network)
Ethernet

Network Topology(2)



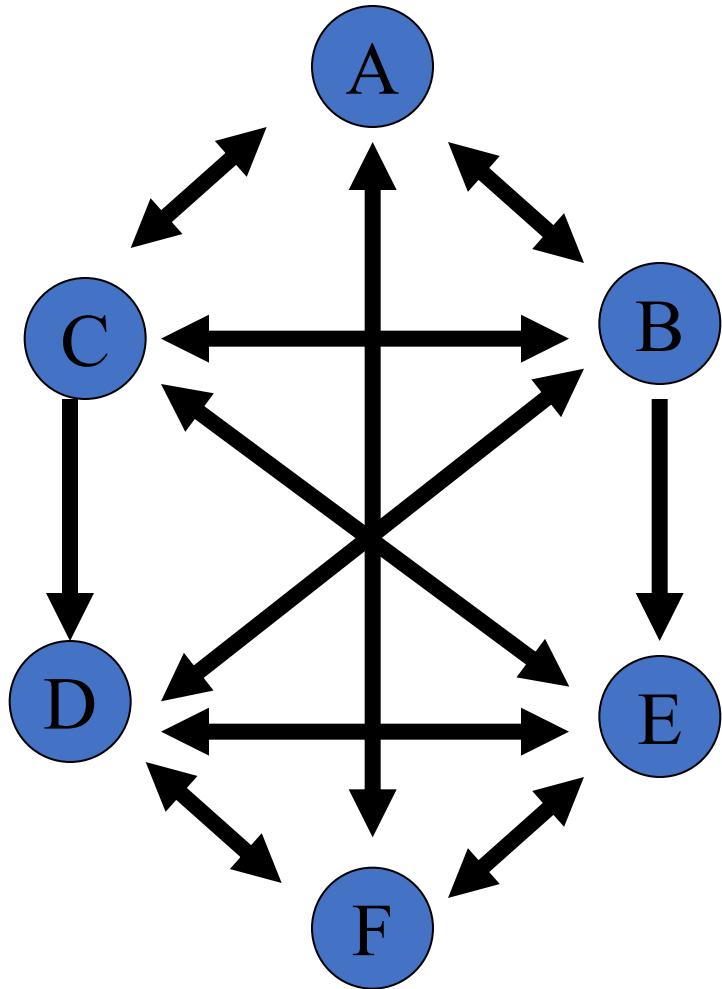
Ring Connection

FDDI(Fiber Distributed Data Interface)

Tree Connection

PSTN(Public Switched Telephone Network)
(Lower Layer)

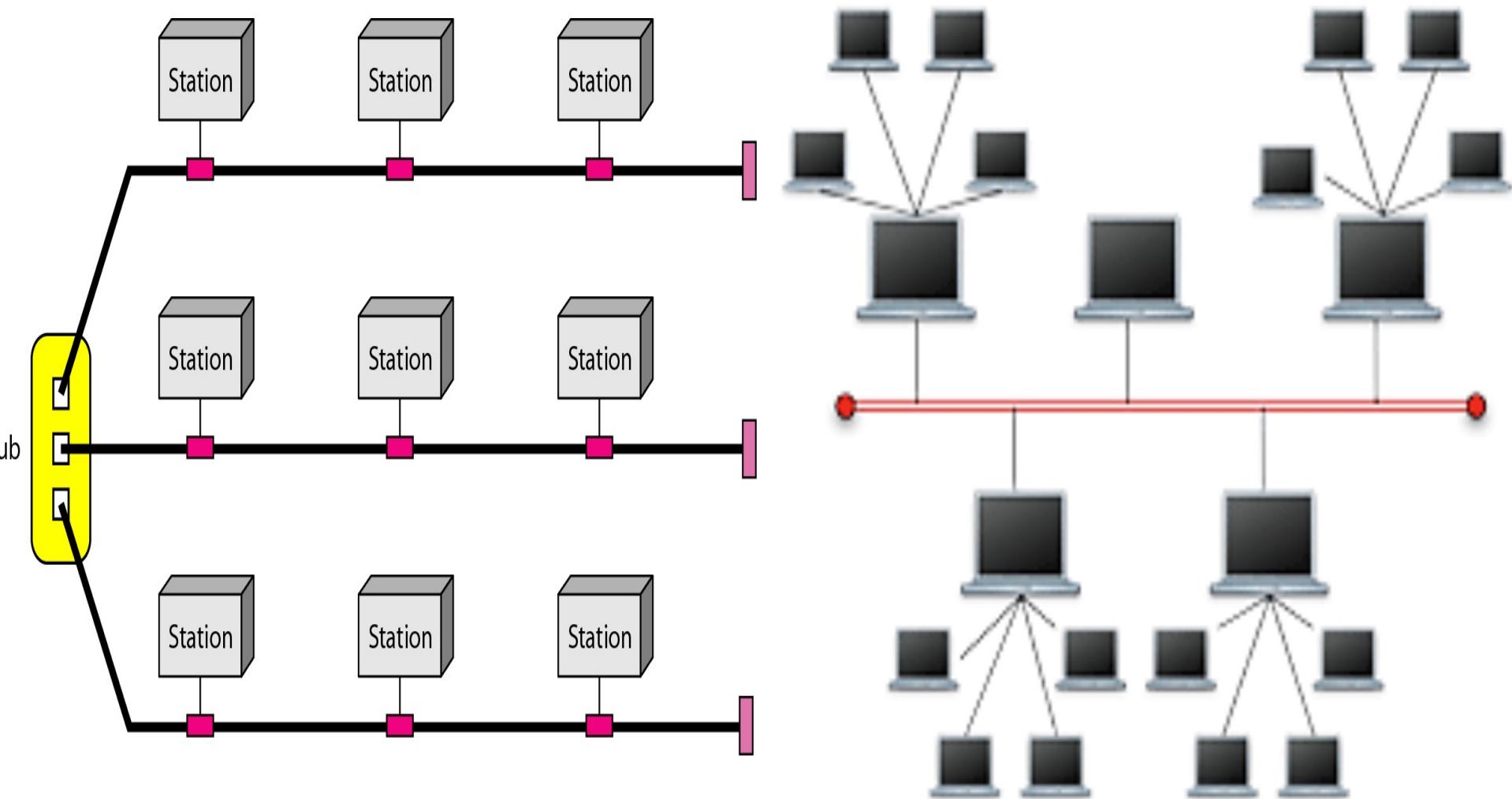
Network Topology(3)



Mesh Connection

PSTN(higher layer)

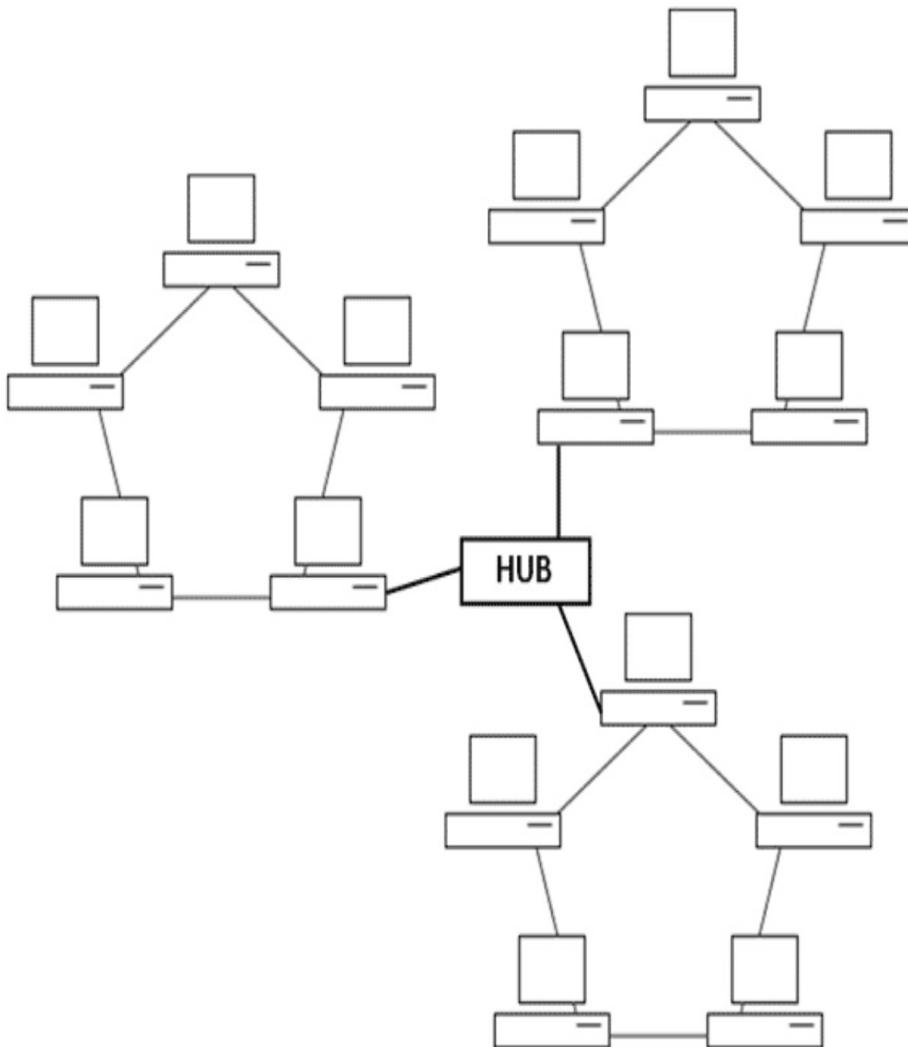
A hybrid topology (Star-Bus)



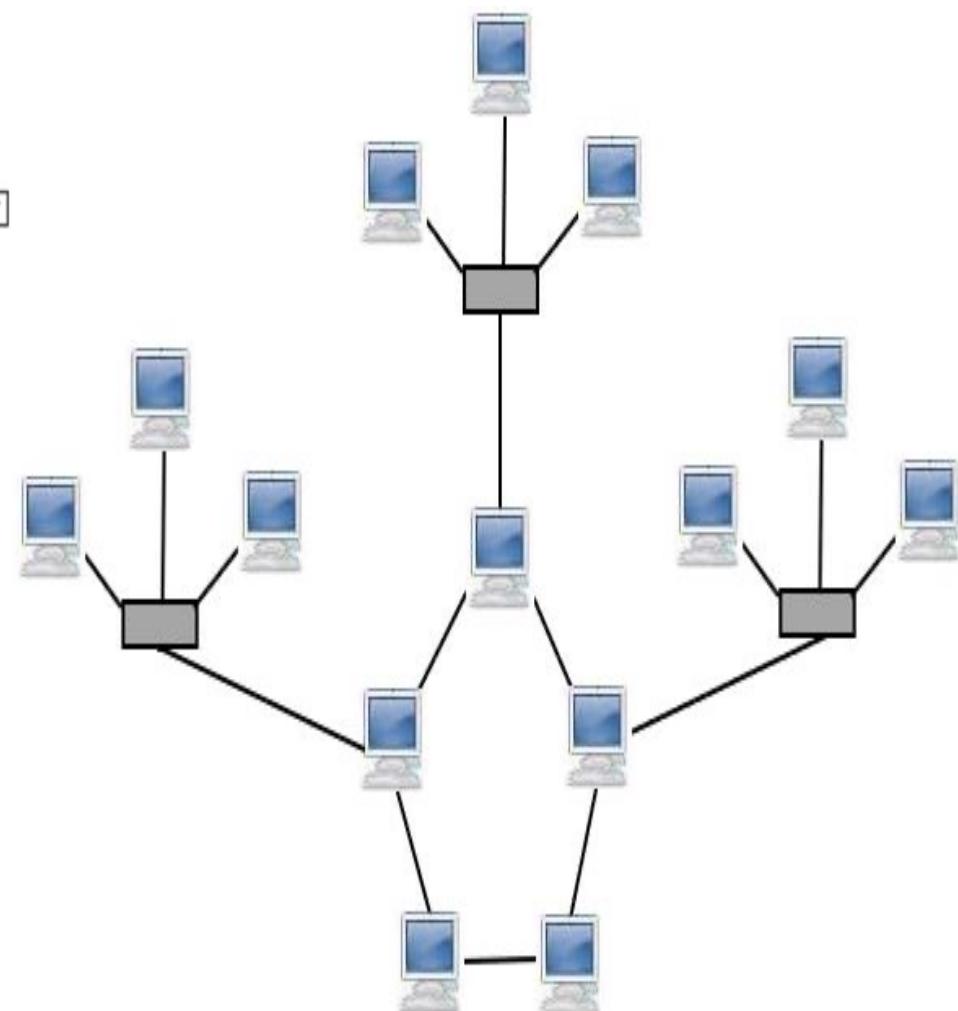
a star backbone with three bus networks

a bus backbone with three star networks

A hybrid topology (Star-Ring)



a star backbone with three ring networks



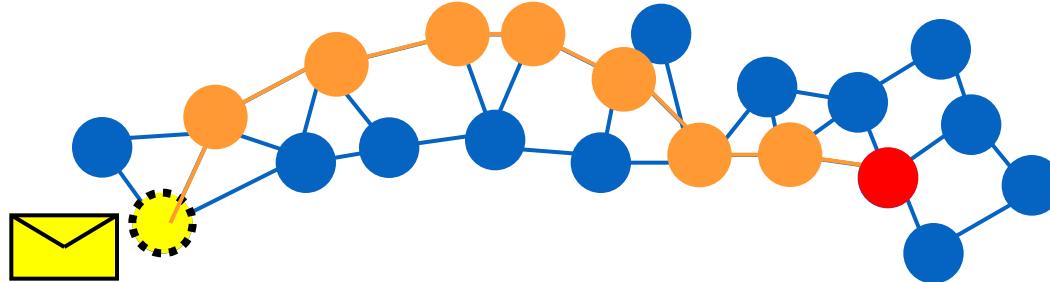
a ring backbone with three star networks

Communication Criteria

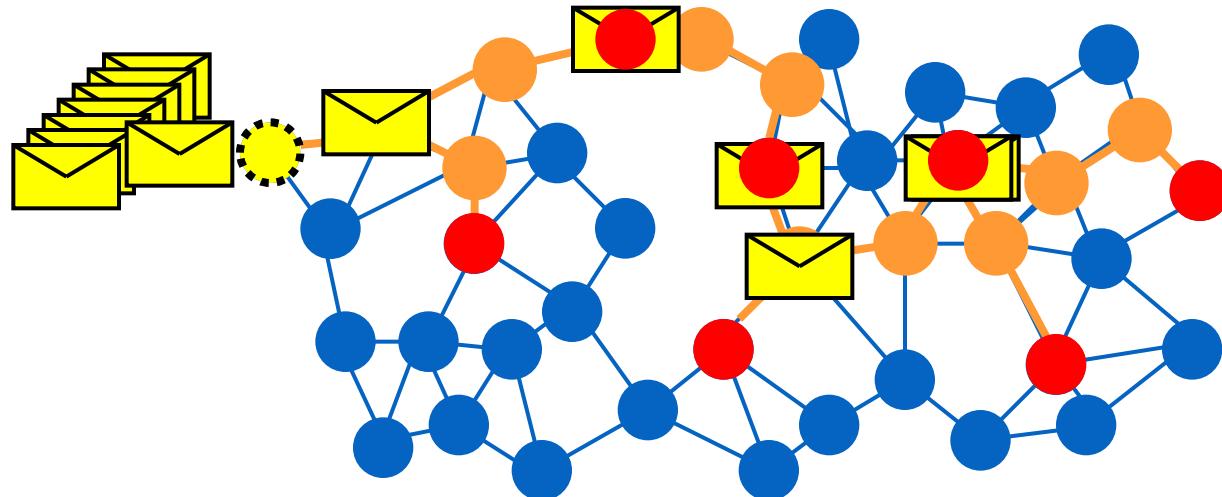
	P to P	P to M.P	Bus	Ring	Tree	Mesh
Sim Plex		TV, Radio B.S. , Pager		FDDI	CATV	
Half Dup lex	String Phone Speaking Tube Intercomm	Wireless LAN PHS, FWA	LAN Ethernet			
Full Dup lex	Telephone (leased line) Mobile Phone (Analogue)	VSAT Mobile Phone (Digital)			PSTN (lower level)	PSTN (higher level)

Transmission Form

- Unicast (send message to a given node)

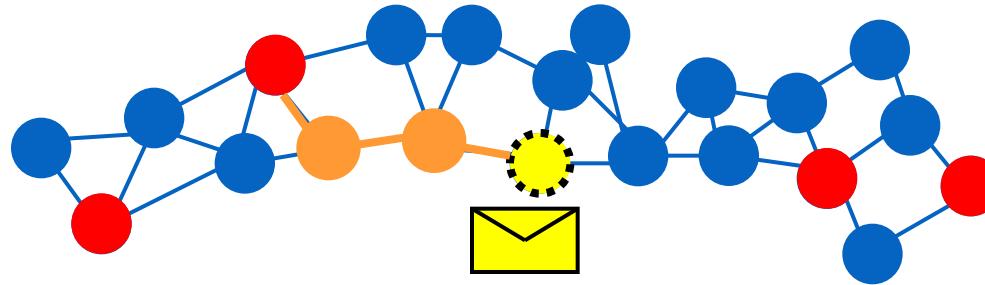


- Multicast (send message to a given set of nodes)



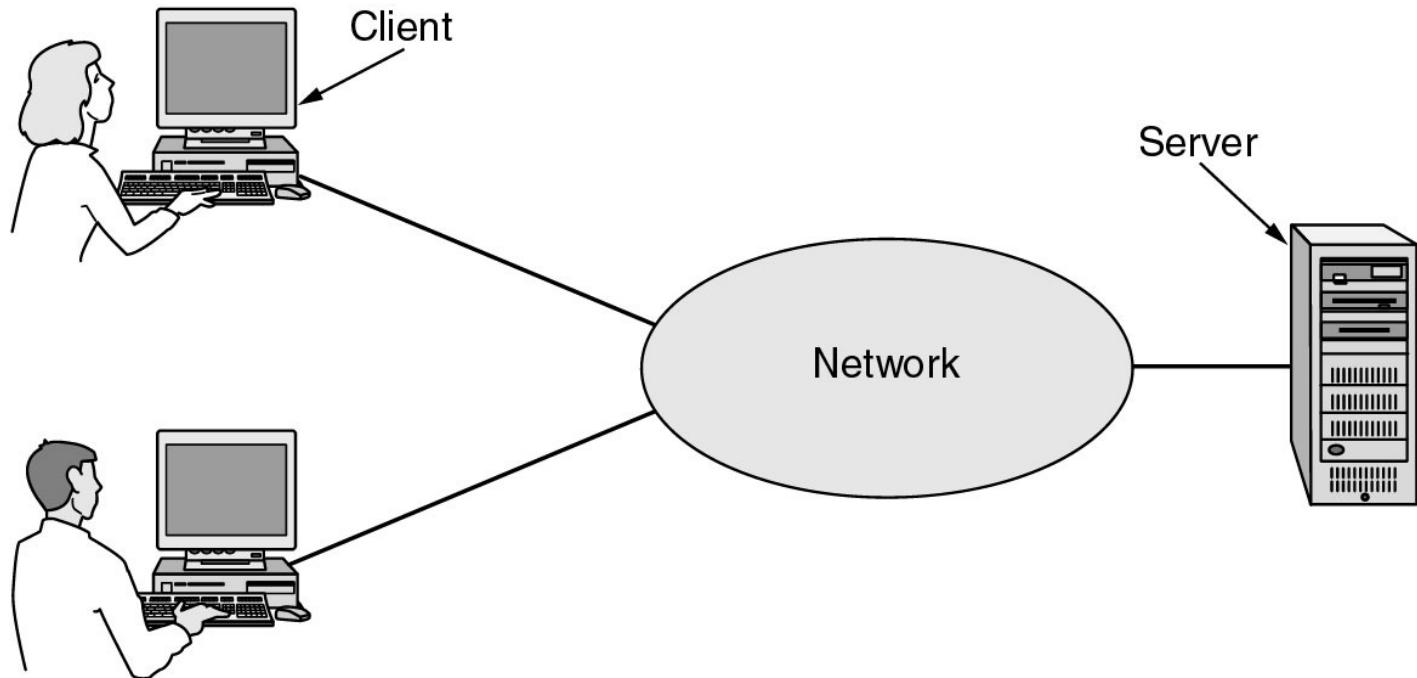
Transmission Form (2)

- Anycast (send message to *any* node of a given set)



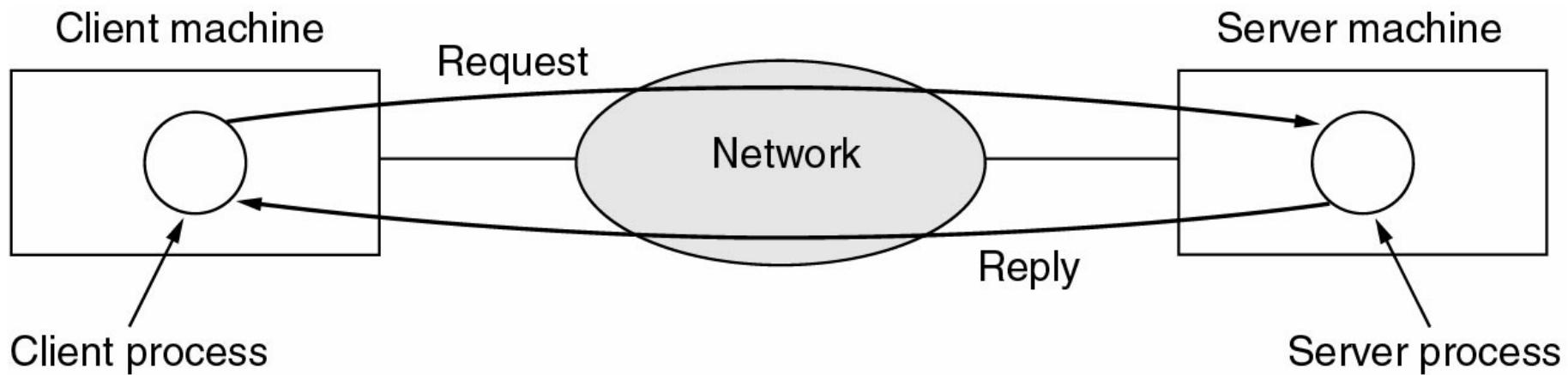
- More
 - Broadcast (special form of multicast, to everybody)
 - Convergecast (data gathering, reverse of broadcast)
 - Geocast (routing to a specific location)
 - ...

Client Server Configuration Scenario



A network with two clients and one server

Client Server Service Flow

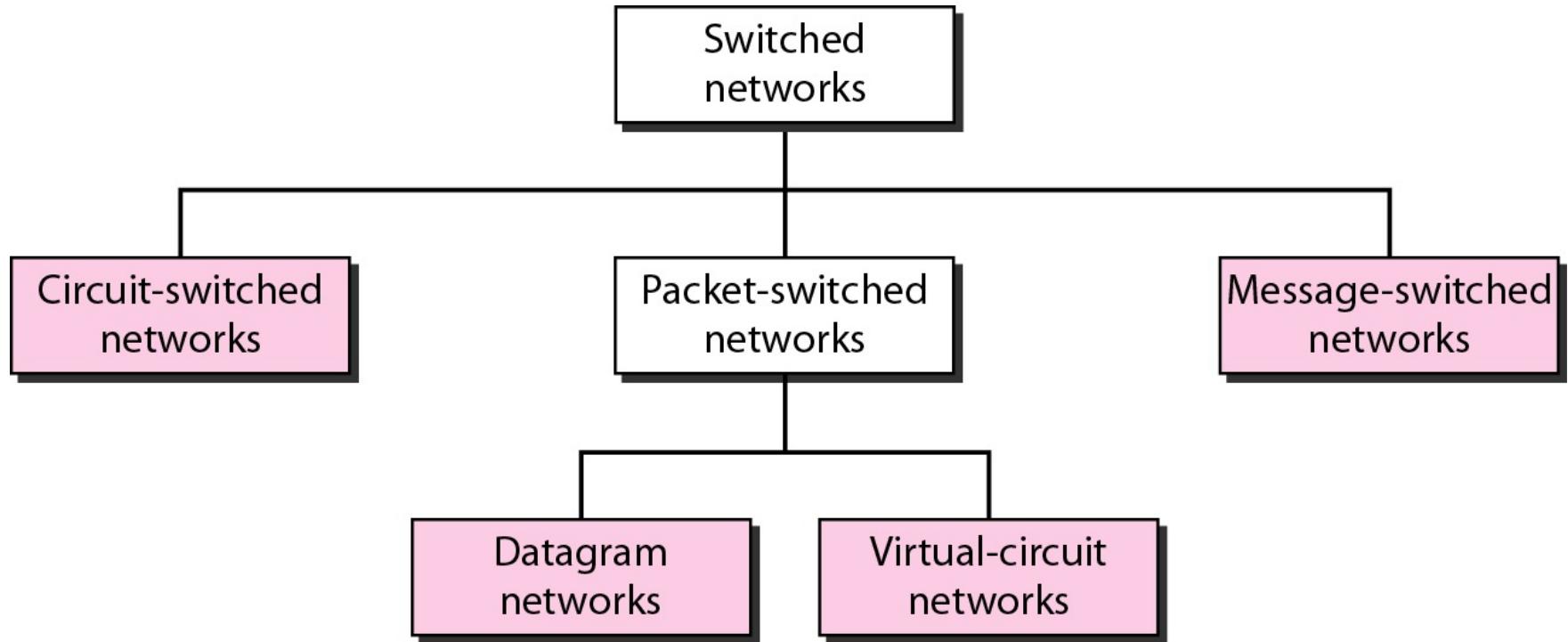


The client-server model involves requests and replies.

Connectionless & Connection-Oriented Services

- Connection-Oriented
 - Three-phases:
 1. Connection setup between two peer entities to initialize state information
 2. Data transfer
 3. Connection release
 - TCP is a connection oriented protocol
- Connectionless
 - Immediate transfer
 - No connection setup
 - E.g. UDP, IP

Taxonomy of switched networks



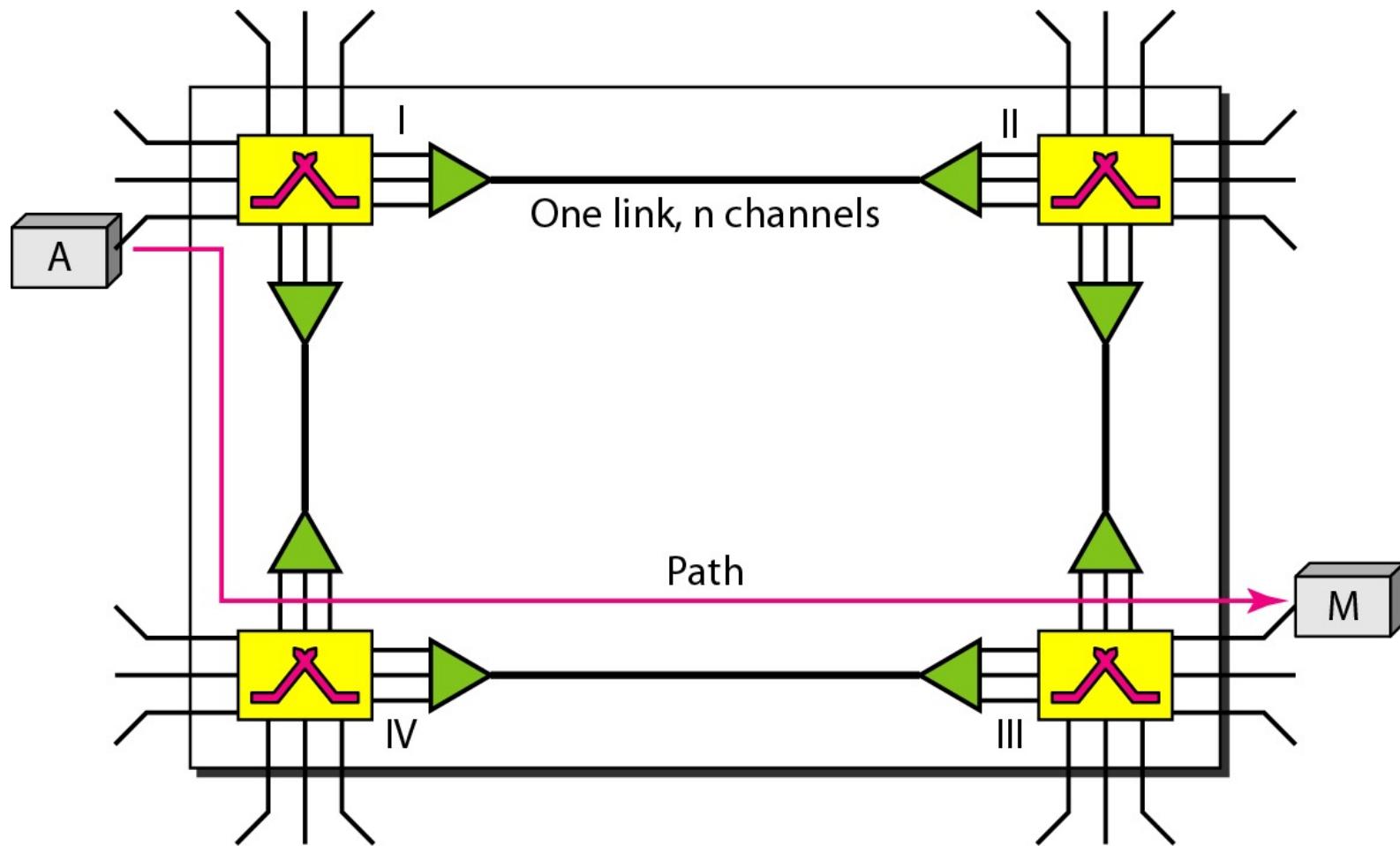
CIRCUIT-SWITCHED NETWORKS

- consists of a set of switches connected by physical links
- connection between two stations is a dedicated path made of one or more links
- each connection uses only one dedicated channel on each link.
- Each link is normally divided into n channels by using FDM or TDM.

Note

A circuit-switched network is made of a set of switches connected by physical links, in which each link is divided into n channels.

A circuit-switched network



In circuit switching, the resources need to be reserved during the setup phase; the resources remain dedicated for the entire duration of data transfer

Switching at the physical layer in the traditional telephone network uses the circuit-switching approach.

Circuit Switching vs Packet Switching

Circuit Switching

- Designed for voice communication.
- Once a circuit is established, it remains connected for duration of session.
- Less well suited to data and nonvoice transmission.
- Lower data rate- it creates a link equivalent of a single cable between two devices and thereby assumes a single data rate for both devices.
- Inflexible- once a circuit has been established, that circuit is the path taken by all parts of transmission whether or not it remains the most efficient/available.
- sees all transmissions as equal- any request is granted to whatever link is available.

Circuit Switching vs Packet Switching

Packet Switching

- Designed for data transmission.
- Data are transmitted in discrete units, packets.
- Maximum length of packets is established by the network.
- Longer transmissions are broken up into multiple packets and each packet contains data as well as header with control information.
- Packets are sent over the network node to node and in each node, the packet is stored shortly then routed according to its information in its header.

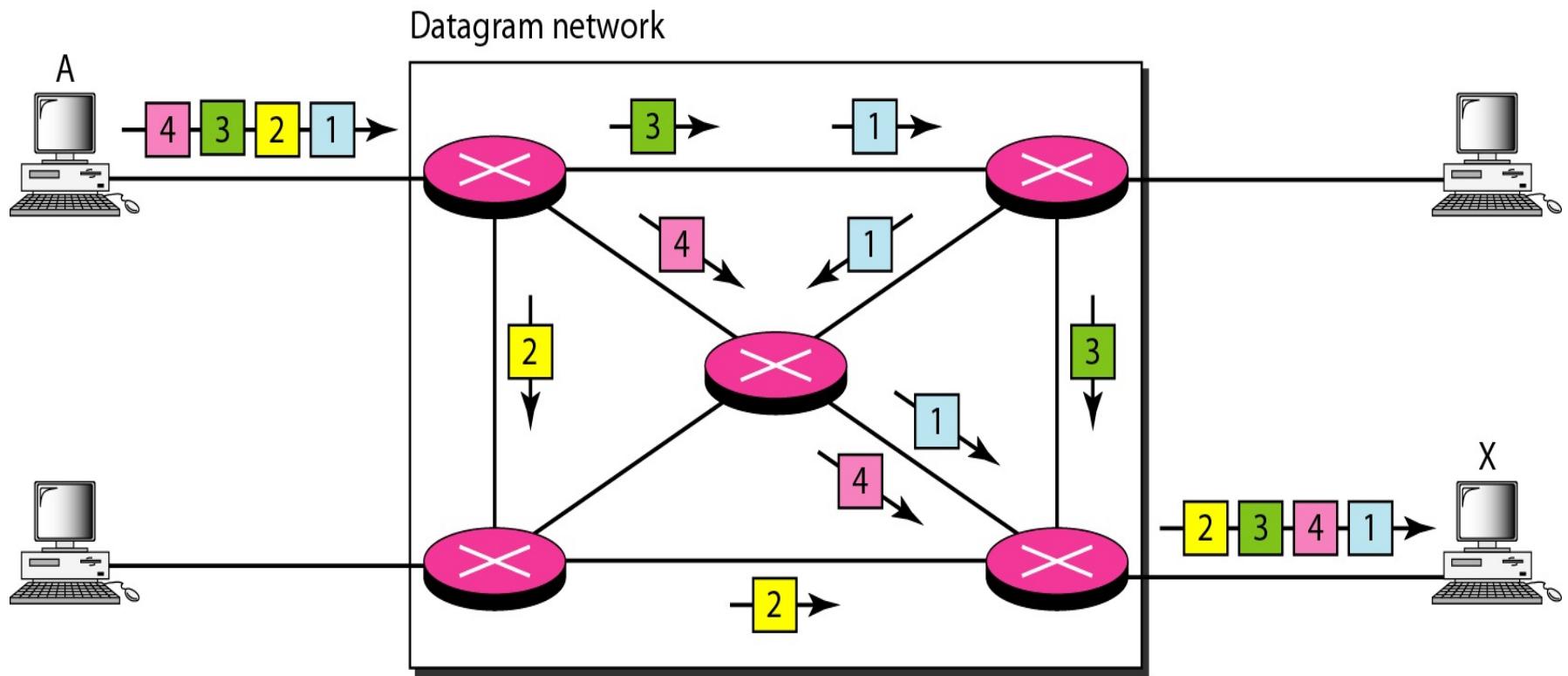
DATAGRAM NETWORKS

- In data communications, we need to send messages from one end to another.
- If the message is going to pass through a packet-switched network, it needs to be divided into packets of fixed or variable size.
- The size of the packet is determined by the network and the governing protocol.

Note

**In a packet-switched network, there
is no resource reservation;
resources are allocated on demand.**

Datagram Network



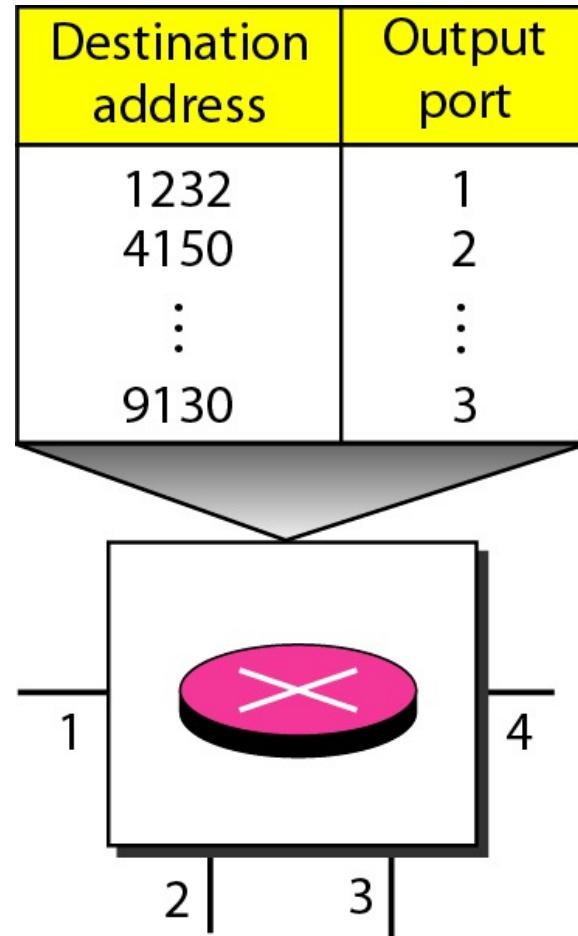
A datagram network with four switches (routers)

Note

A switch in a datagram network uses a routing table that is based on the destination address.

The destination address in the header of a packet in a datagram network remains the same during the entire journey of the packet.

Routing table in a datagram network



Note

Switching in the Internet is done by using the datagram approach to packet switching at the network layer.

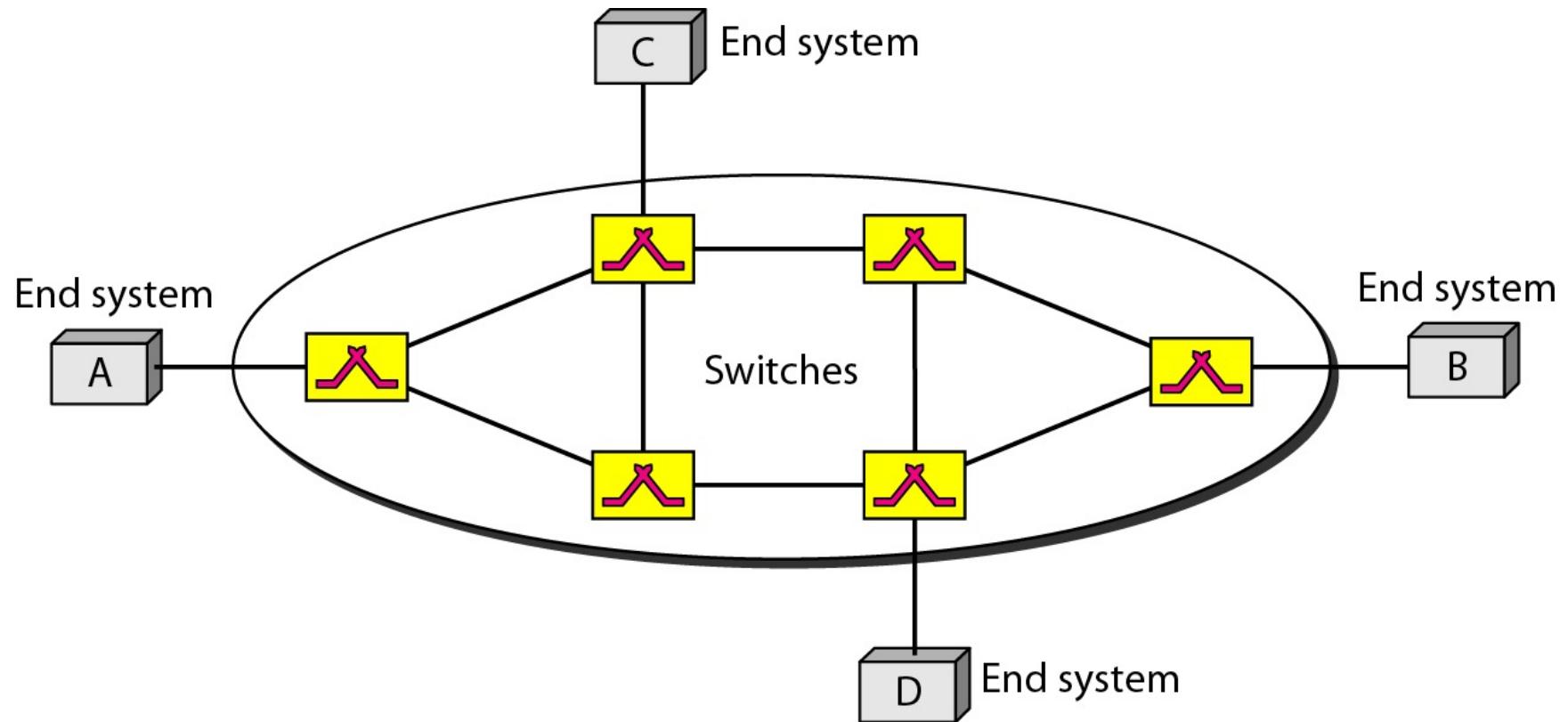
VIRTUAL-CIRCUIT NETWORKS

A virtual-circuit network is a cross between a circuit-switched network and a datagram network. It has some characteristics of both.

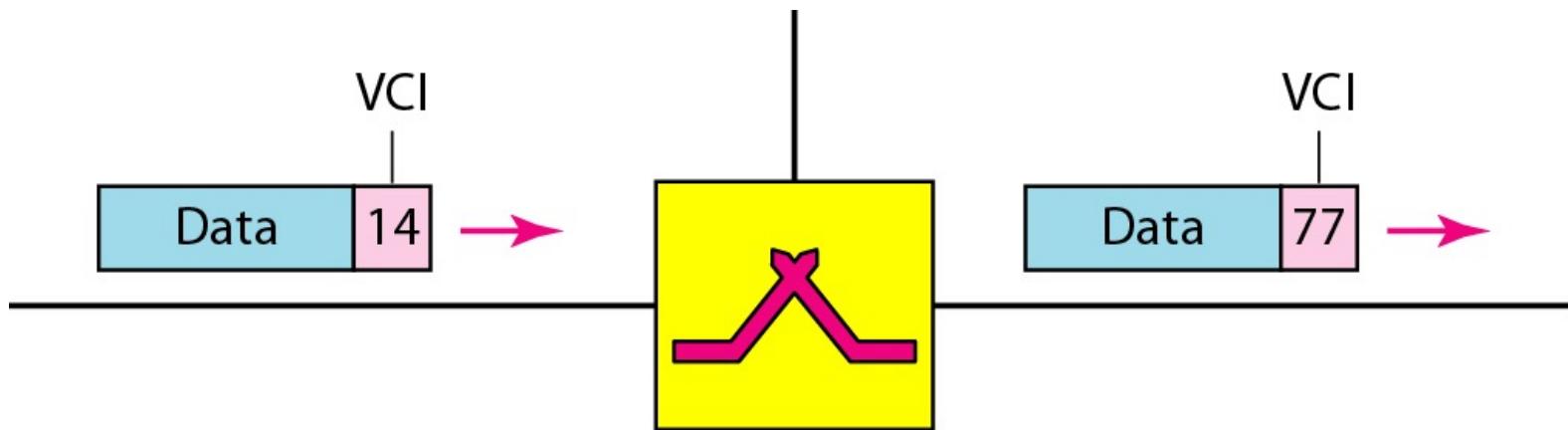
Note

Switching at the data link layer in a switched WAN is normally implemented by using virtual-circuit techniques.

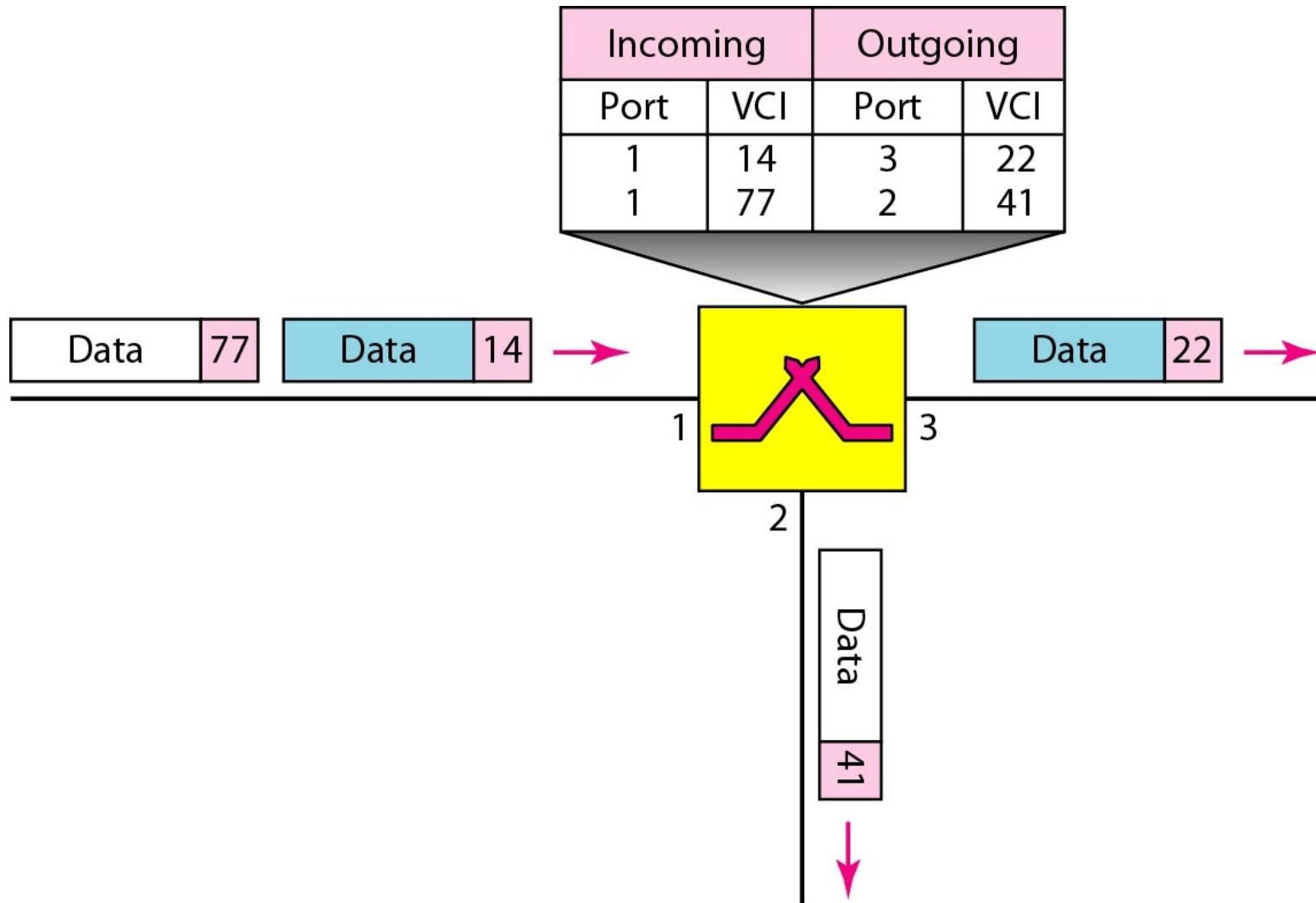
Virtual-circuit network



Virtual-circuit identifier (VCI)



Switch and tables in a virtual-circuit network



Network Types

- Local Area Networks
- Metropolitan Area Networks
- Wide Area Networks
- Wireless Networks

Broadcast Networks

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

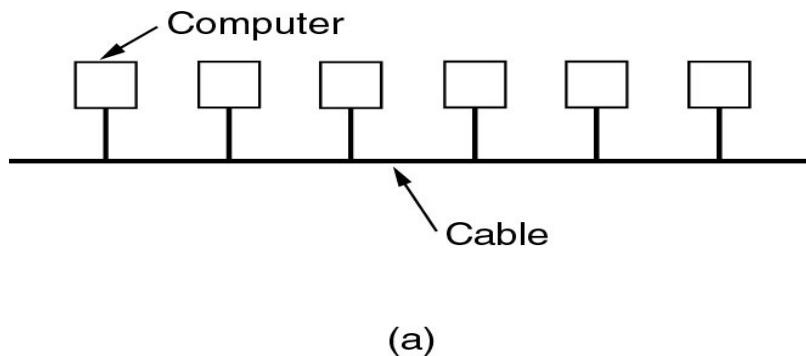
Classification of interconnected processors by scale.

Local Area Networks

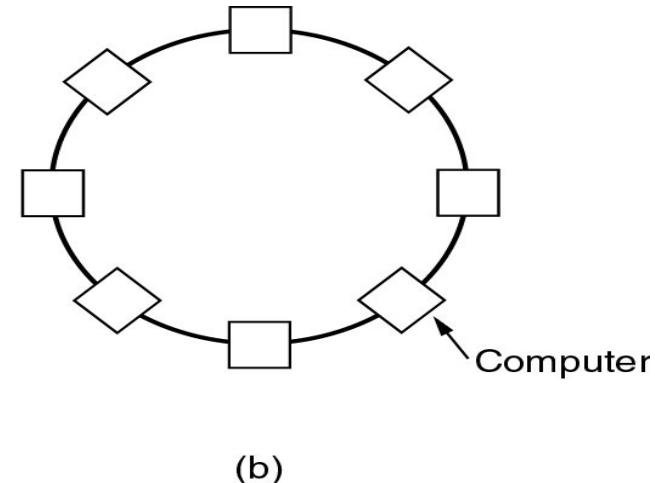
- Private networks within a single building or campus of up to a few kilometers in size.
- Connect personal computers and workstations to share resources (e.g., printers) and exchange information.
- Distinguished from other networks by three characteristics: (1) size, (2) transmission technology, and (3) topology.
- Traditional LANs run at speeds of 10 Mbps to 100 Mbps, have low delay (microseconds or nanoseconds), and make very few errors.
- In a bus (i.e., a linear cable) network, at any instant one machine is the master and is allowed to transmit. All other machines are required to refrain from sending.

Local Area Networks

- IEEE 802.3, popularly called Ethernet
- In a bus-based broadcast network with decentralized control, usually operating at 10 Mbps to 10 Gbps.
- Computers on an Ethernet can transmit whenever they want to.
- if two or more packets collide, each computer just waits a random time and tries again later.



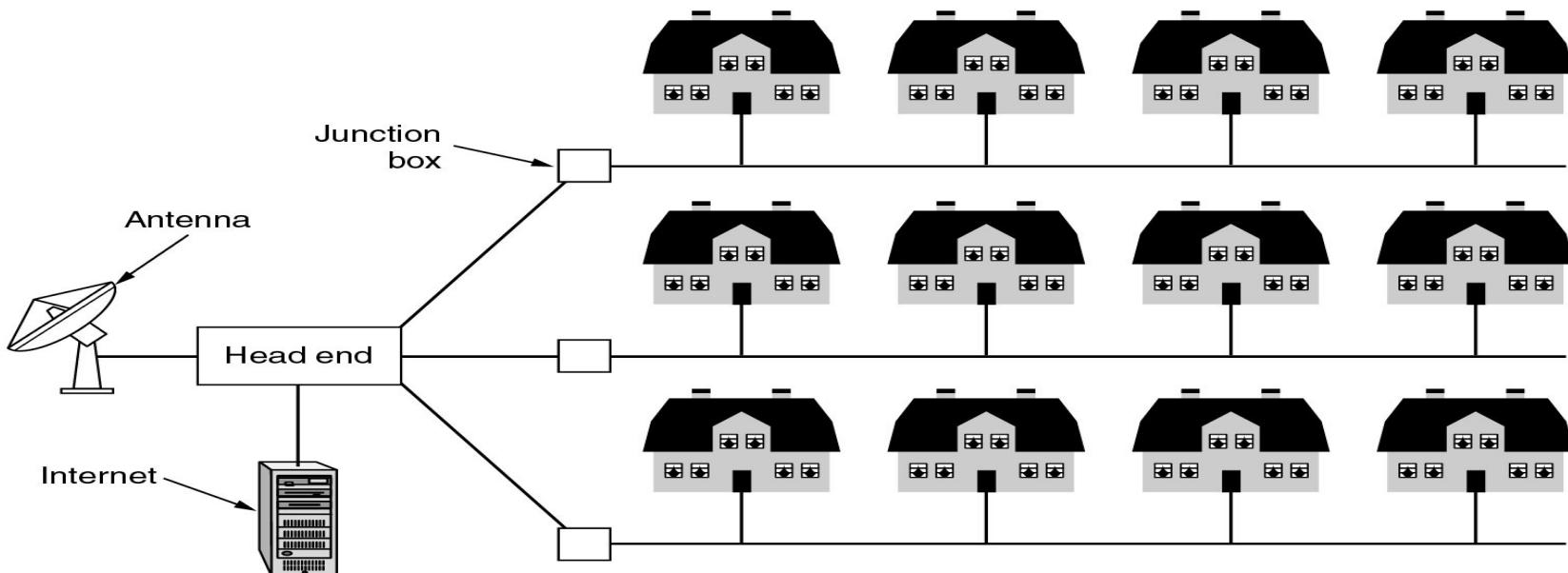
(a) Bus



(b) Ring

Metropolitan Area Networks

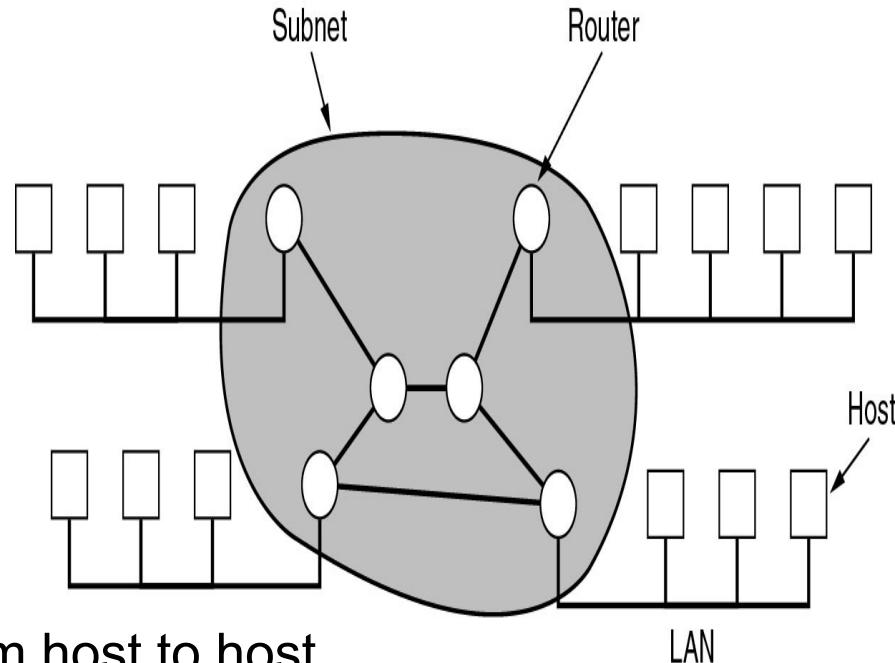
- A collection of LANs with large geographical area
- Provide high speed network (Not as fast as LAN) to share regional resources.
- IEEE 802.16 wireless broadband is a form of MAN network
- Best example of a MAN is the cable television network available in many cities.



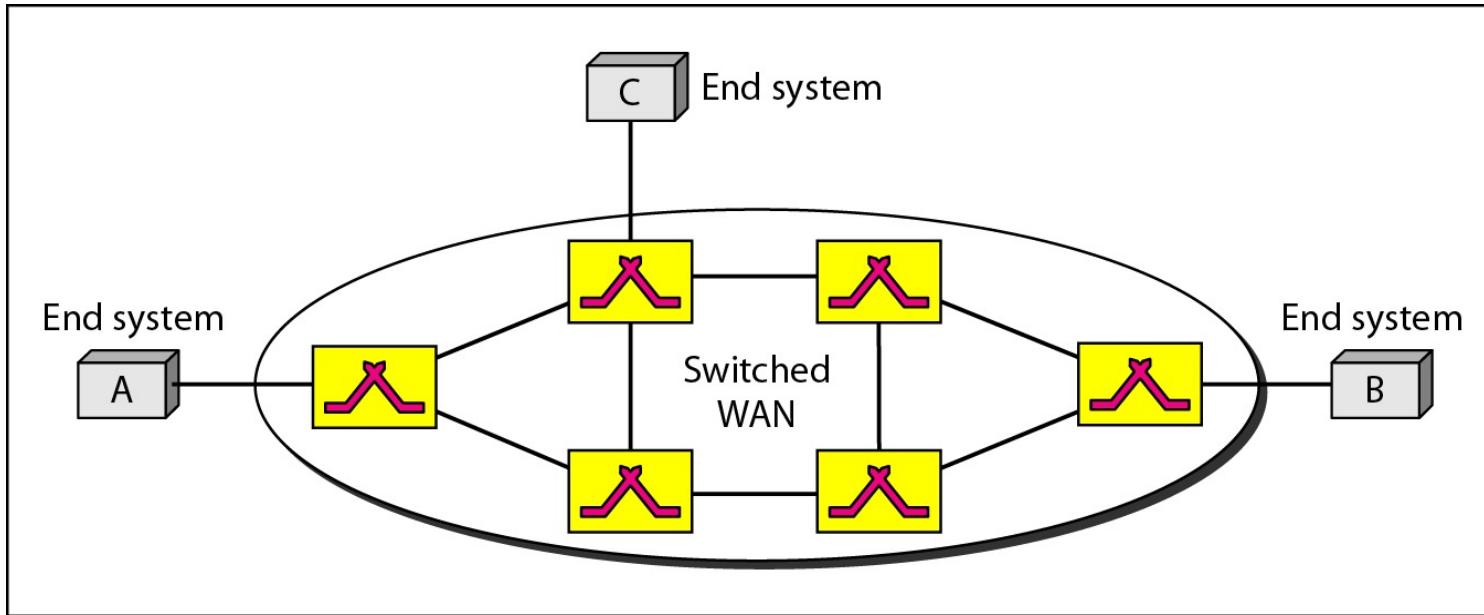
A metropolitan area network based on cable TV

Wide Area Networks

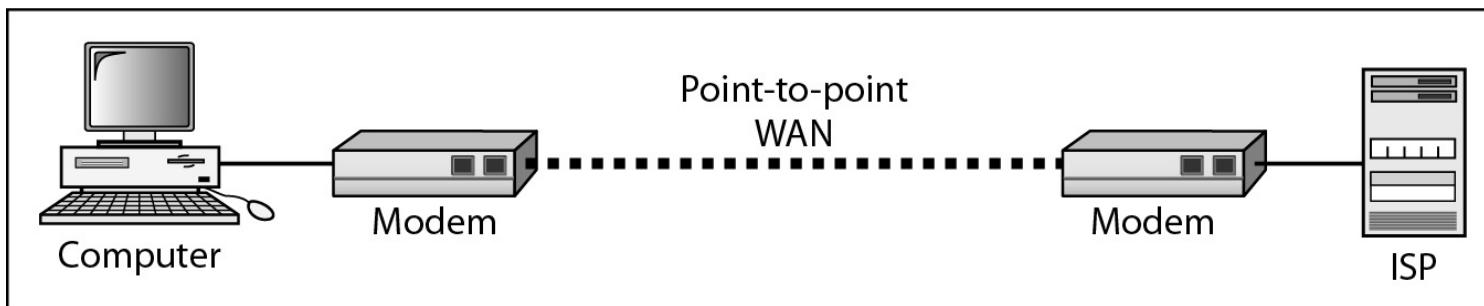
- A group of MANs or LANs or mixed of both constitute a WAN network
- Covers a large geographical area, often a country or continent.
- Follows a *MESH* topology network
- The popular example of MAN network is internet.
- Subnet is used to carry messages from host to host
- Subnet consists of two distinct components:
 - transmission lines and switching elements
- Transmission lines move bits between machines
- Switching element helps to choose an outgoing line to forward bits



Wide Area Networks (2)



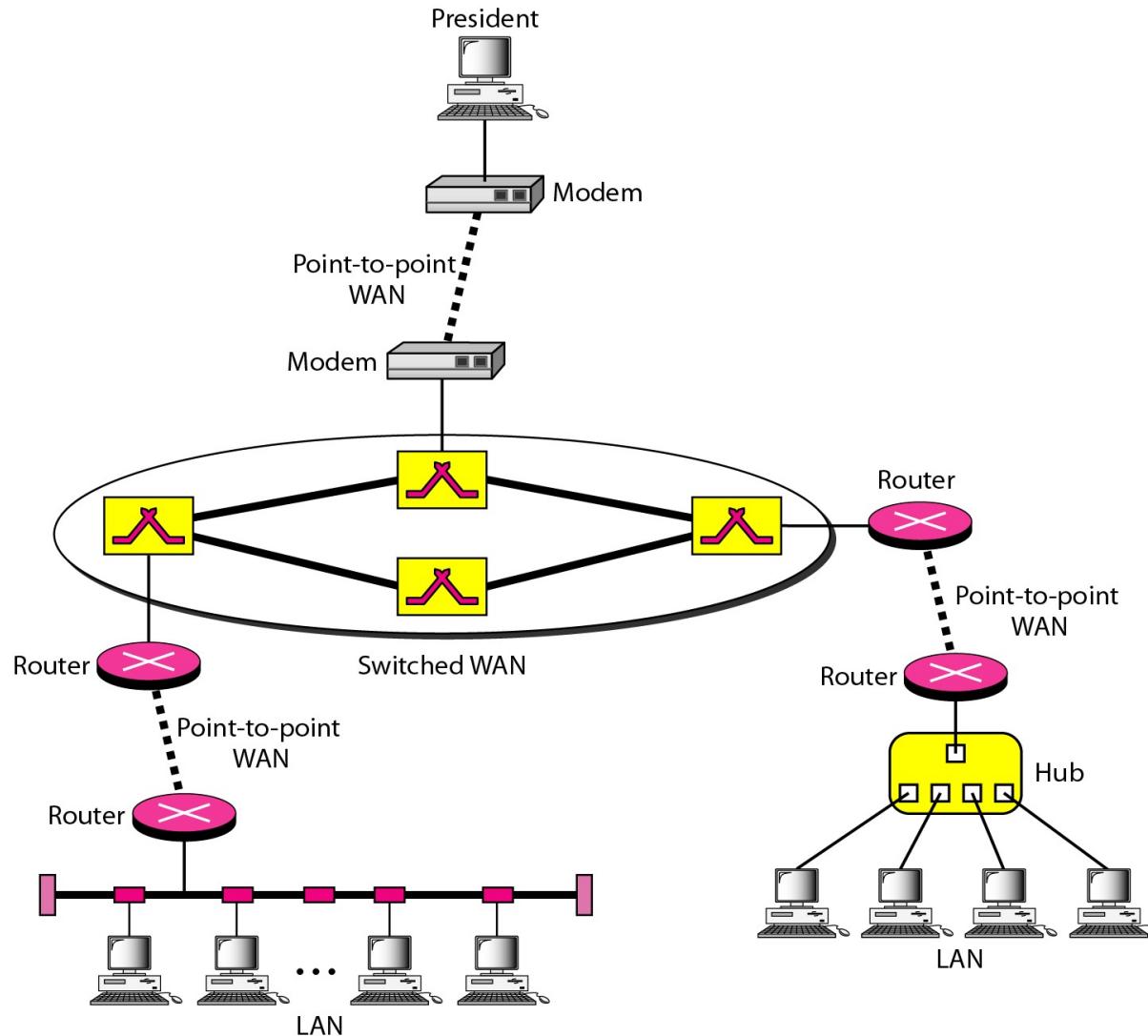
a. Switched WAN



b. Point-to-point WAN

WANs: a switched WAN and a point-to-point WAN

Wide Area Networks (3)



A heterogeneous network made of four WANs and two LANs

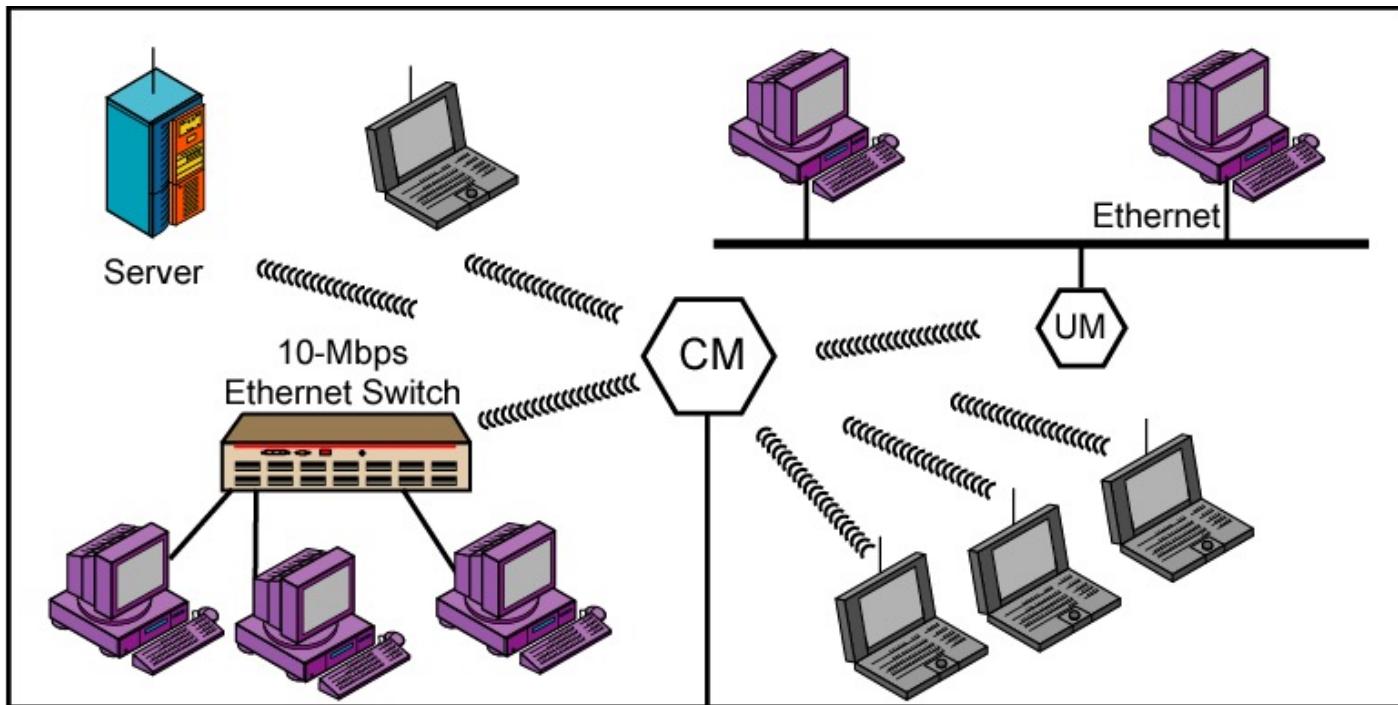
Wireless LAN

- A wireless LAN uses wireless transmission medium
- low data rates, occupational safety concerns, and licensing requirements
- Popularity of wireless LANs has grown rapidly
- Used protocol CSMA/CA
- IEEE standard 802.11

Wireless LAN Standards

<u>802.11</u>	<u>Release</u>	<u>Freq</u>	<u>Typ Throughput</u>	<u>Max Net Bitrate</u>	<u>Mod</u>
----	1997	2.4 GHz	0.9 Mbps	2	IR/FHSS/DSSS
a	2003	5	23	54	OFDM
b	1999	2.4	4.3	11	DSSS
g	2003	2.4	19	54	OFDM
n	2009	2.4 / 5	74	600	OFDM

Single Cell Wireless LAN Configuration

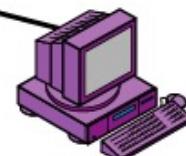


UM = user module
CM = control module

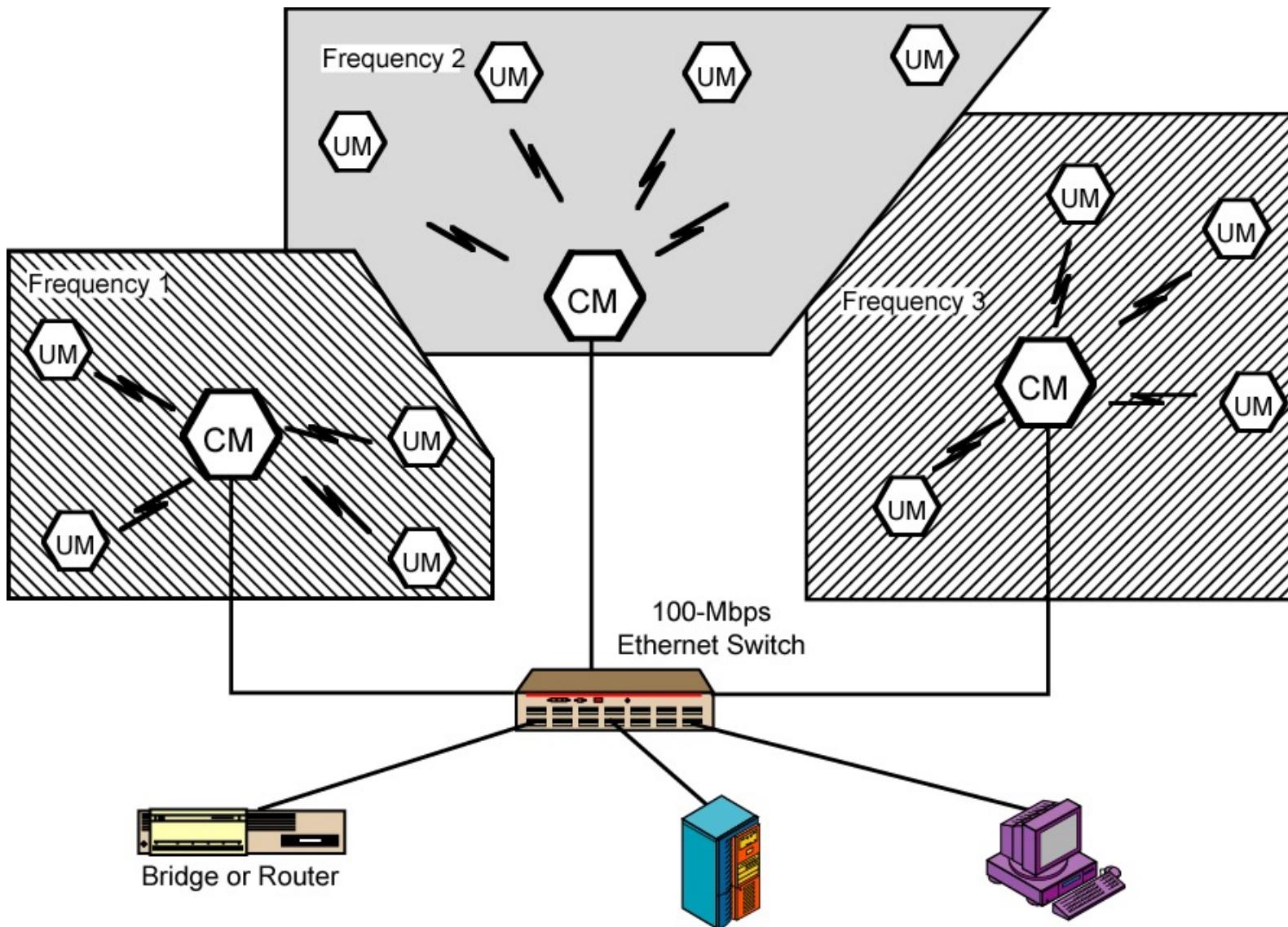
100-Mbps Ethernet Switch



Bridge or Router



Multi-Cell Wireless LAN Configuration



Creating WLAN Connections

- An Access Point (AP) broadcasts its SSID (service set identifier) roughly every 100 ms and at 1 Mbps (to accommodate the slowest client)
- The Wi-Fi spectrum is divided into a fixed number of channels
 - 11 in North America
 - 13 in most of Europe and China
 - 14 in Japan

Creating WLAN Connections (2)

- But not all channels are used due to the concern of overlapping frequencies
- In North America, only channels 1, 6 and 11 are recommended for 802.11b and g.
- IEEE 802.11a has 42 channels, of which only 24 are used in North America, from which only about 12 are used to reduce overlapping frequencies

Other Network Communications

- Campus Area Network
- Home area Network
- Personal area Network