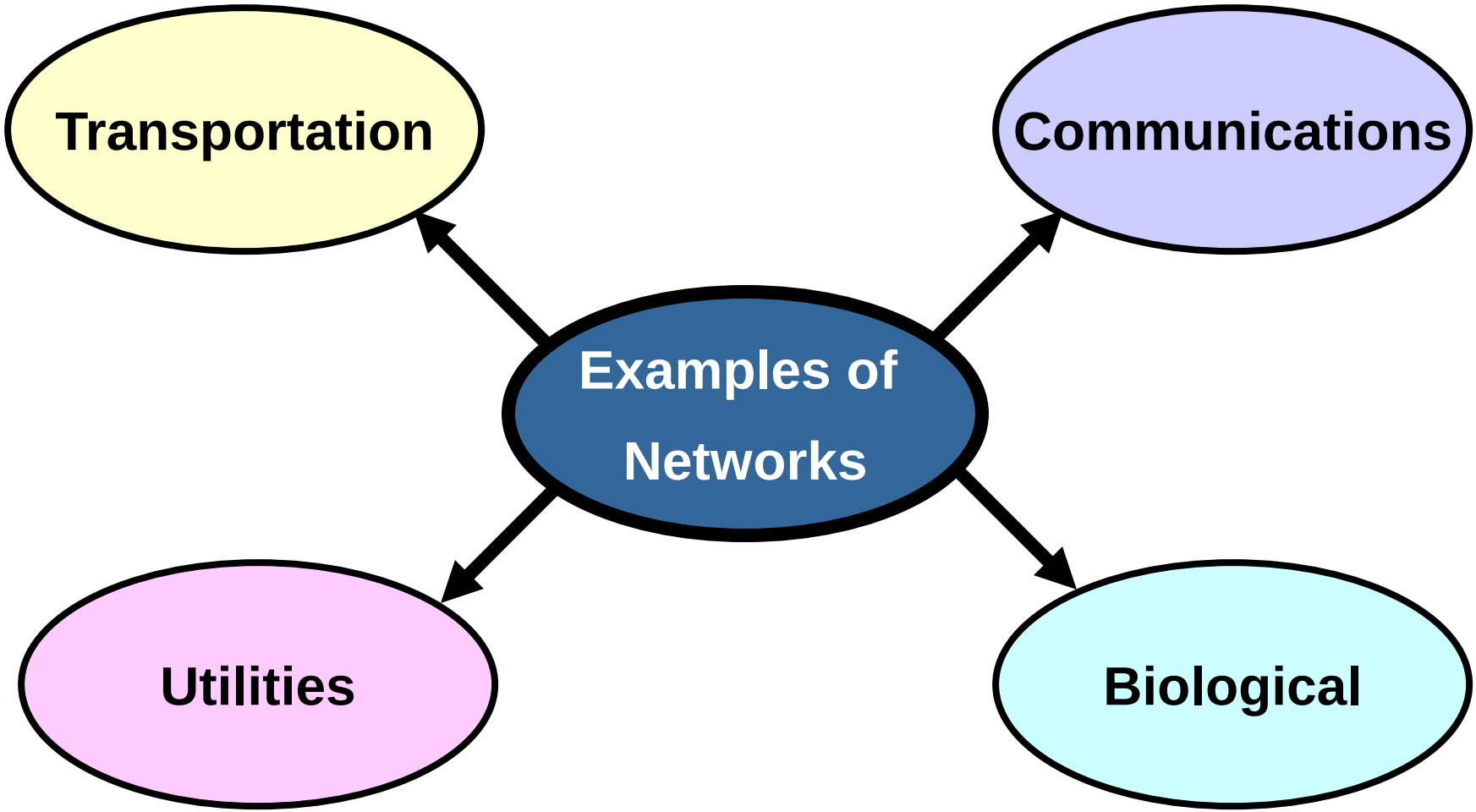
The Saigon CTT

Chapter 1

BASIC NETWORKING

Examples of Networks



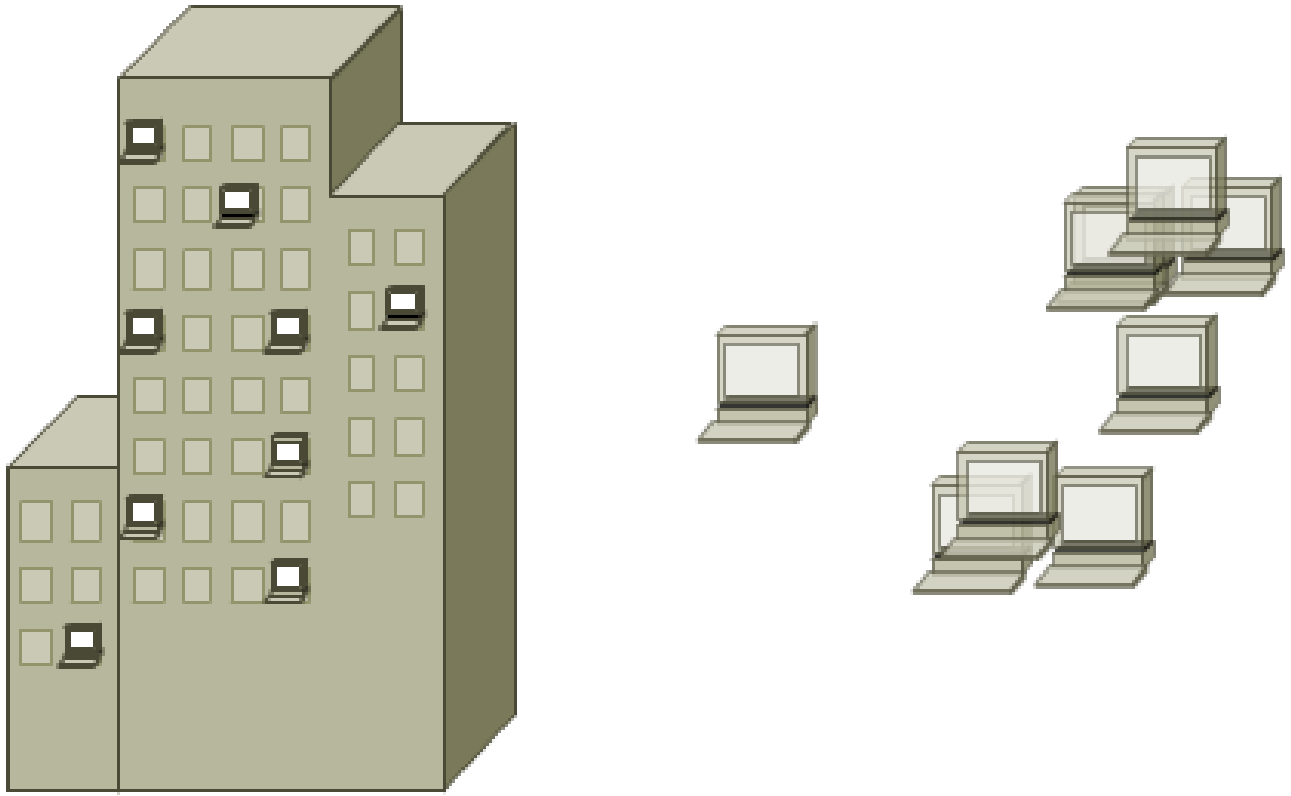
Network = Net + Work

- What is flowing ?
- What different forms flow ?
- What rules govern flow ?
- Where does the flow occur ?

Data Network

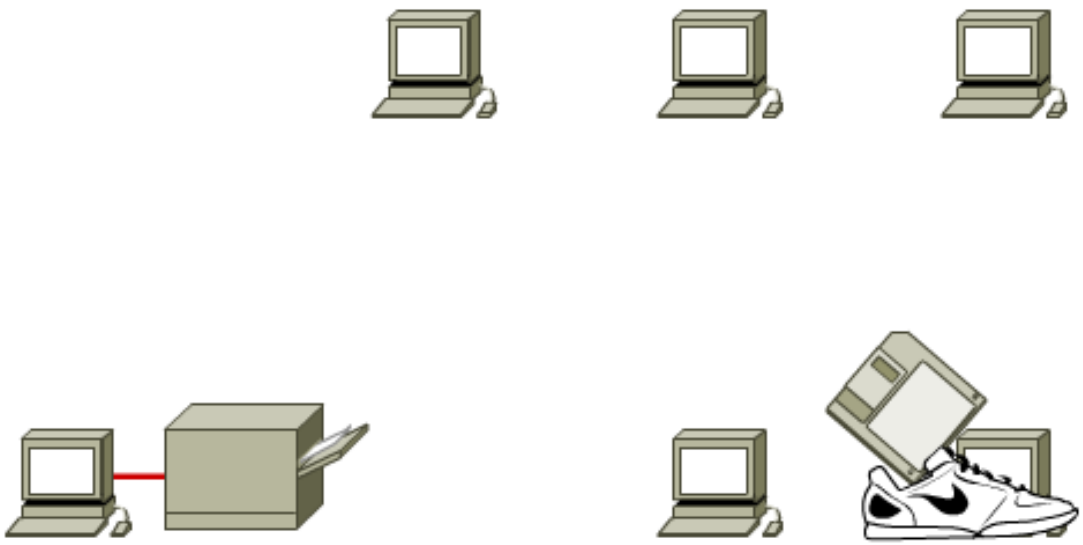
- What is flowing ?
  - Data
- What different forms flow ?
  - Text, Graphic, Video ...
- What rules govern flow ?
  - Standard, Protocol ...
- Where does the flow occur ?
  - Wire, Cable, Atmosphere ...

Evolution of Networking (1)



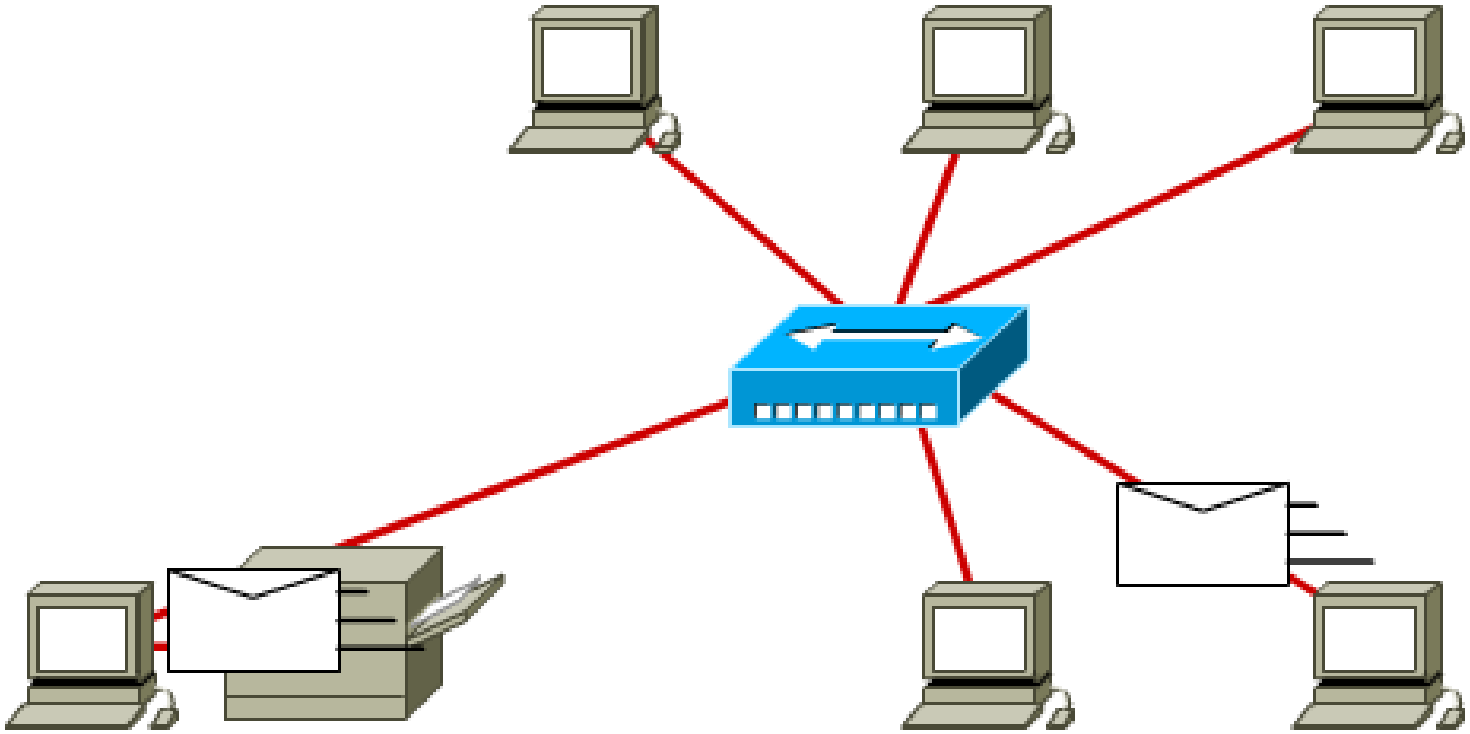
Individual Computers

Evolution of Networking (2)



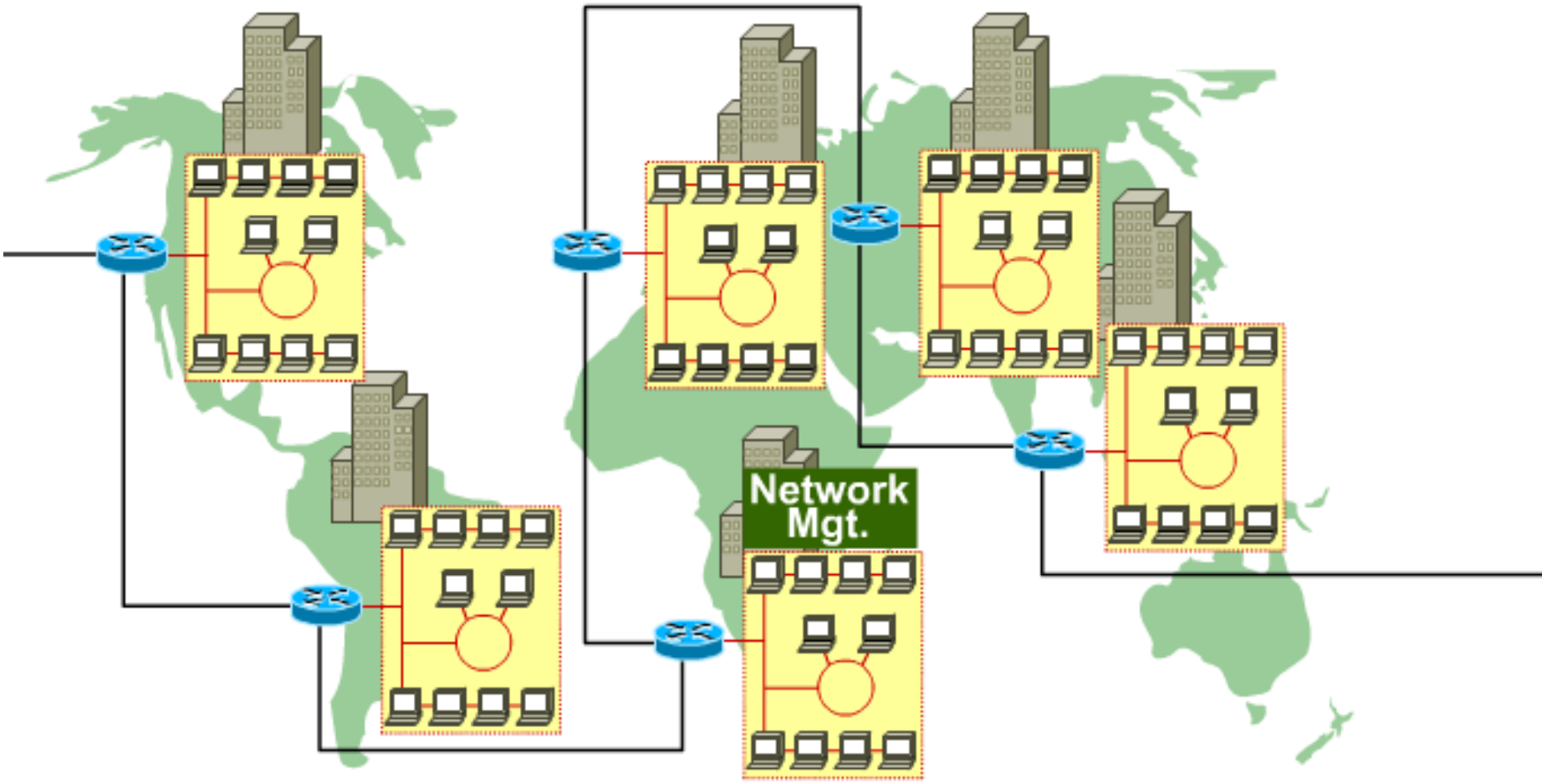
- Duplicate equipment and resources
- Difficult to communicate
- Difficult to provide management

Evolution of Networking (3)



LAN: Local Area Network

Evolution of Networking (4)

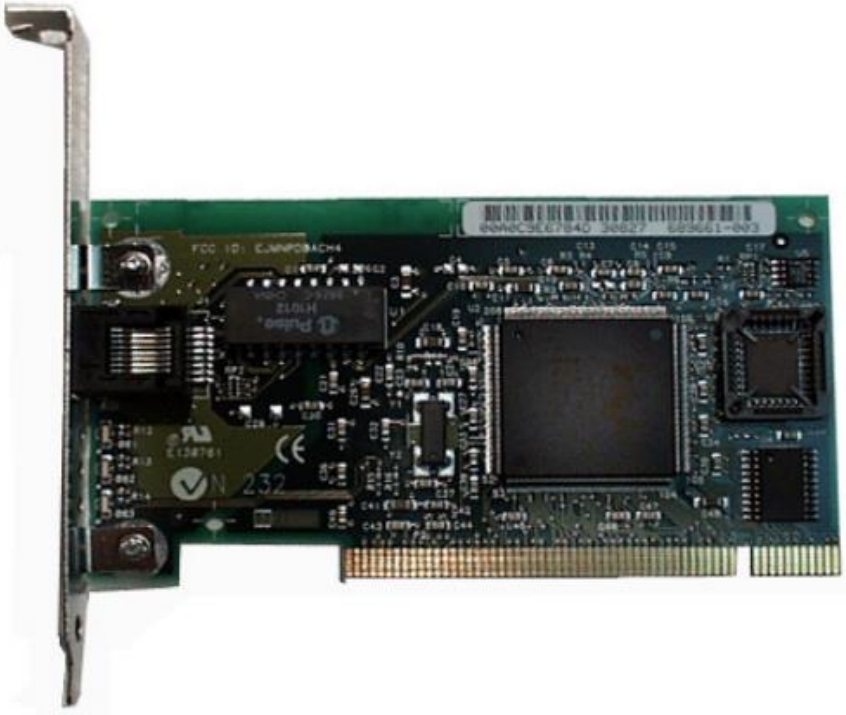


WAN: Wide Area Network

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

NIC: Network Interface Card



PCMCIA

Personal **C**omputer **M**emory **C**ard **I**nternational **A**ssociation

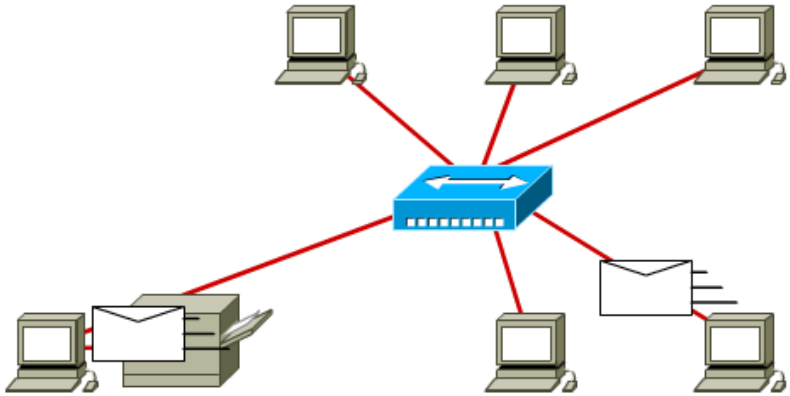
- IRQ
- I/O address
- Memory address

Select a NIC

- Type of Network:
  - Ethernet, Token Ring, FDDI
- Type of media:
  - Twisted-pair, Coaxial, Fiber-optic cable
- Type of system bus:
  - PCI, ISA

LAN = Local Area Network

- Connect physically adjacent devices
- Operate within a limited geographic area
- High-bandwidth media
- Full-time connectivity
- Control the network privately



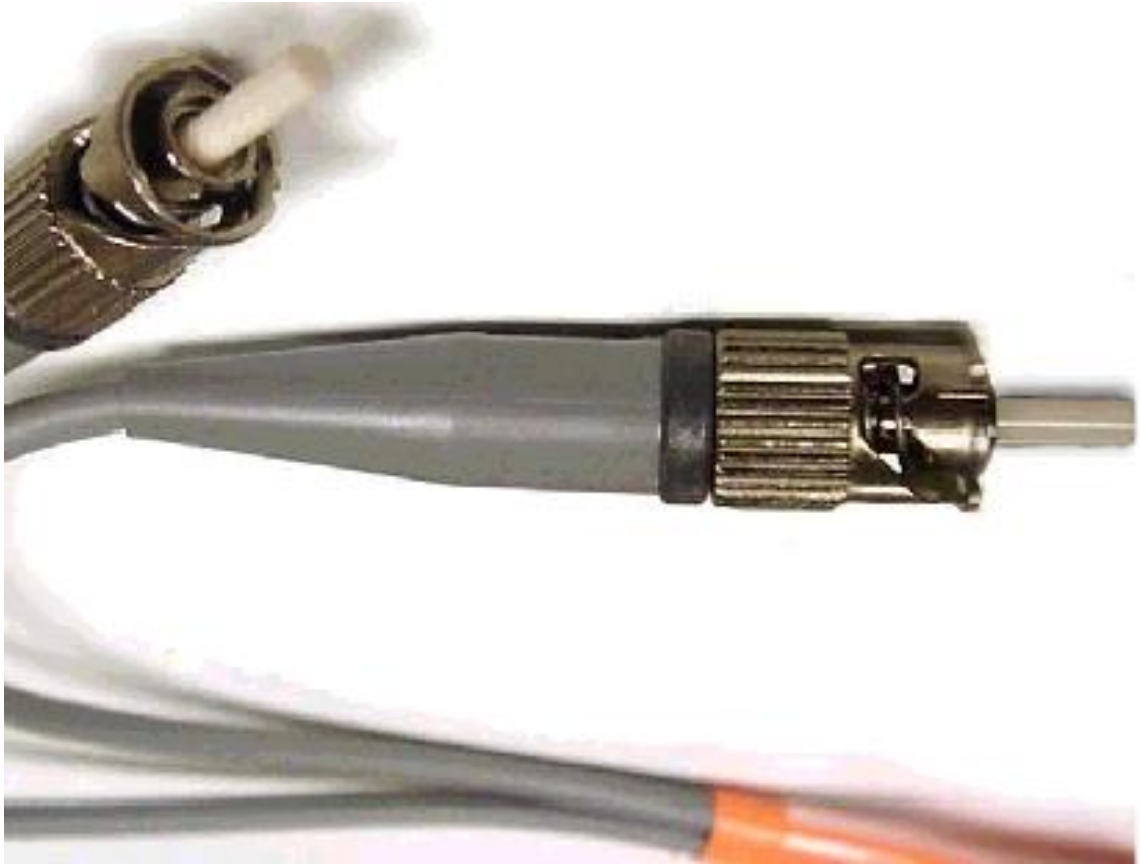
LAN Media: Coaxial Cable

- 10Base2
- 10Base5

LAN Media: UTP & STP

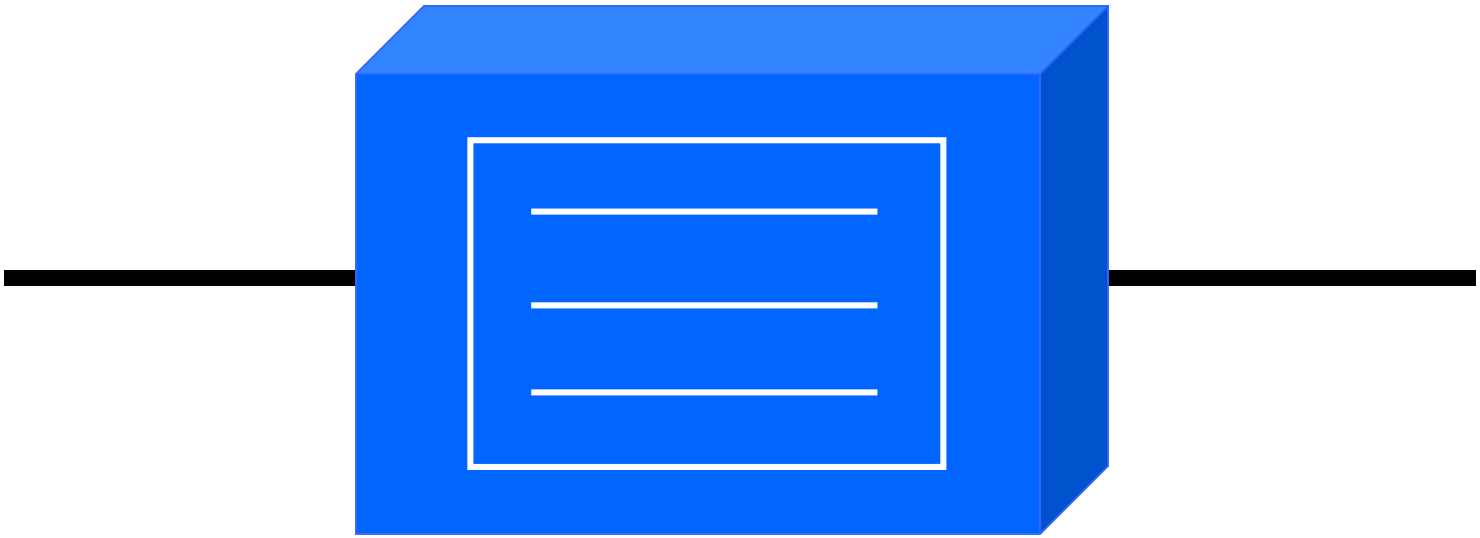
- 10BaseT
- 100BaseTX

LAN Media: Fiber Optic



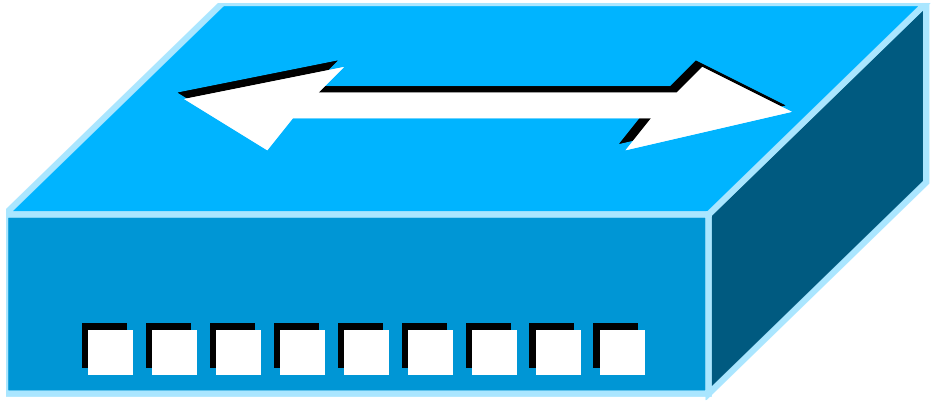
- 100BaseFX
- 1000BaseLX

LAN Equipment: Repeater



Regenerates and Repeats the signal.

LAN Equipment: HUB

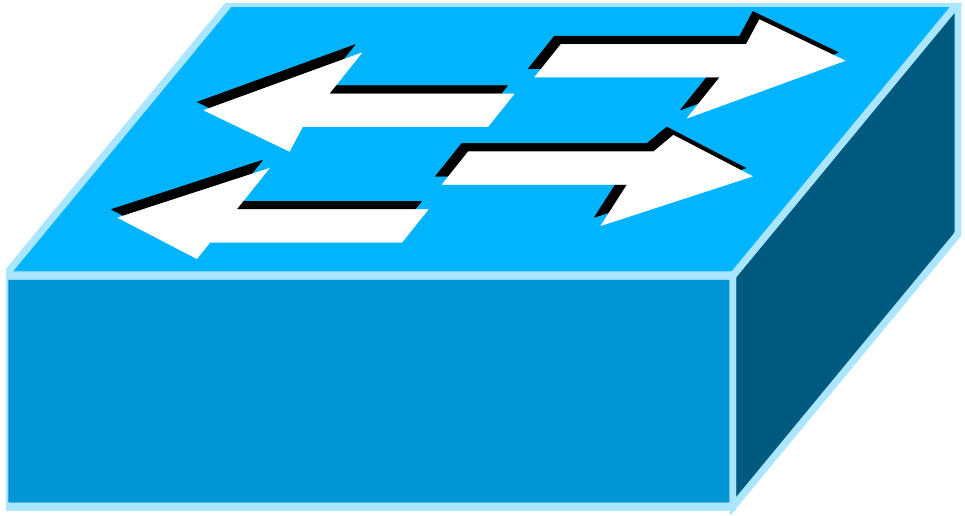


Multiport Repeater

LAN Equipment: Bridge

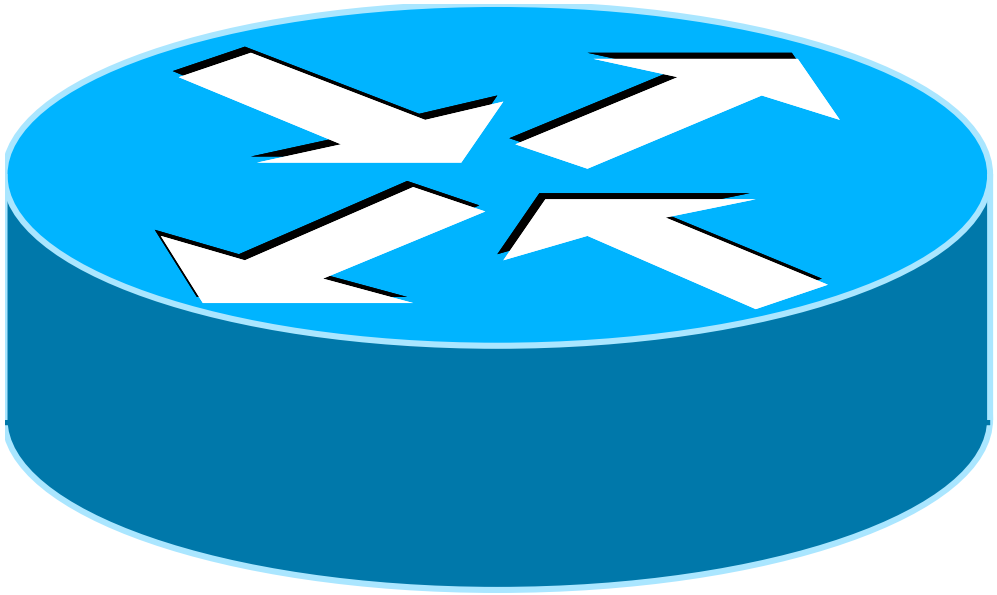
Filter traffic based on MAC Addresses.

LAN Equipment: Switch



Multiport Bridge

LAN Equipment: Router

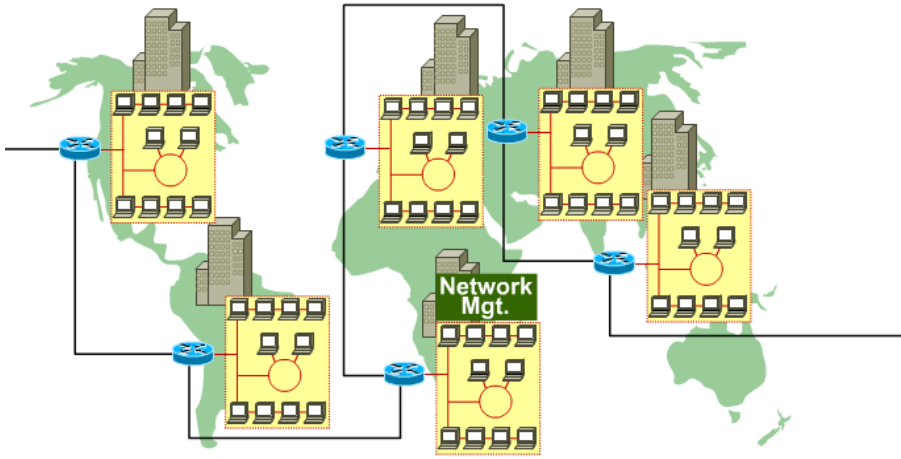


Path determination

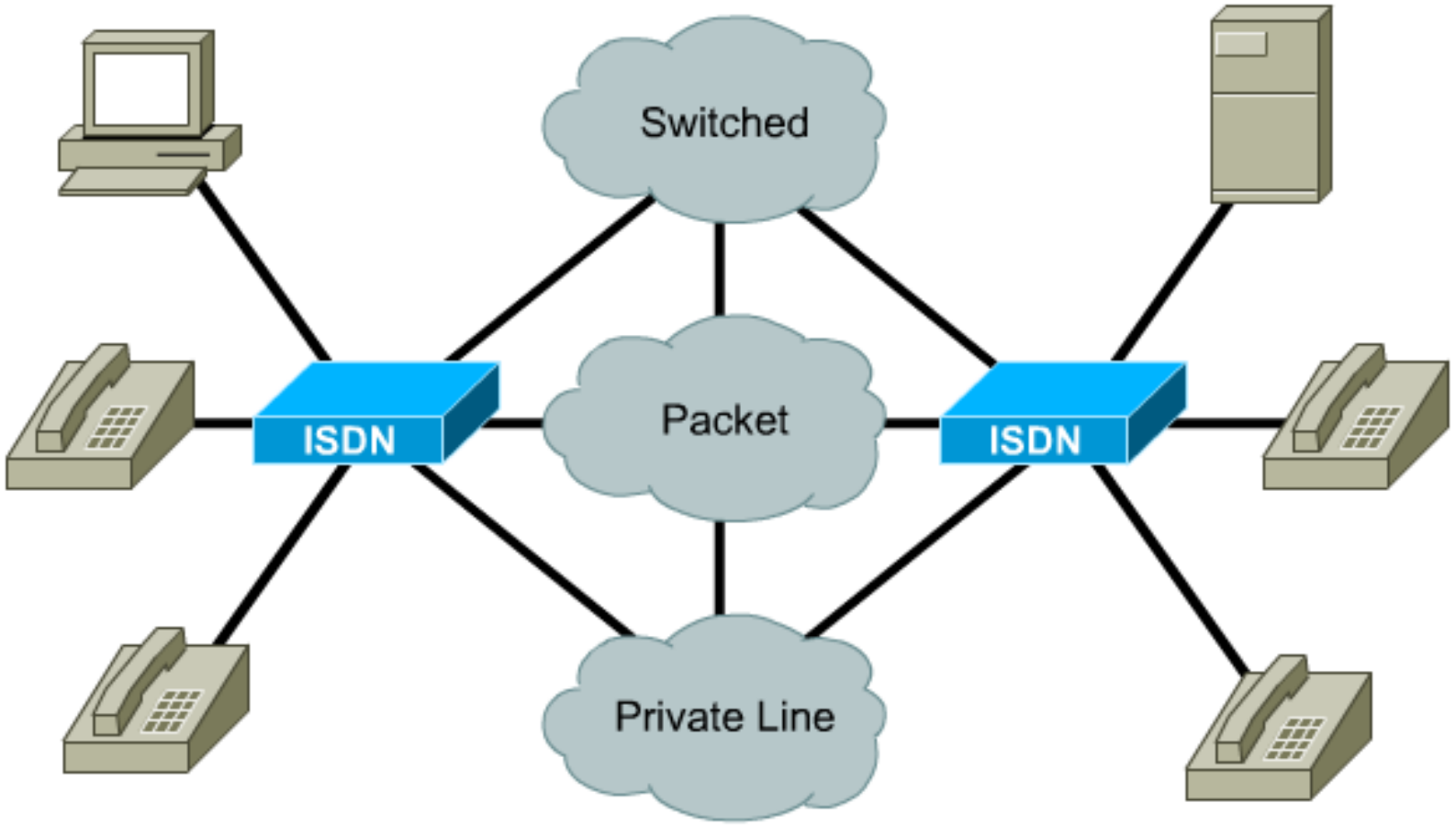
Packet switching

WAN = Wide Area Network

- Devices separated over wide areas
- Operate over large geographical area
- Slow speed
- Full-time and Part-time connectivity

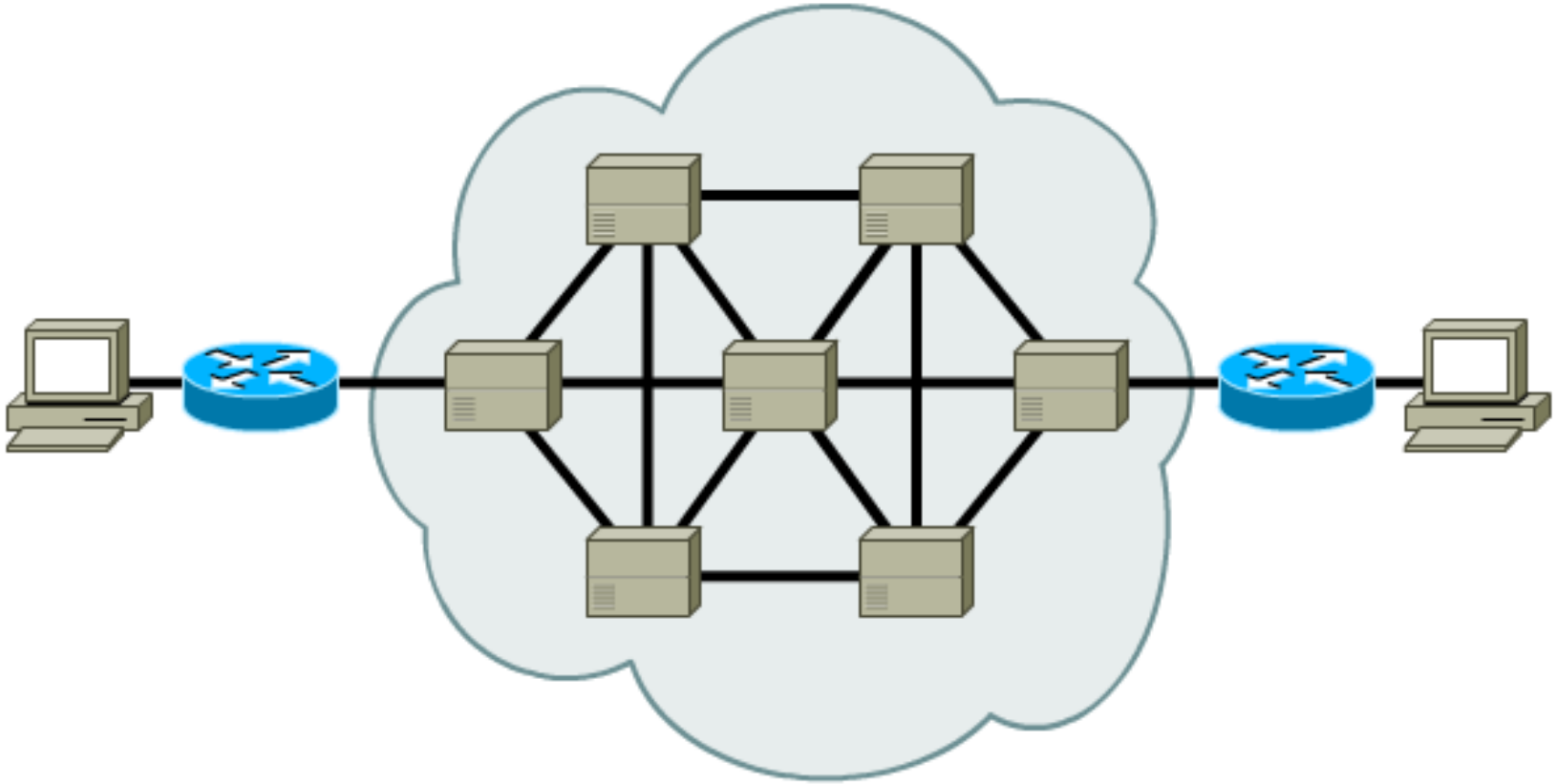


WAN Media: ISDN & PSTN



Part-time connectivity (Dial-up by modem)

WAN Media: Frame Relay

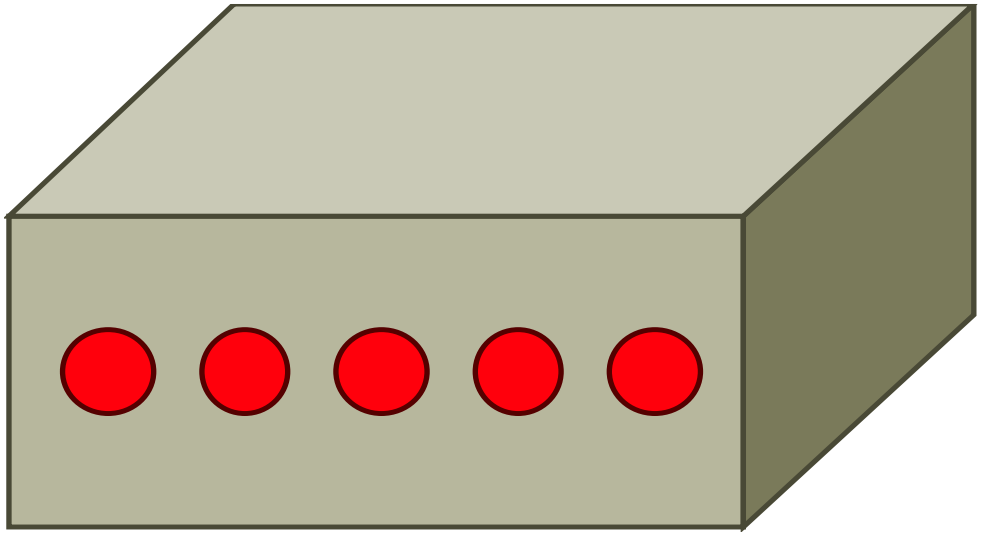


Full-time connectivity

WAN Media: Leased Line

Full-time connectivity

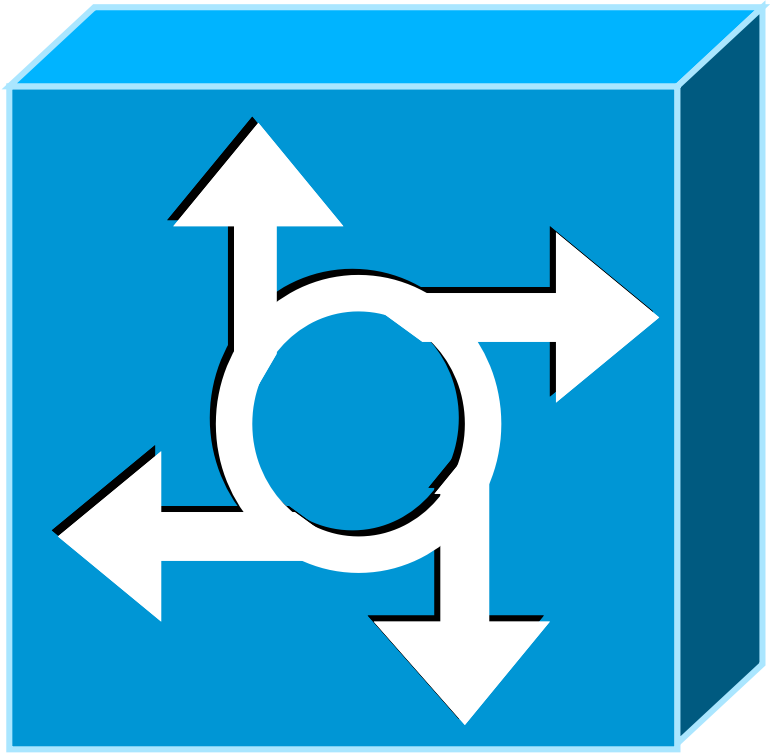
WAN Equipment: Modem



MODEM = MOdulate and DEModulate

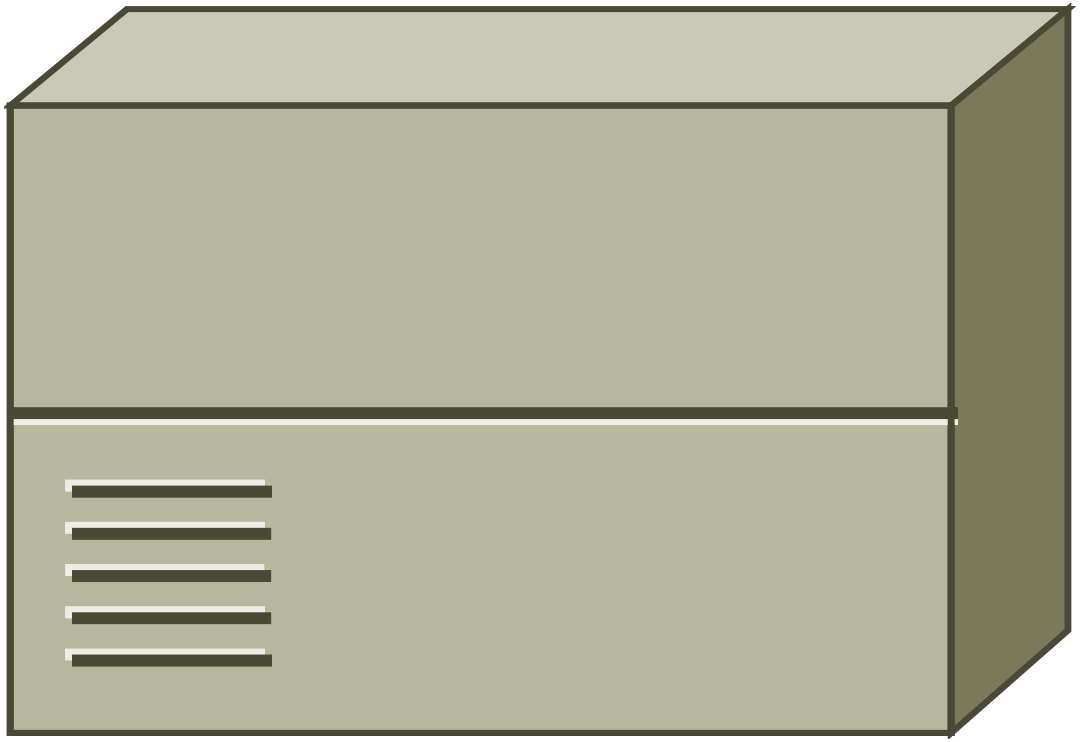
Syn Modem, Asyn Modem

WAN Equipment: Comm. Server



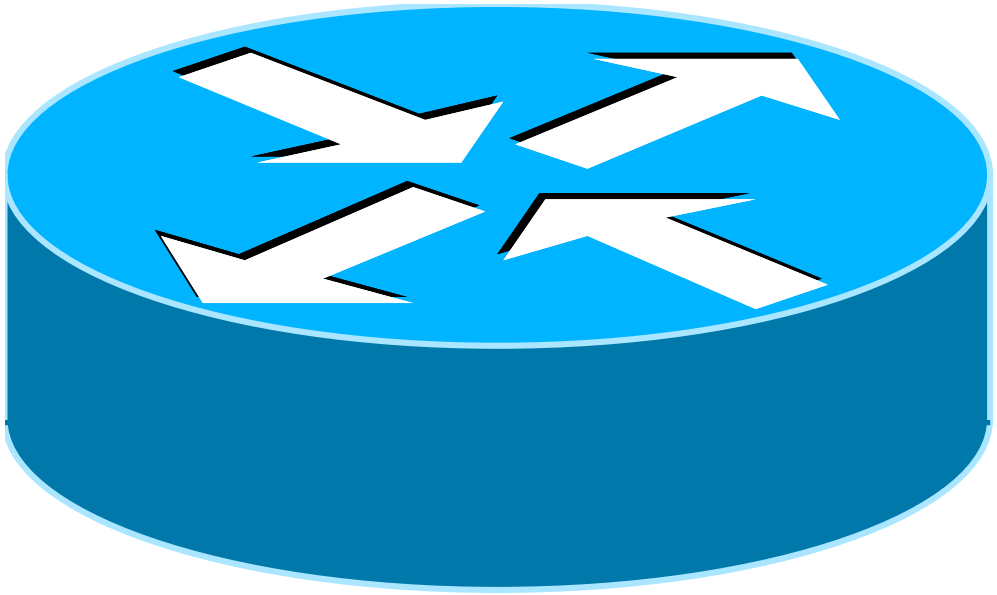
Remote Access Server

WAN Equipment: WAN Switch



Frame Relay switch

WAN Equipment: Router



LAN and WAN connectivity

Digital Bandwidth

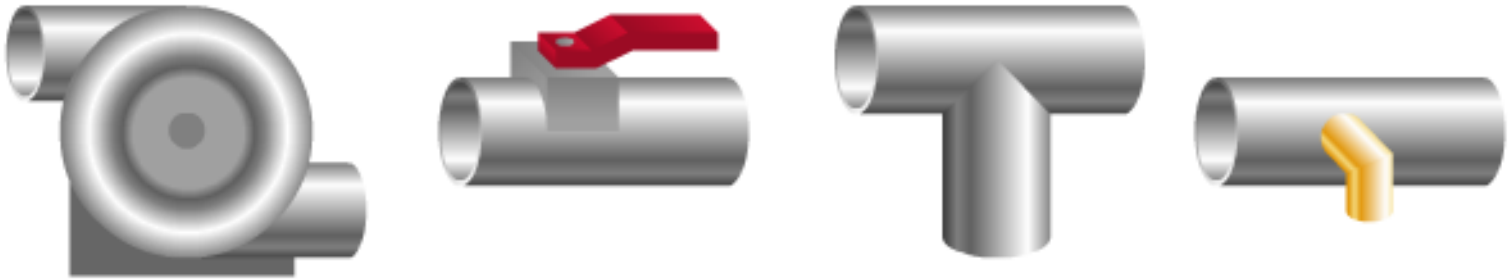
- **How much information can flow from one place to another in a given amount of time.**

Unit of Bandwidth	Abbrev.	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

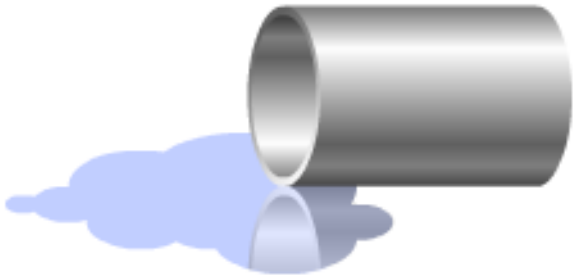
Analogy for Bandwidth: Pipe

Bandwidth is like pipewidth.

Network devices are like pumps, valves, fittings, and taps.



Packets are like water.



Analogy for Bandwidth

- Highway
- Radio system

Bandwidth: LAN Media

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: WAN Services

Type of WAN service	Typical User	Bandwidth
Modem	Individuals	56 Kbps = 0.056 Mbps
ISDN	Telecommuters, Small businesses	128 Kbps = 0.128 Mbps
Frame-Relay	Small institutions (schools); reliable WANs	56 Kbps - 1544Kbps = 0.056 Mbps - 1.544 Mbps
T1	Larger entities	1.544 Mbps
T3	Larger entities	44.736 Mbps
E1	Larger entities	2.048 Mbps
E3	Larger entities	34.368 Mbps

Throughput <= Bandwidth

- Throughput refers to actual, measured, bandwidth, at a specific time of day.
- The throughput is effected by:
  - Internetworking devices
  - Type of data being transferred
  - Topology
  - Number of users
  - User's computer
  - Server computer
  - Power and weather-induced outages

Time Calculations

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

The importance of Bandwidth

- It’s finite
- It can save money
- A key measure of network performance
- A key to understanding the Internet
- Increases constantly