COMPUTER NETWORKS

- Chapter 1.1: Introduction

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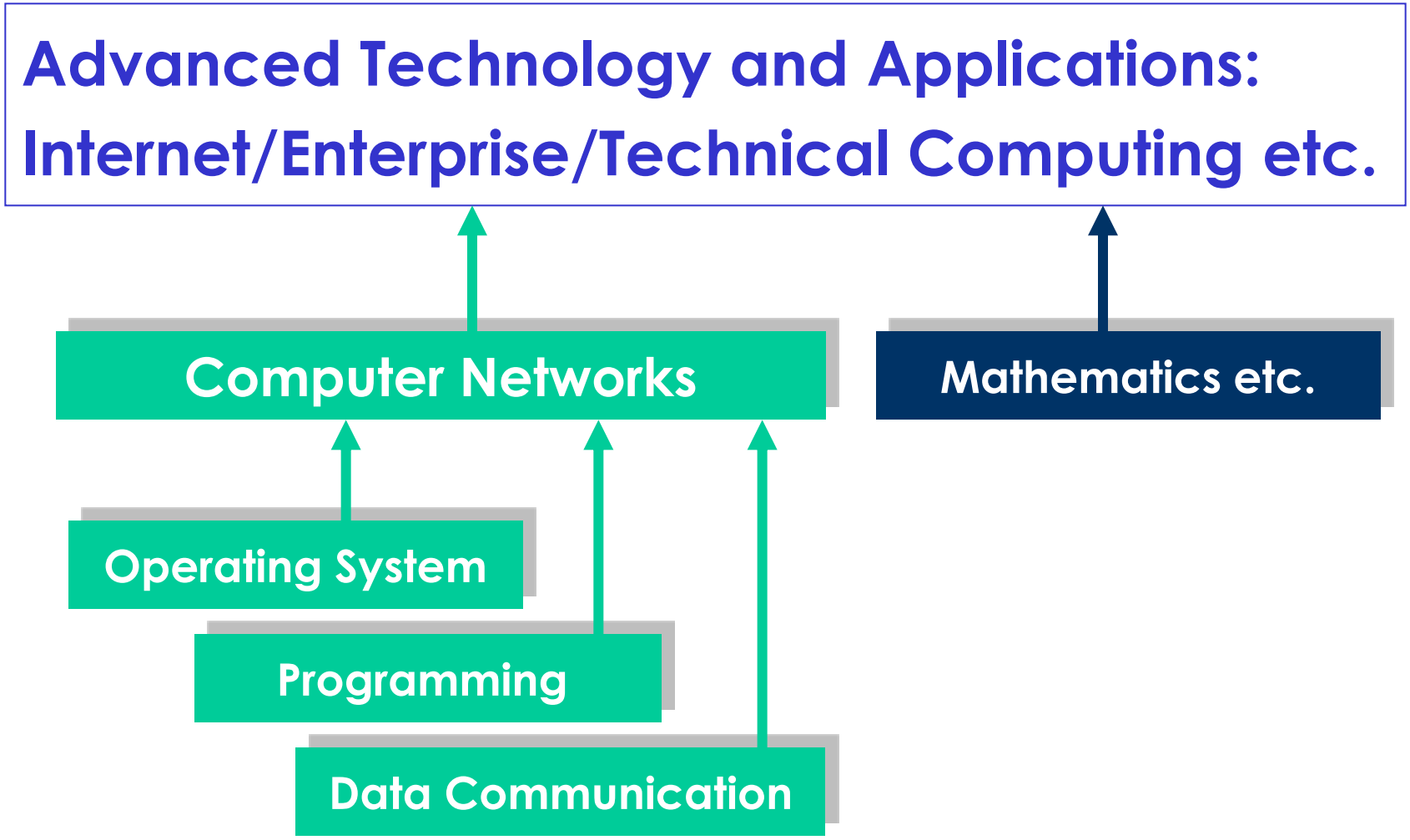
CN: Position and important



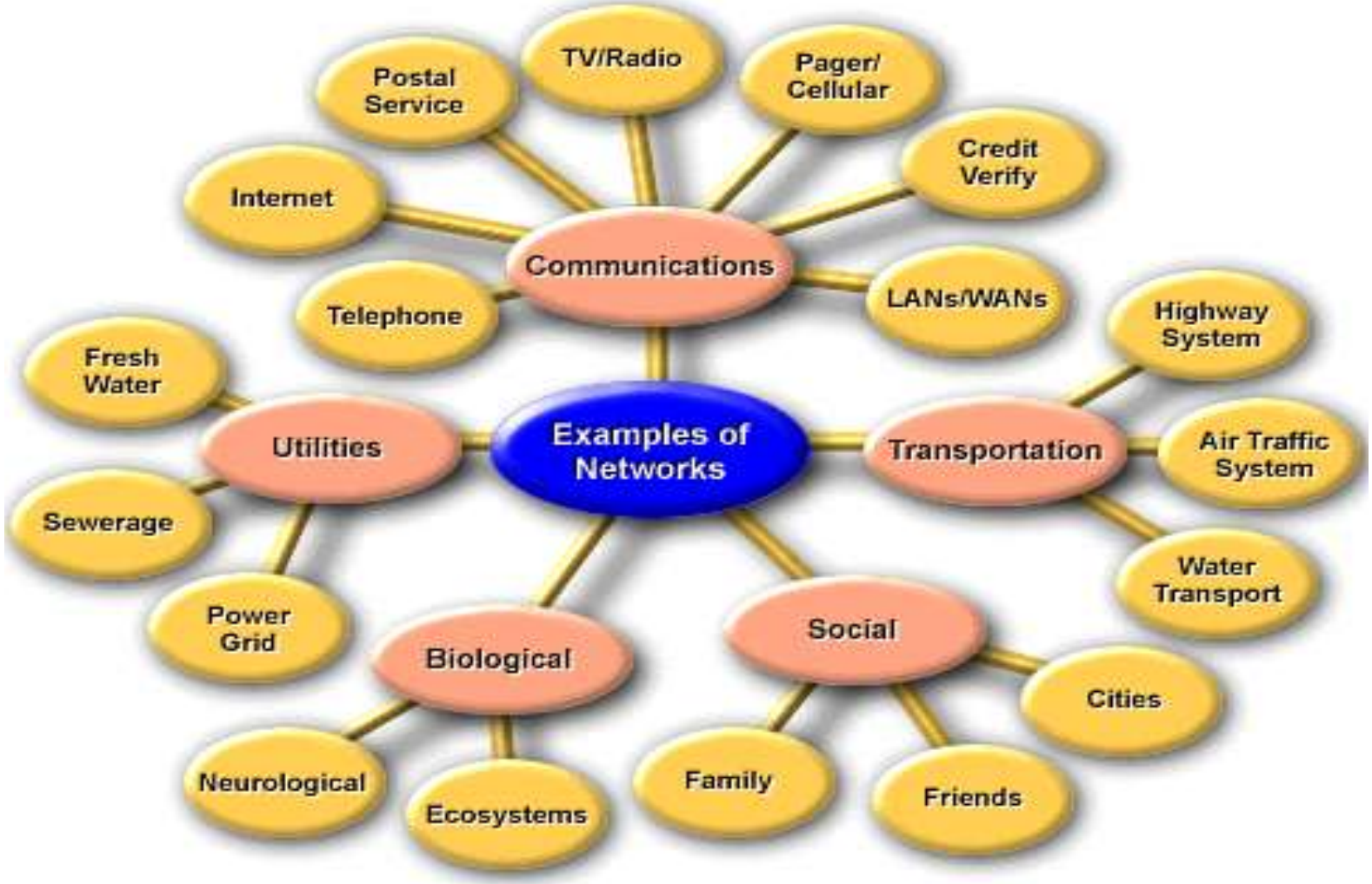
Reference

- Andrew S. Tanenbaum，《Computer Networks》
- 谢希仁等著,《计算机网络》
- Vito Amato（美），《思科网络技术学院教程》
- James F. Kurose, Keith W. Ross, 《Computer Networking: A Top-Down Approach Featuring the Internet》
- Larry L. Peterson, Bruce S. Davie, 《Computer Networks: A Systems Approach》

Session 1

- What is the Networks
- Classify Computer Networks

What is the networks in general ?



What is "Computer Networks"

- Computer: CPU + MEM + Peripherals.
- Basic Concept of Computer Networks:
  - A collection of autonomous computers interconnected.
    - Interconnected: Be able to exchange information
    - Autonomous: Be able to handle independently
- Host/Computer toward Distributed System:
  - Multi – Tasks, Multi-Users, Multi-Cores…
- In modern and broad sense of CN:
  - Network is the Computer (Complicated & Ind.)

Network History-Communications

Internet Timeline	
Pre-1900	Long distance communications via messenger, rider, smoke signals, carrier pigeon, optical telegraph, electrical telegraph
1890s	Bell invents the telephone; telephone service expands rapidly.
1901	Marconi's first transatlantic wireless transmission
1920s	AM Radio
1939	FM Radio
1940s	WWII spurs radio and microwave development.
1947	Shockley, Barden and Brittain invent the solid-state (semiconductor) transistor.
1948	Claude Shannon publishes "A Mathematical Theory of Communication".
1950s	Invention of Integrated Circuits.
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.

Network History-Computers

Internet Timeline	
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	ISO releases OSI Model and protocols; the protocols die but the model is very influential.
1983	Transmission Control Protocol/Internet Protocol (TCP/IP) becomes the universal language of the Internet. ARPANET is split into ARPANET and MILNET.
1984	Cisco Systems founded; gateway and router development begins. Domain Name Service introduced. The number of Internet hosts exceeds 1000.
1986	NSFNET is created (with a backbone speed of 56 KBps).
1987	The number of Internet hosts exceeds 10,000.
1988	Computer Emergency Response Team (CERT) is formed by DARPA

Network History-Internet

Internet Timeline	
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.

Communication networks ?

Digital/Data Communication

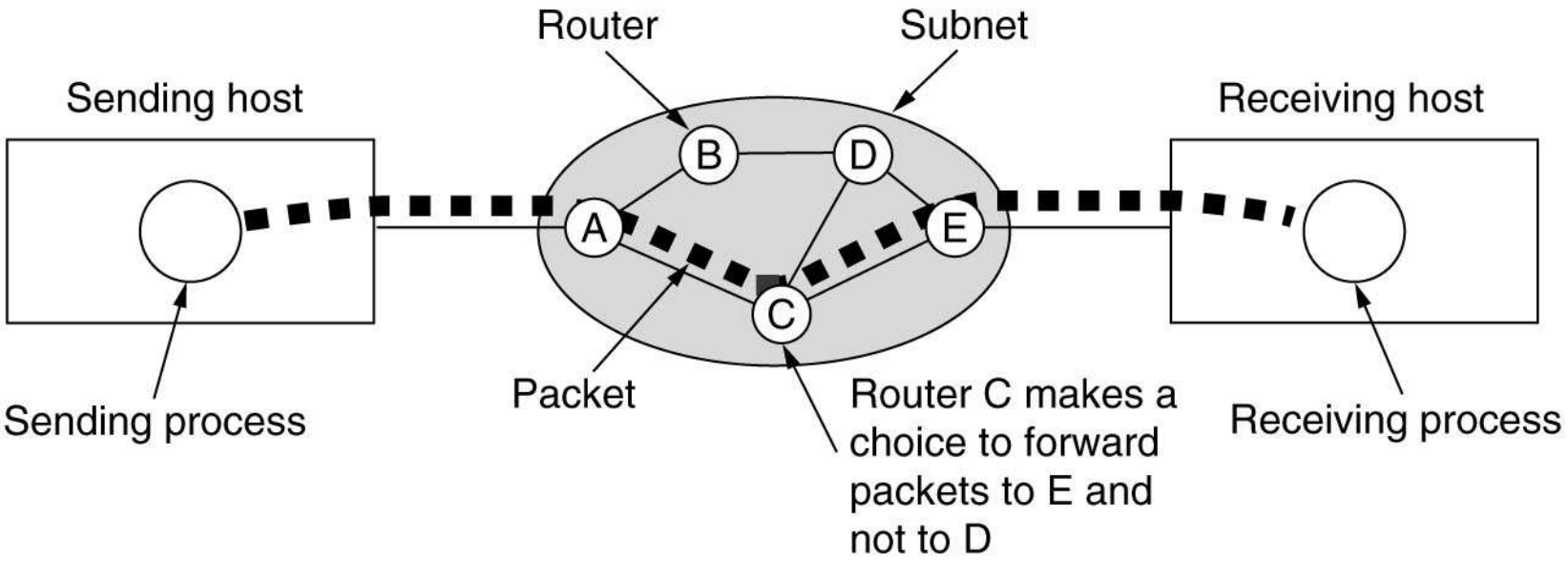
Computer Networks

Data Networks

Internet: NGI,NGN

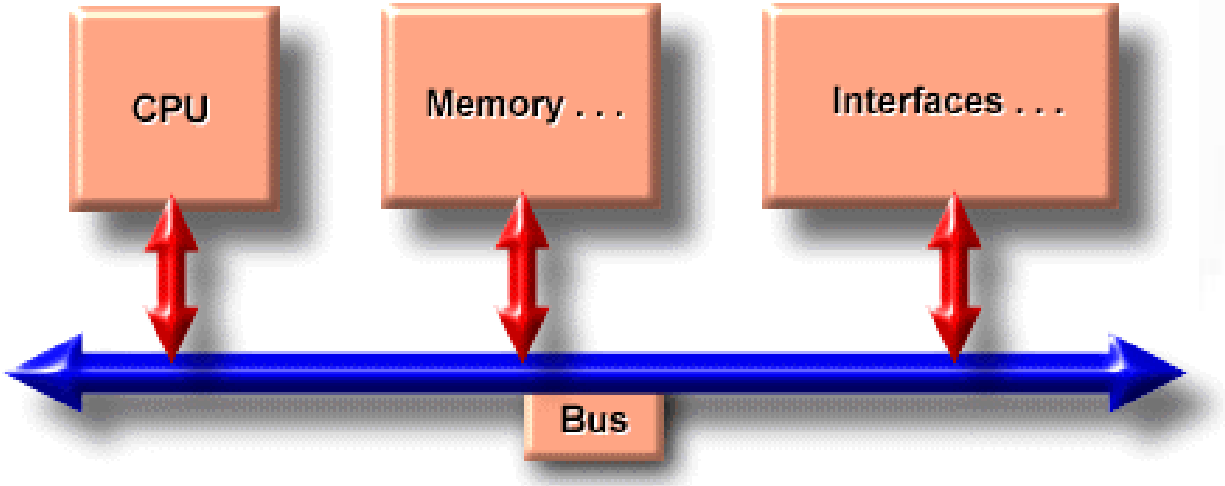
Sensor Networks

Computer networks:



A stream of packets from sender to receiver

“Network” Hardware & Arch.



All Computers Have:

- CPU : Performs computations paced by a clock
- Memory : RAM, ROM, floppy, hard-disk, CD-ROM drives
- Interfaces : All of those backplane ports

Inter-connections between ? (Any)

So many different:

1. Variety of Size
2. Variety of Topology
3. Variety of Speed/Bandwidth
4. Variety of Transmission Medium
5. Variety of Communication Tech.
6. Variety of Communication mode/BD
7. Variety of Services
8. Variety of Applicants/Usage

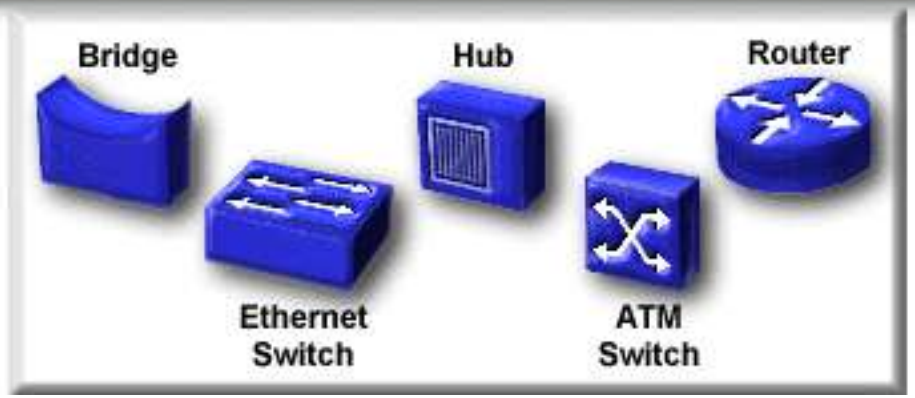
研究方法：**Think about Library ?**

Networks Classify in Size

Distance Between CPUs	CPUs are in the same	Icon	Name
0.1 m	Printed circuit board Personal data asst.		Motherboard Personal Area Network (PAN)
1.0 m	Millimeter Mainframe		Computer System 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 U.
10,000 m = 10 km	City		Metropolitan Area Network (MAN) San Francisco
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

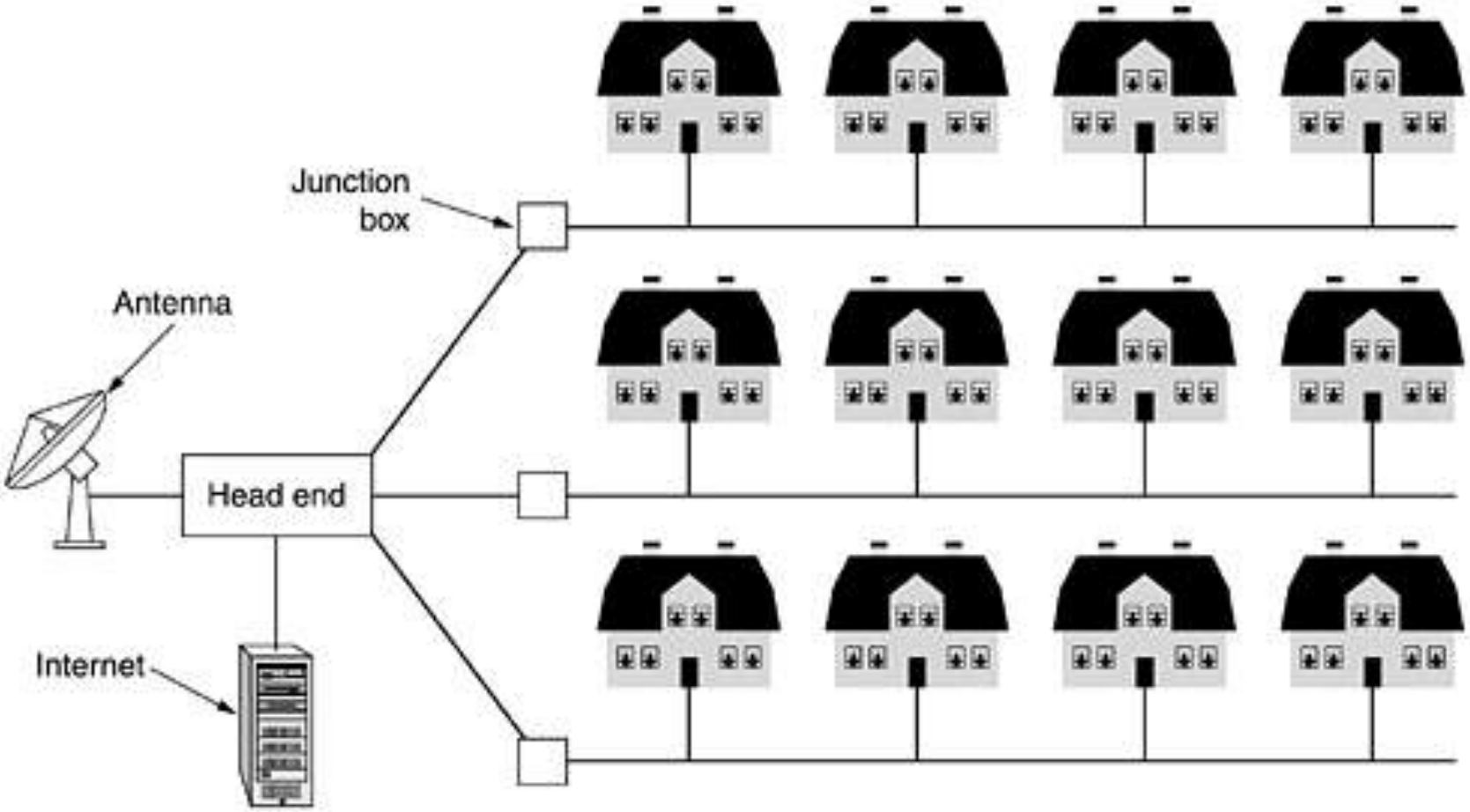
Local Area Networks

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



Widely used to connect pc and workstations in company offices and factories to share resources (e.g., printers) and exchange information

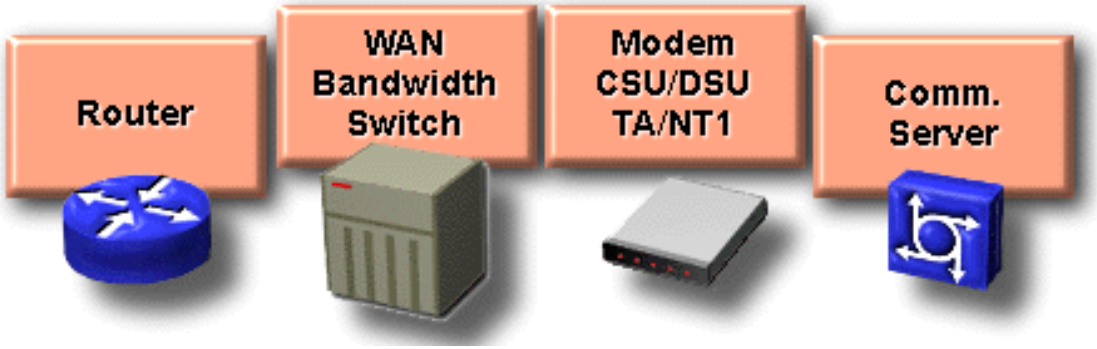
Local/Metropolitan Area Networks



Wide Area Networks

WANs are designed to:

- Operate over 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

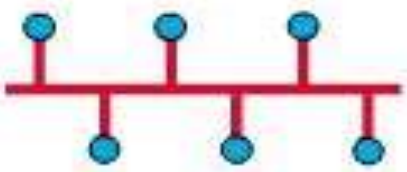


Some common WAN technologies are:

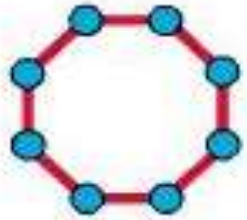
- **Frame-Relay/ATM (Asynchronous Transfer Mode) : 64Kbps – 155Mbps**
- **E/T-Carrier Series (in U.S.:T1, T3, etc.) : 1.5Mbps/2Mbps – 155Mbps**
- **SONET/SONET (Synchronous Optical Network) : 155Mbps- 10G+**

Network Topology:

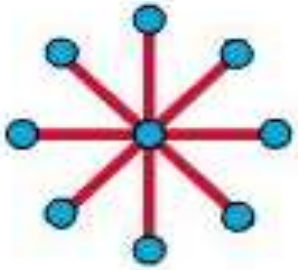
Layout of inter-connections (信道的分布方式)



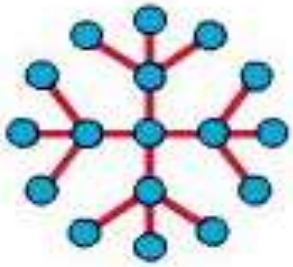
Bus Topology



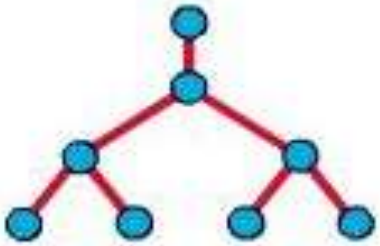
Ring Topology



Star Topology



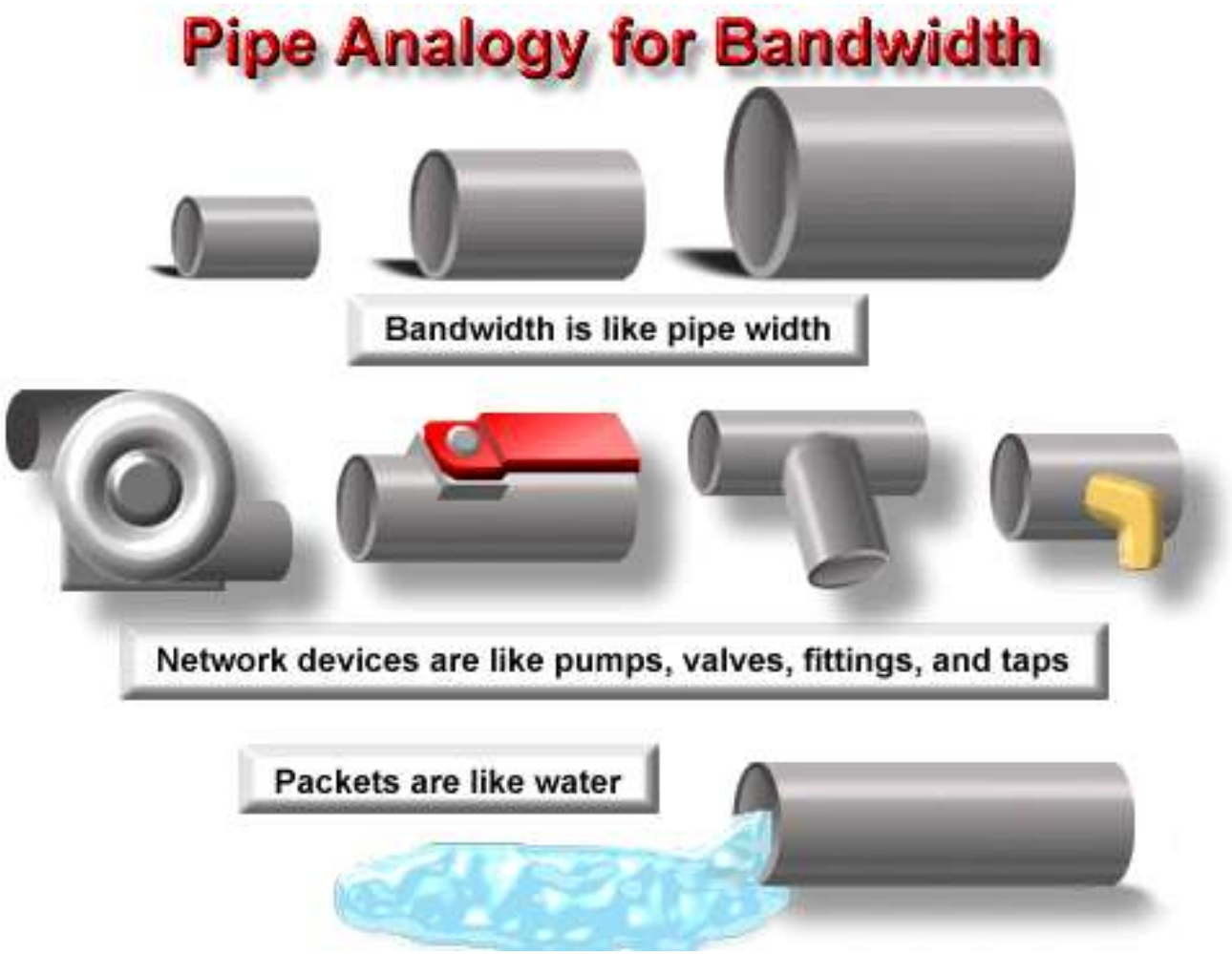
Extended Star Topology



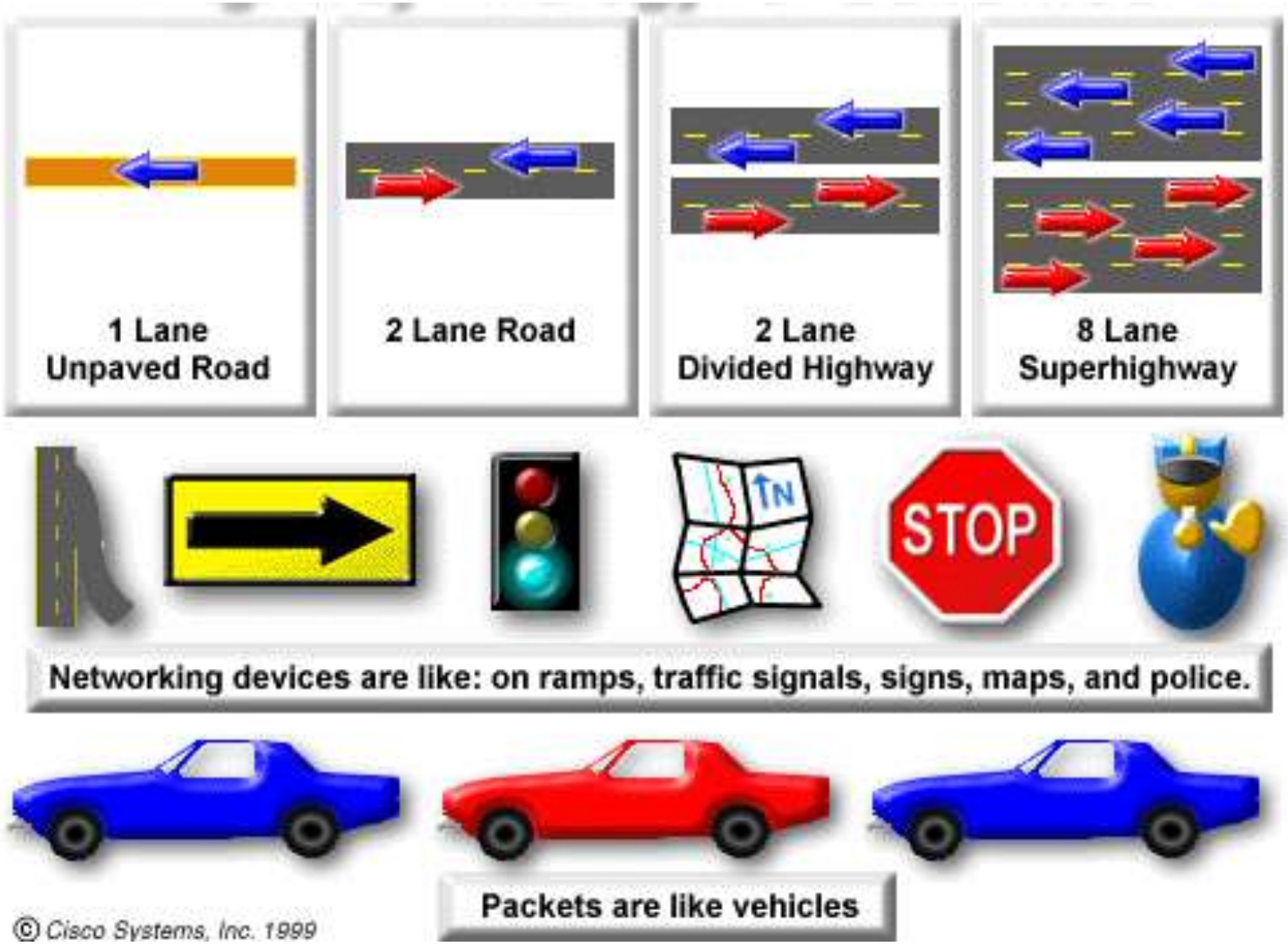
Hierarchical Topology

Mesh Topology

Network Bandwidth-I:



Highway Analogy for Bandwidth:



Measurement-I:

Unit of Information	Definition	Approximate Bytes	Approximate Bits	Examples
Bit (b)	Binary digit, a 1 or 0	1 bit	1 bit	On/Off; Open/Closed +5 Volts or 0 Volts
Byte (B)	Usually 8 bits	1 byte	8 bits	Represent the letter "X"
Kilobyte (KB)	1 kilobyte = 1024 bits	1000 bytes	8,000 bits	Typical Email = 2 KB 10-page report = 10 KB Early PCs = 64 KB of RAM
Megabyte (MB)	1 megabyte = 1024 kilobytes = 1,048,576 bytes	1 million bytes	8 million bits	Floppy disks = 1.44 Mb Typical RAM = 32 MB CDROM = 682 MB
Gigabyte (GB)	1 gigabyte = 1024 megabytes = 1,073,741,824 bytes	1 billion bytes	8 billion bits	Typical Hard Drive = 2 GB
Terabyte (TB)	1 terabyte = 1024 gigabytes = 1,099,511,627,778 bytes	1 trillion bytes	8 trillion bits	Amount of data theoretically transmittable in optical fiber in one second

Measurement-II:

Unit of Bandwidth	Abbreviation	Equivalence
Bits per second	bps	1 bps = fundamental unit of bandwidth
Kilobits per second	kbps	1 kbps = 1000 = 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

The fundamental unit of bandwidth:

- **A unit of information (lets say the bit) per unit of time (lets say a second) is the bit per second,**

Throughput:

Usually refers to actually measured bandwidth, at a specific time of day.

Throughput <= digital bandwidth of a medium

Why?

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

The Importance of Bandwidth:

- It is finite
- It is worth money
- It is a key measure of network performance
- It is a key factor in network design
- It is key to understanding the information age
- Everyone wants more

Transmission medium:

Some Typical Media	Maximum Theoretical Bandwidth	Maximum Physical Distance
50-Ohm Coaxial Cable (Ethernet 10Base2, ThinNet)	10-100 Mbps	200m
75-Ohm Coaxial Cable (Ethernet 10Base5, ThickNet)	10-100 Mbps	500m
Category 5 Unshielded Twisted Pair (UTP) (Ethernet 10BaseT, 100Base-TX)	10 Mbps	100m
Category 5 Unshielded Twisted Pair (UTP) (Ethernet 100Base-TX)(Fast Ethernet)	100 Mbps	100m
Multimode (62.5/125um) Optical Fiber 100Base-FX	100 Mbps	2000m
Singlemode (10um core) Optical Fiber 1000Base-LX	1000Mbps (1.000 Gbps)	3000m
Other technologies being researched	2400 Mbps (2.400 Gbps)	40km = 40,000m
Wireless	2.0 Mbps	100m

No matter how you send your messages, no matter which physical medium you use, bandwidth is limited. This is due both to the laws of physics and to current technological advances.

Communication Technology:

- For twisted-pair cable:
  - Modem:
    - 300bps,1200bps,9600bps,28kbps,33kbps,56kbps
  - XDSL:
    - 128Kbps, 1Mbps,4Mbps,6Mbps
  - Ethernet:
    - 10Mbps, 100Mbps, 1000Mbps…
- For Fiber:
  - Ethernet: 10/100Mbps, 1/10Gbps +
  - SDH: 155Mbps, 2.5Gbps, 1.6Tbps +

Communication Mode:

- Point-to-Point
- Multicast
- Broadcast

Type of Services

	Service	Example
Connection-oriented	Reliable message stream	Sequence of pages
	Reliable byte stream	Remote login
	Unreliable connection	Digitized voice
Connection-less	Unreliable datagram	Electronic junk mail
	Acknowledged datagram	Registered mail
	Request-reply	Database query

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Think about telephone network ?

Many thanks:

Cisco Academy.