Computer Networks 1

INTRODUCTION TO NETWORKS

Fatemeh Rezaei

K. N. Toosi
University of Technology

COMPUTER NETWORKS

Computer Networks

Technologies

Categories

Background

Architecture

Protocol Stack

OUTLINE

Computer Networks
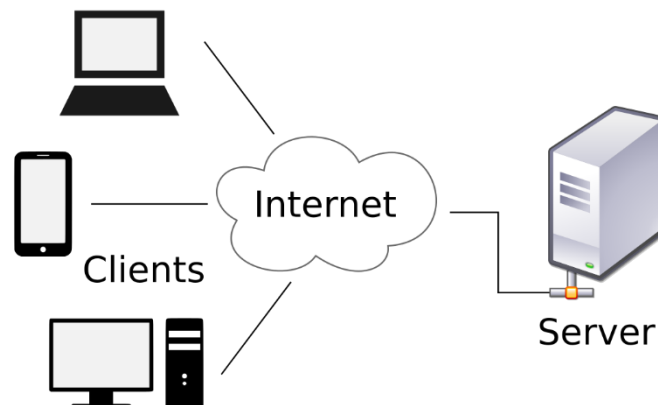
Technologies

Categories

Background

Architecture

Protocol Stack

COMPUTER NETWORKS

Yesterday

Today

OUTLINE

Computer Networks

Technologies

Categories

Background

Architecture

Protocol Stack

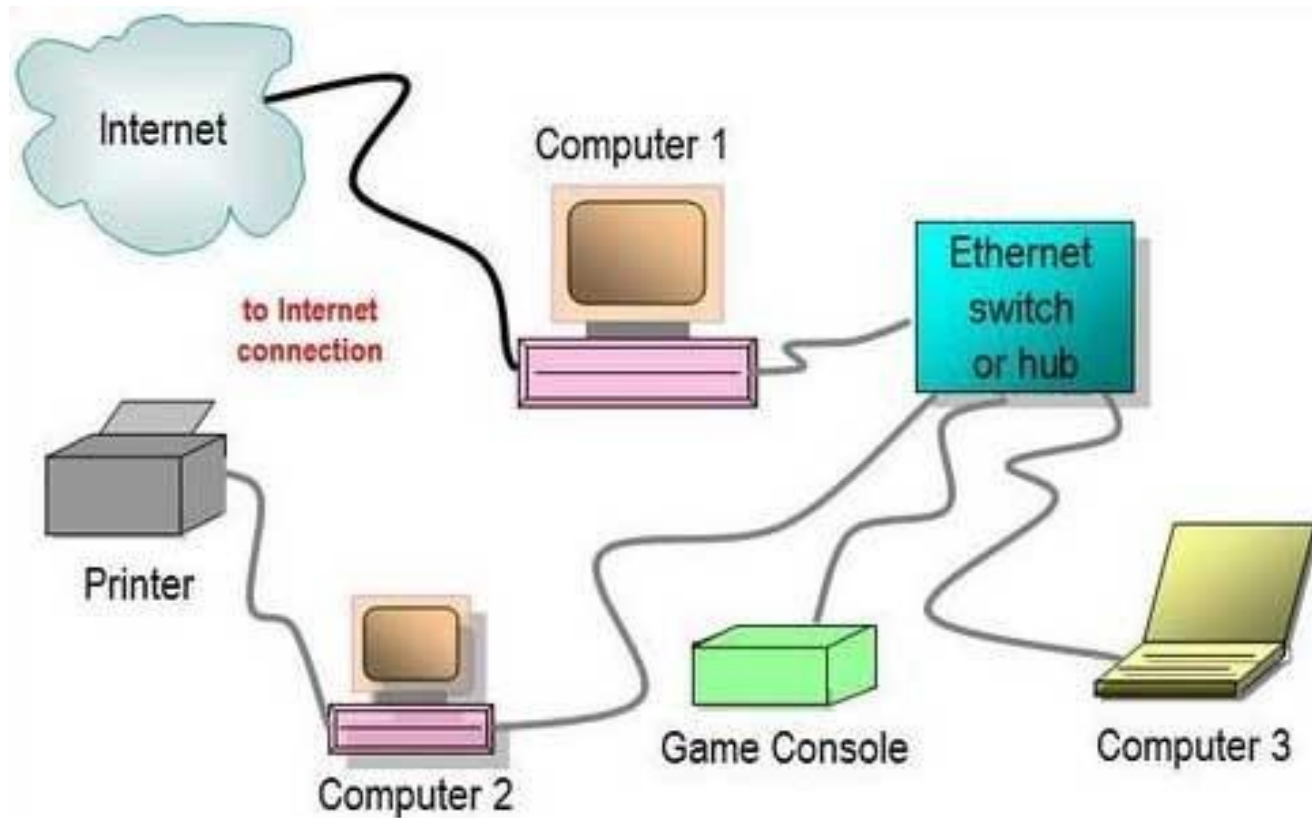# NETWORK TECHNOLOGIES

Wired Networks

Wireless Networks

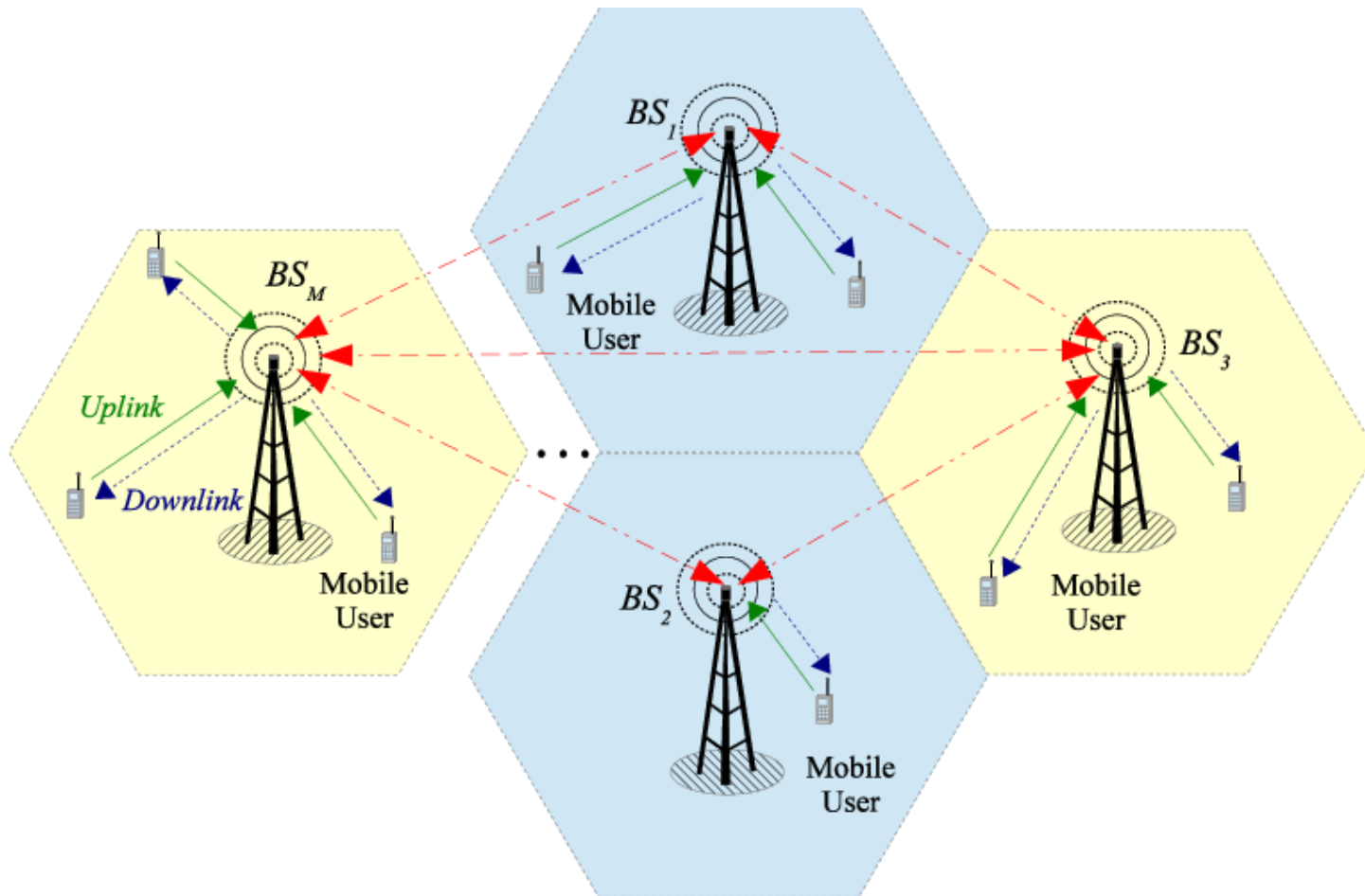Cellular Networks

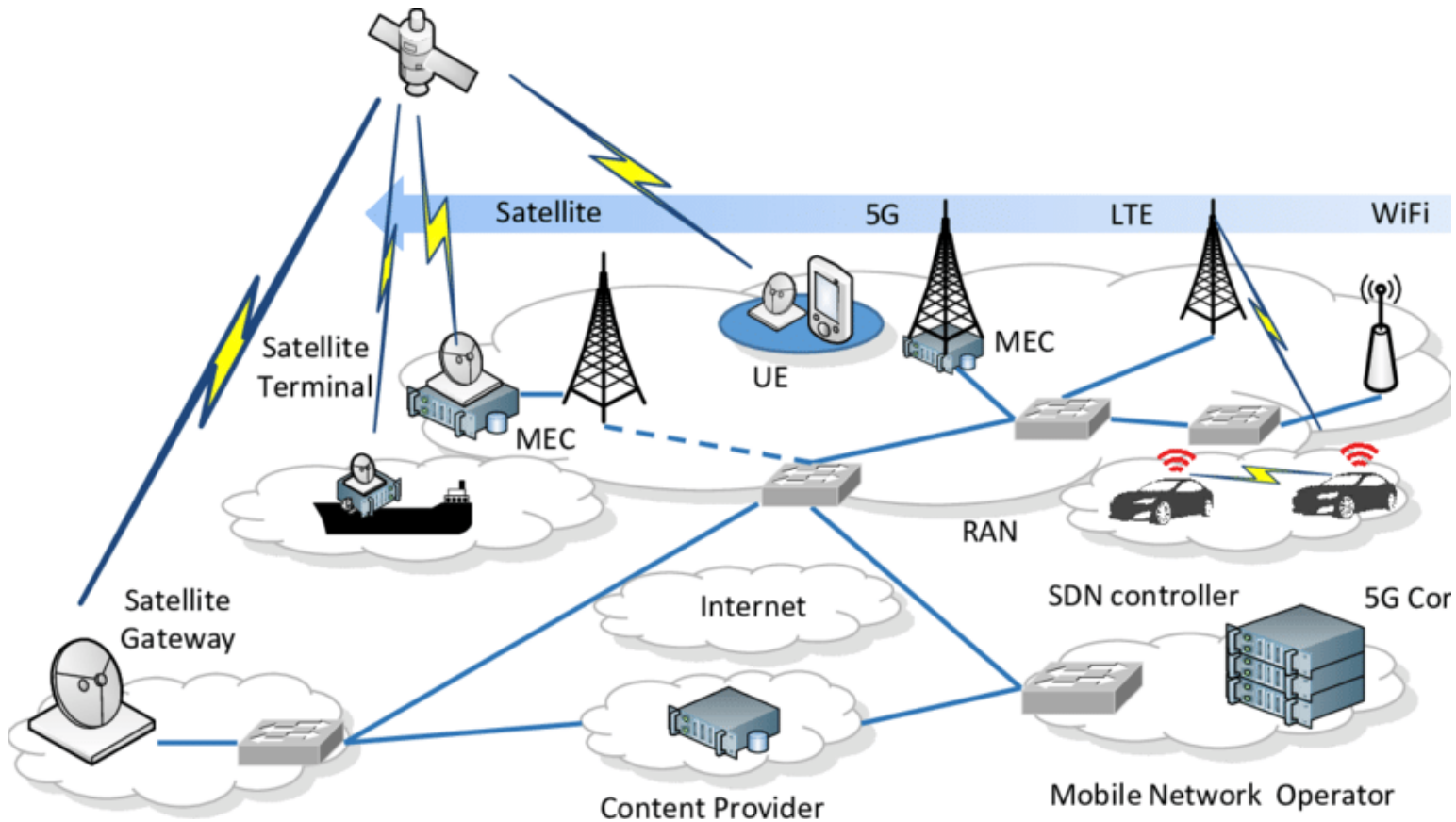Satellite Networks

Optical Networks

…

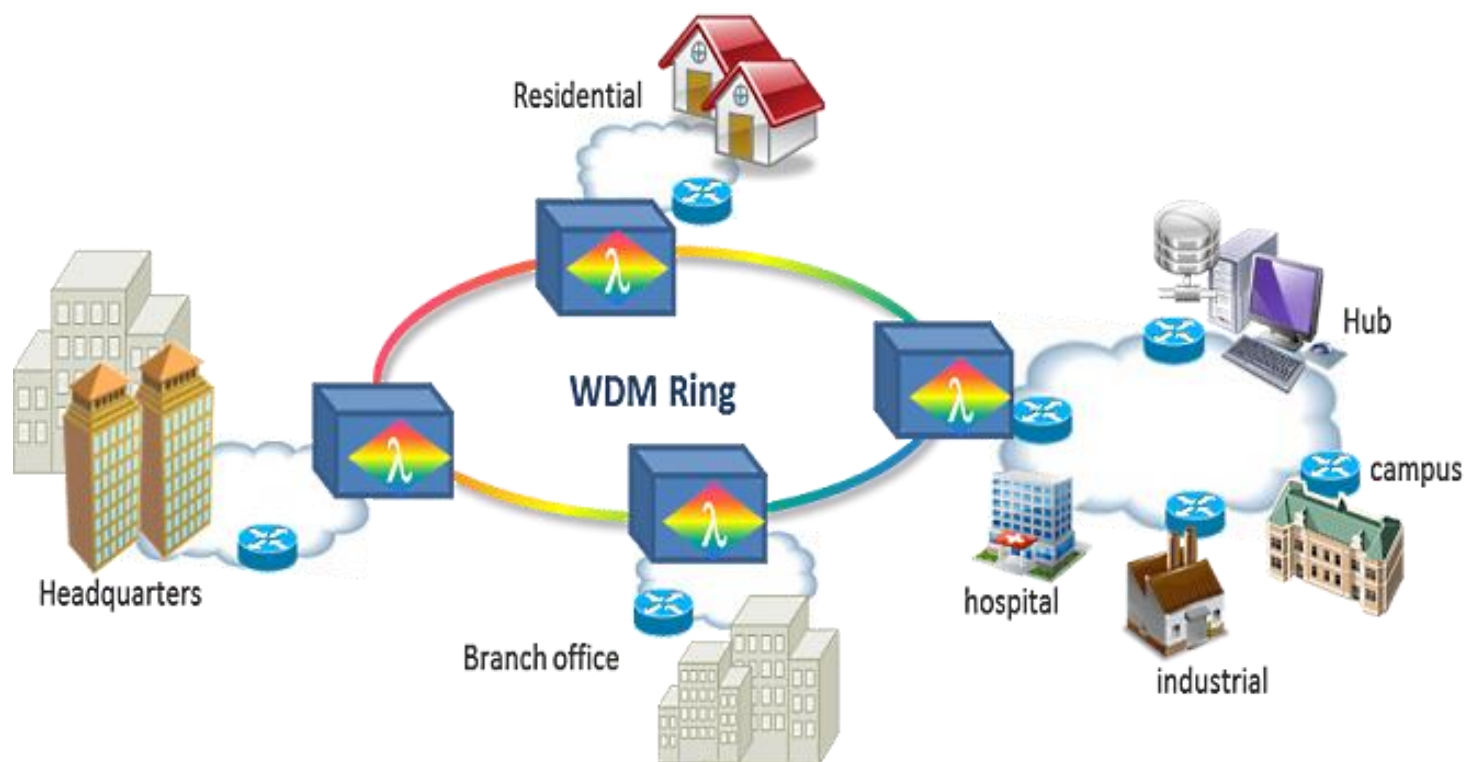# WIRED NETWORKS

WIRELESS NETWORKS

CELLULAR NETWORKS

SATELLITE NETWORKS

OPTICAL NETWORKS

OUTLINE

Computer Networks

Technologies

Categories

Background

Architecture

Protocol Stack

TYPES OF COMPUTER NETWORKS

PAN (PERSONAL AREA NETWORK)

❑Interconnecting devices on an individual workspace

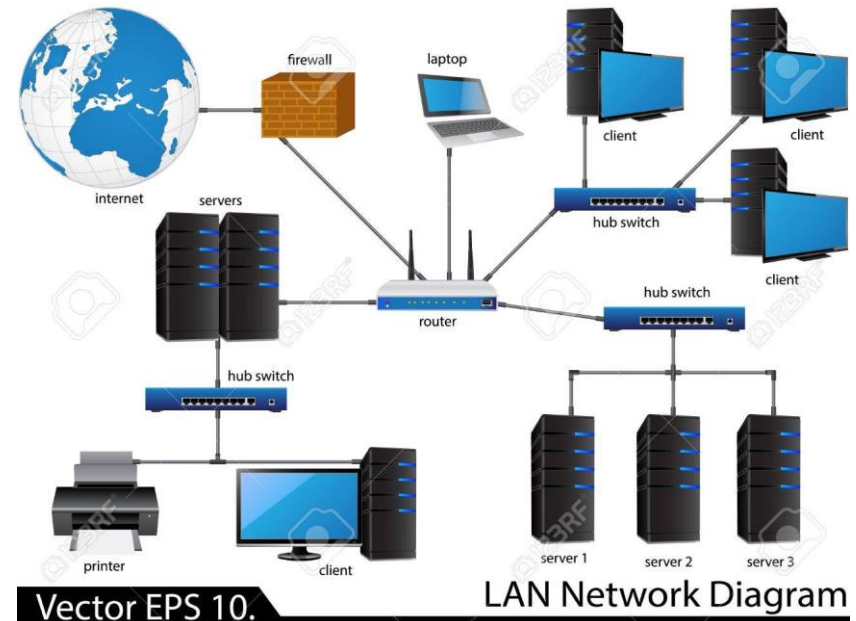❑Example

▪ Bluetooth

LAN (LOCAL AREA NETWORK)

❑Usually within a building

❑Restricted Size, delay

❑Example

▪Ethernet (IEEE 802.3)

▪Wireless LAN (IEEE 802.11)
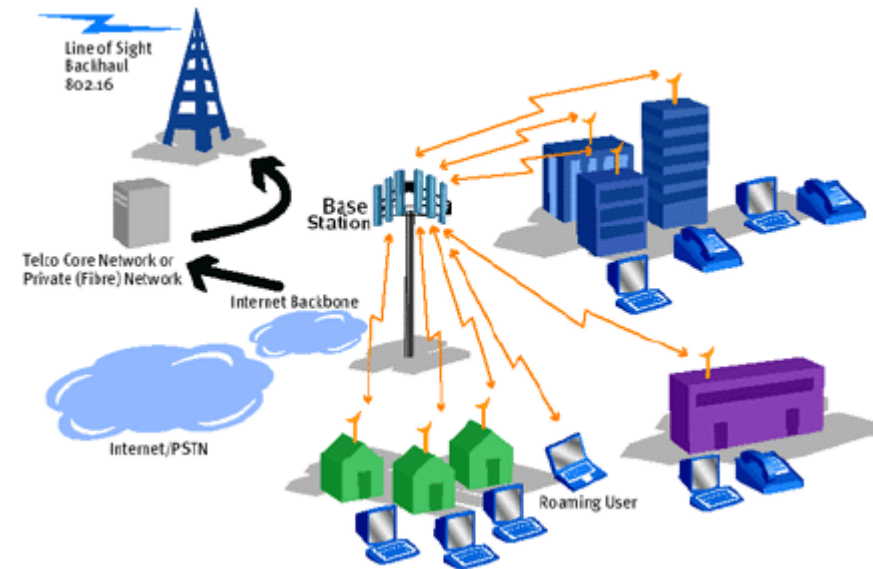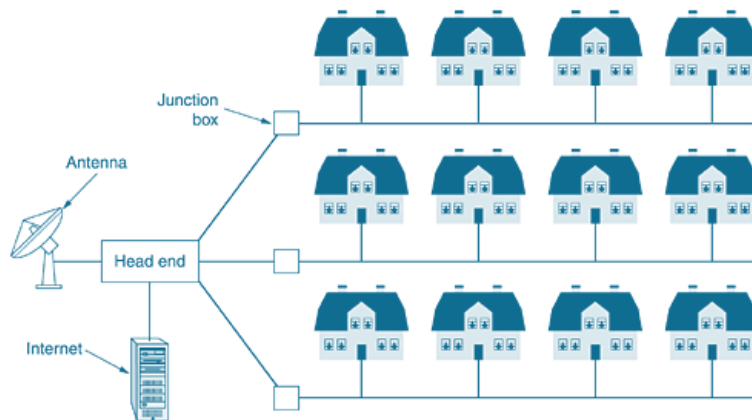

LAN Network Diagram

MAN (METROPOLITAN AREA NETWORK)

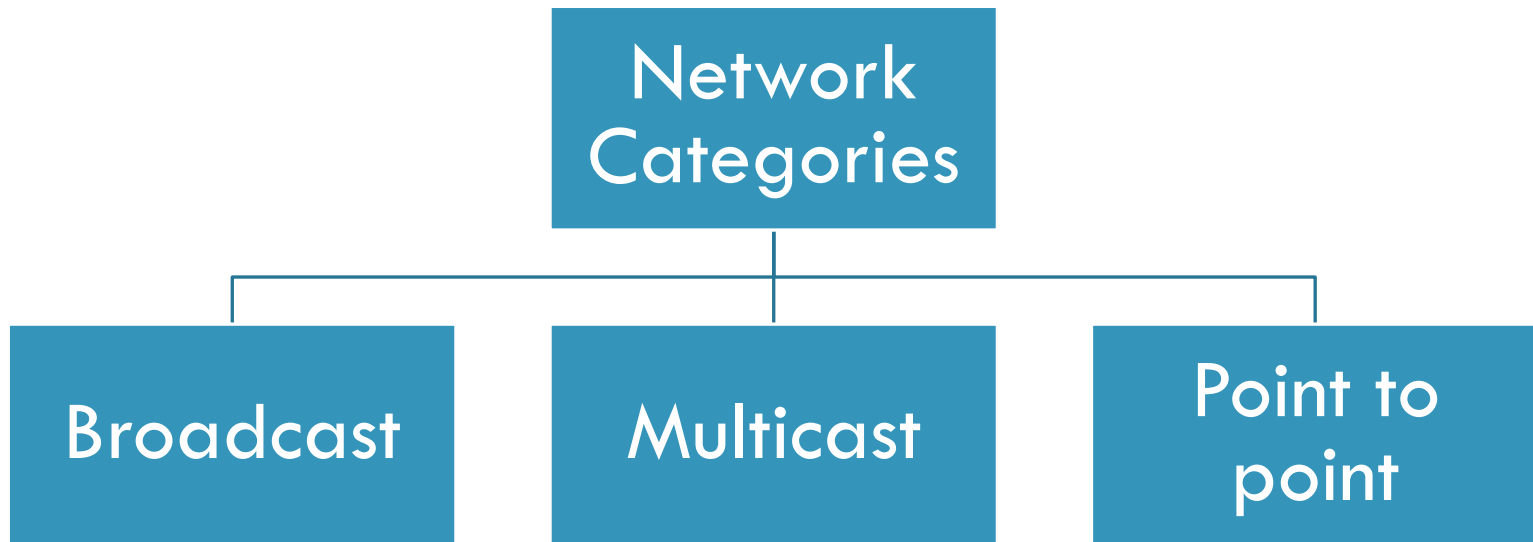❑A network within a city

❑Examples
▪WiMAX
▪Cable TV network

WAN (WIDE AREA NETWORK)

❑A network with large area such as a country
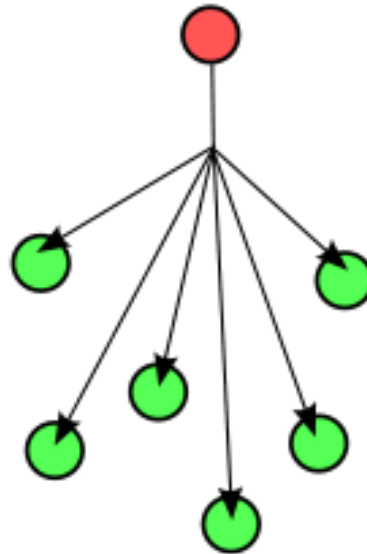
❑Example

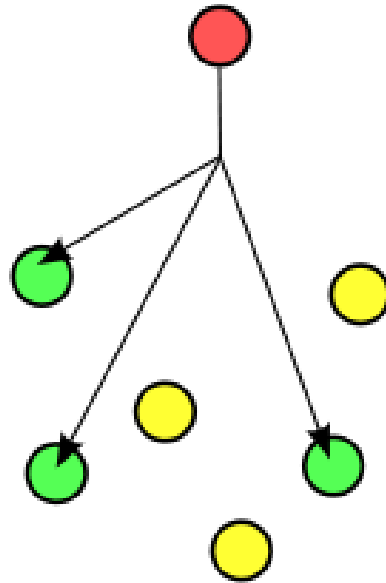▪Backbone optical transmission network

NETWORK CATEGORIES

BROADCAST

❑Single channel shared by all parties

▪All receivers listen to every message
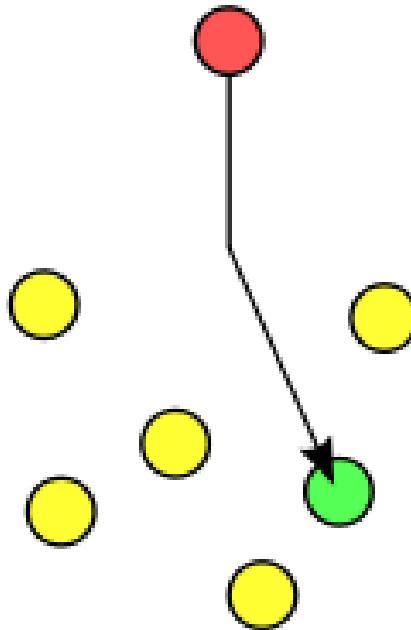 ▪Use the one intended for them

▪Small networks

MULTICAST

❑Data sent by a source, received by some users

❑Video conferencing, collaboration

POINT TO POINT

❑Multiple roots between source and destination

❑Large networks
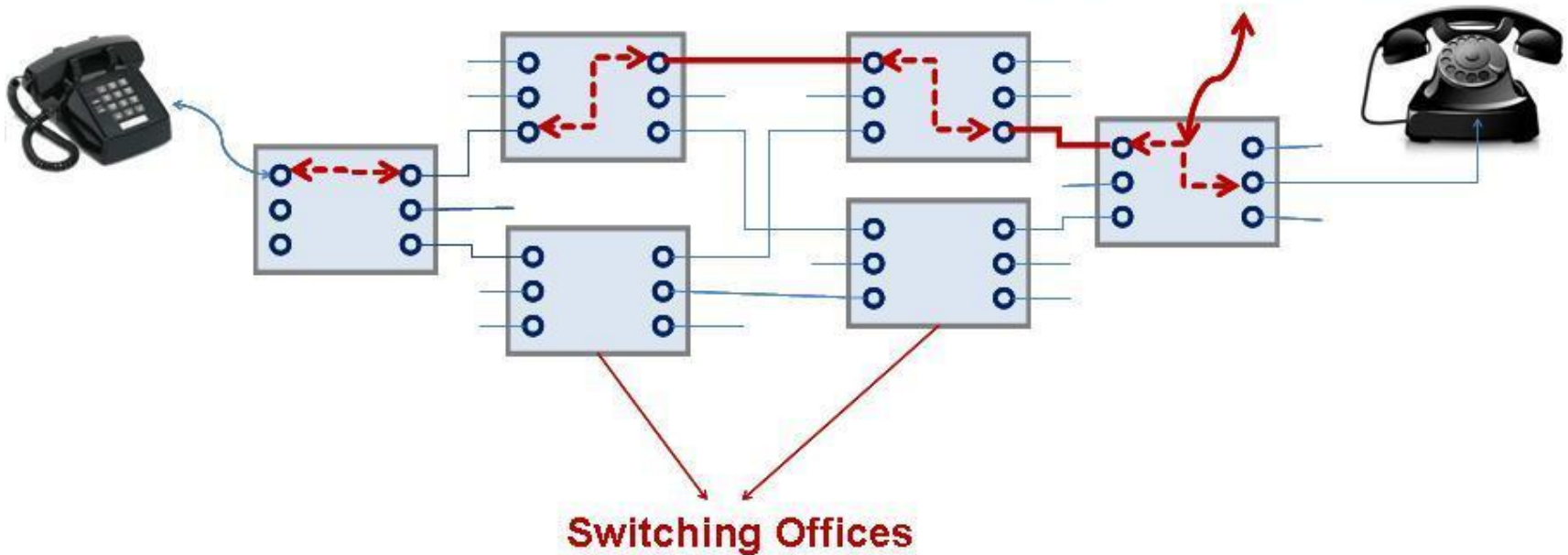
OUTLINE

Computer Networks

Technologies

Categories

Background

Architecture

Protocol Stack

VOICE NETWORKS
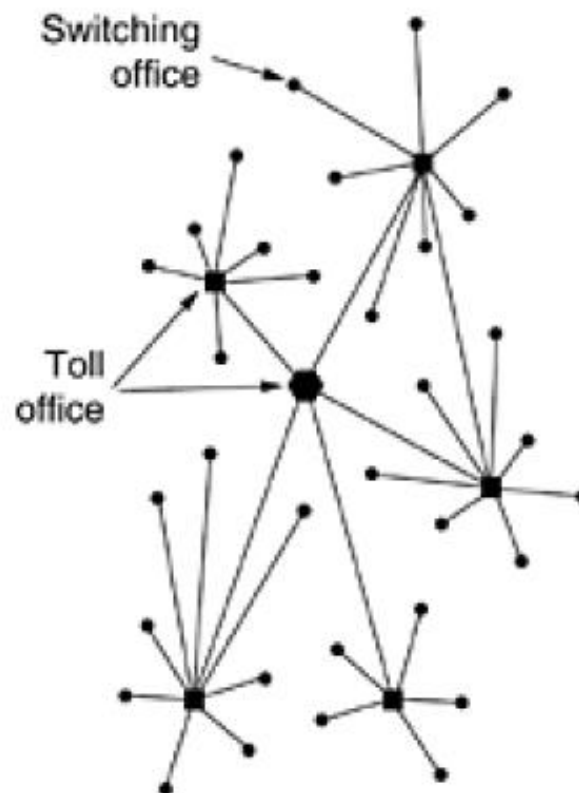

Physical Connection is setup
When call connection is made

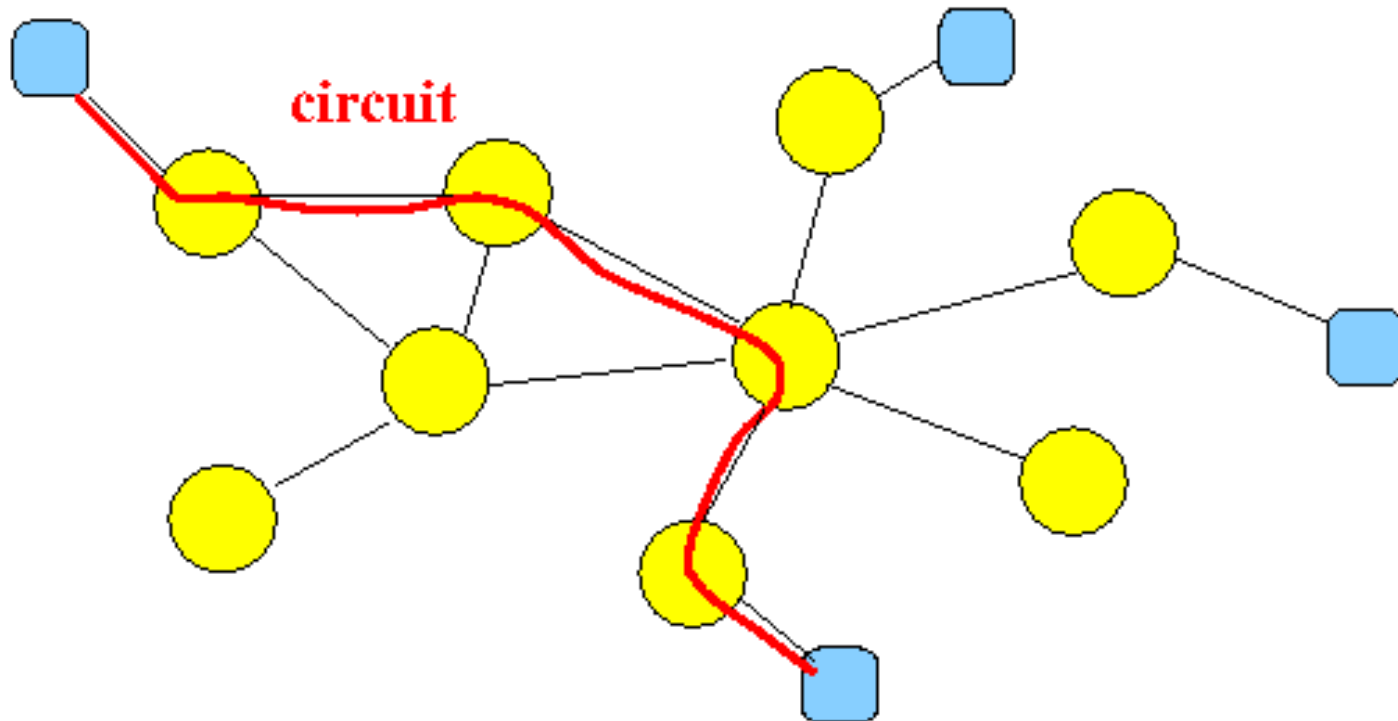Switching Offices

VOICE NETWORKS

❑ Star Topology
 ▪ Switching Office

❑ Circuit Switching
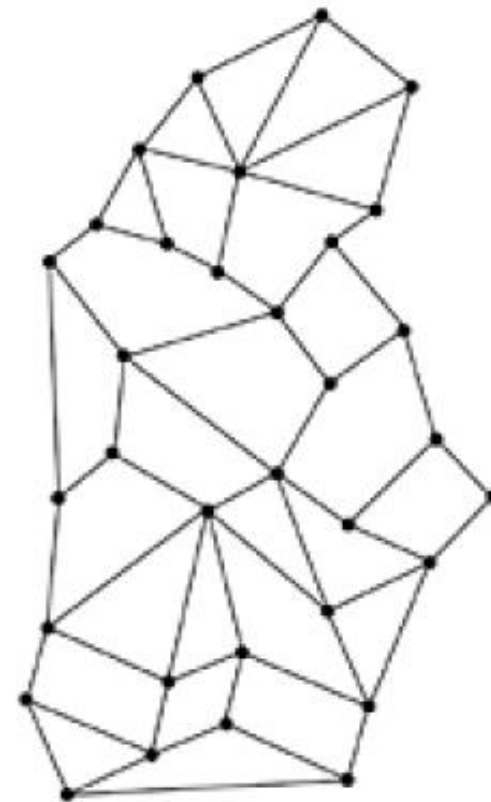
CIRCUIT SWITCHING

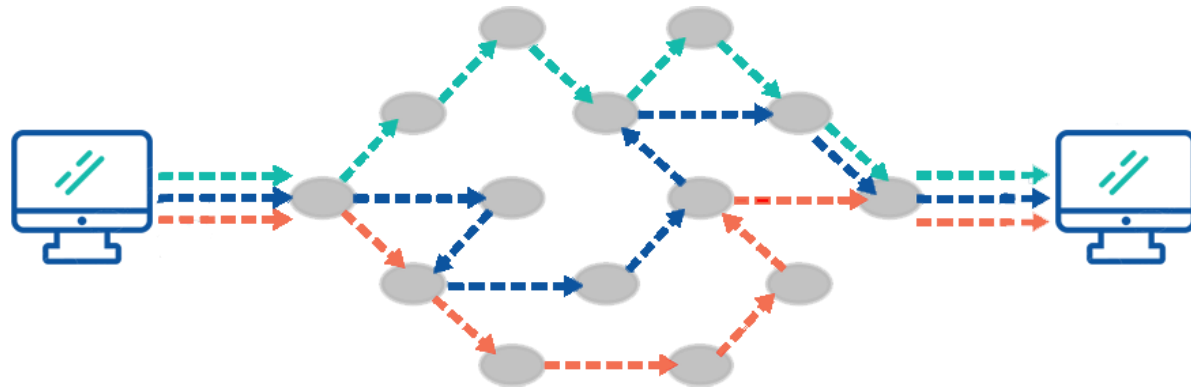

circuit

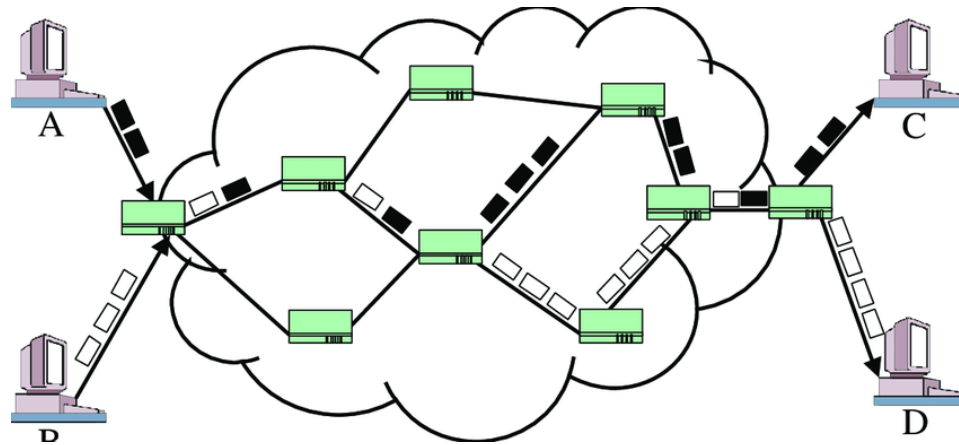# COMPUTER NETWORKS

☐ ARPANET: 1960's

☐ Mesh Topology

☐ Packet Switching
 ▪ Store and Forward

PACKET SWITCHING

COMPUTER NETWORKS HISTORY

❑ARPANET

▪ Developed in DARPA

▪ First network started operation in 1969

❑Rapid expansion of ARPANET

▪ Including most key universities in USA and Europe

❑NSFNET

▪ U.S. National Science Foundation Network for Academia

▪ First TCP/IP WAN early 1980s

INTERNET HISTORY

❑Internet

- Connection of ARPANET and NSFNET in 1983

- Millions of hosts, many more users

- Size doubling every year

❑Web Browsing

- Developed in 1990 in CERN

- Application that changed internet

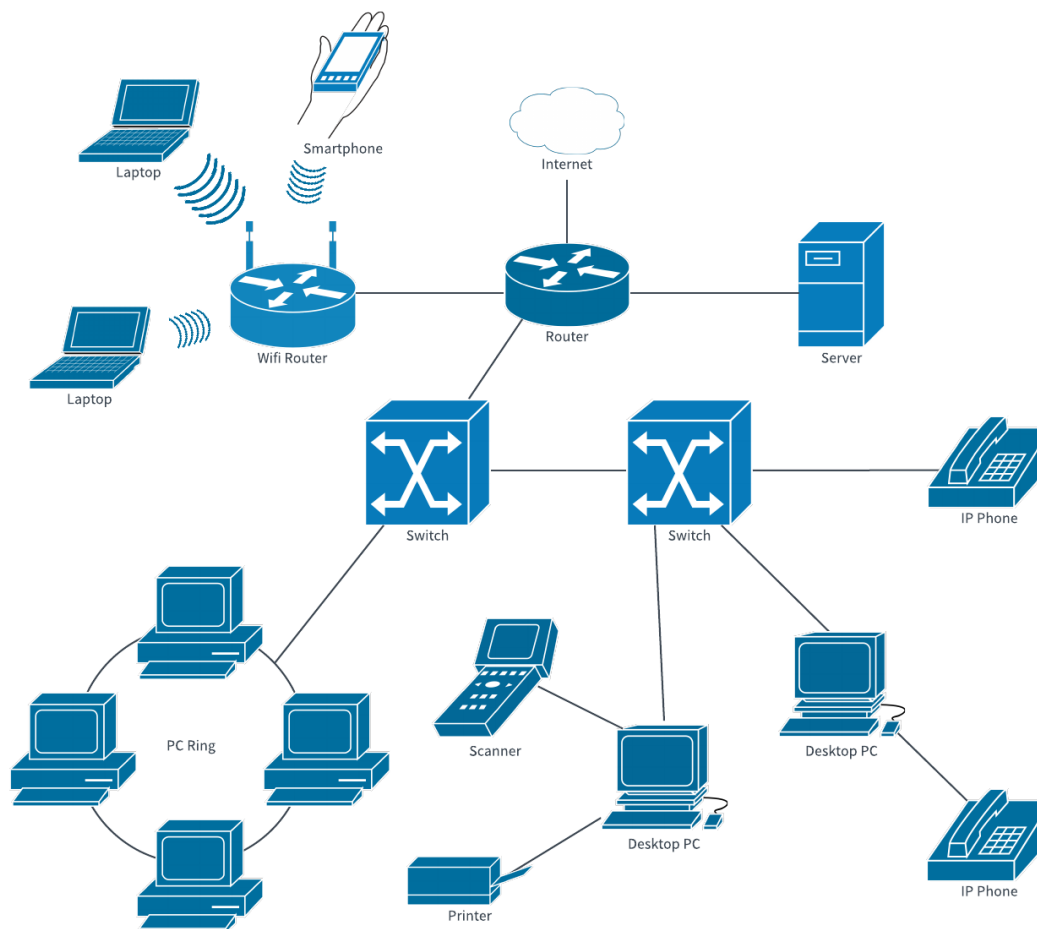# OUTLINE

Computer Networks

Technologies

Categories

Background

Architecture

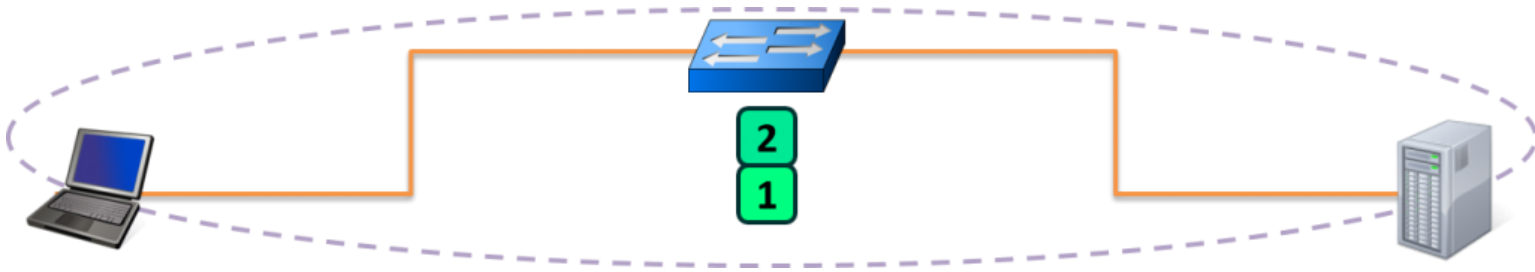Protocol Stack

COMPUTER NETWORKS COMPONENTS
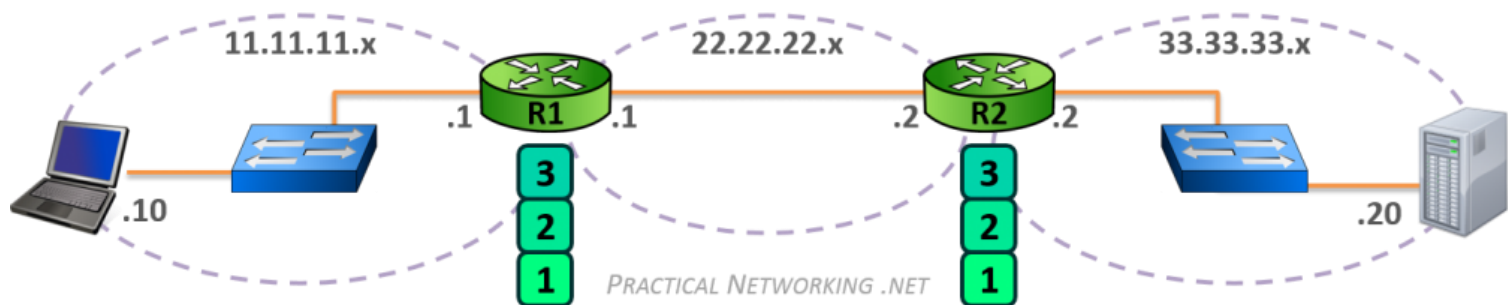
HOST

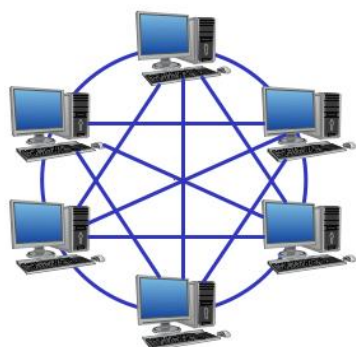❑End systems

❑They host application programs

❑Clients/Servers

SWITCH

ROUTER

11.11.11.x   22.22.22.x   33.33.33.x

.1   R1   .1   .2   R2   .2

.10   .20

3   2   1

3   2   1

PRACTICAL NETWORKING .NET
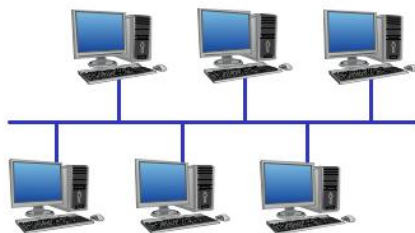
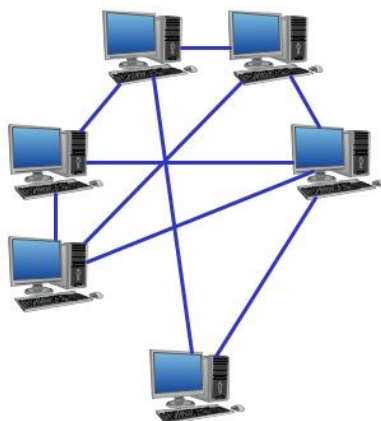# COMPUTER NETWORK TOPOLOGY

Fully Connected Network Topology

Mesh Network Topology
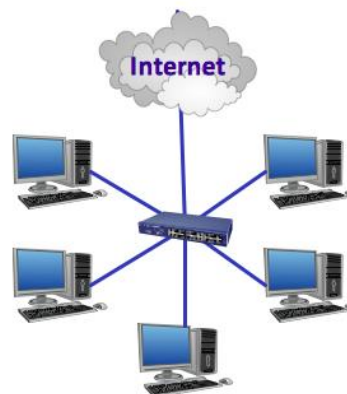
Star Network Topology

Common Bus Topology
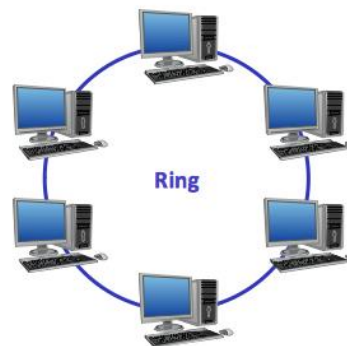
Ring Network Topology

INTERNET

mobile network

global ISP

home network

regional ISP

institutional network
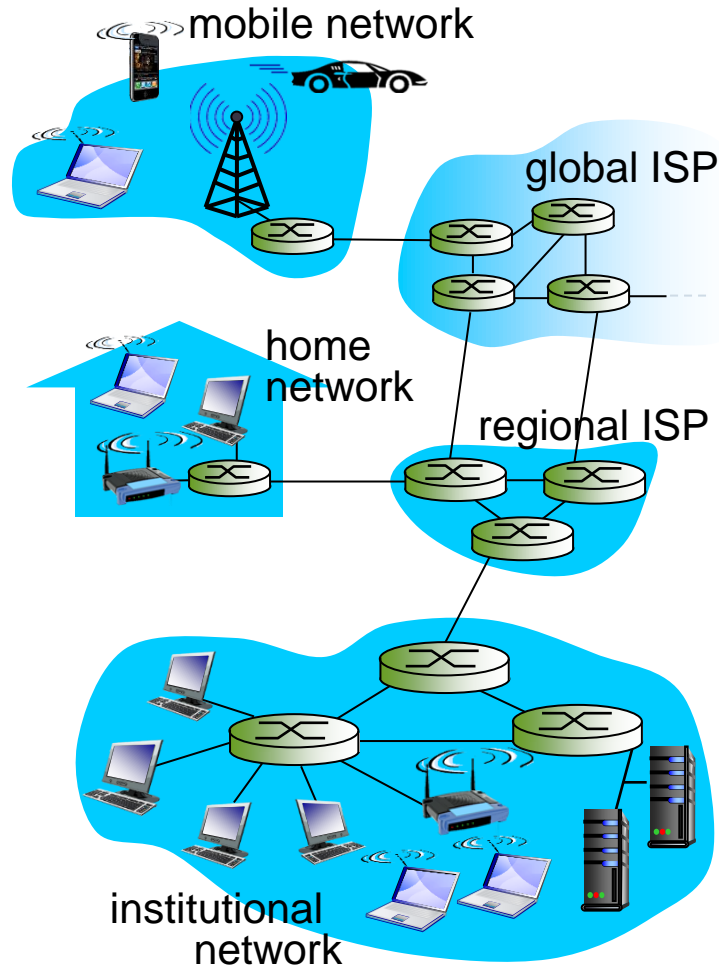
COMPUTER NETWORKS DESIGN ISSUES

Addressing

Data transfer rules

Routing

Packet sequencing

Flow control

Multiplexing

Scheduling

Error control

….

ADDRESSING

❑Specifying source and destination

DATA TRANSFER RULES
❑Duplexing

ROUTING

Source

Destination
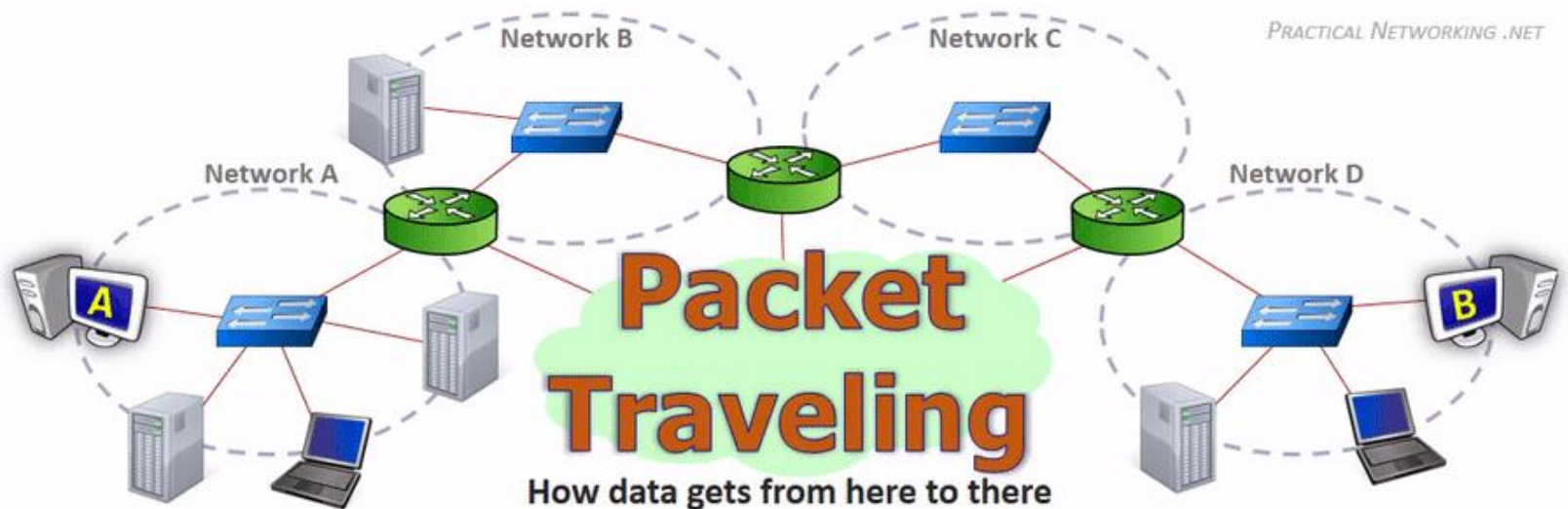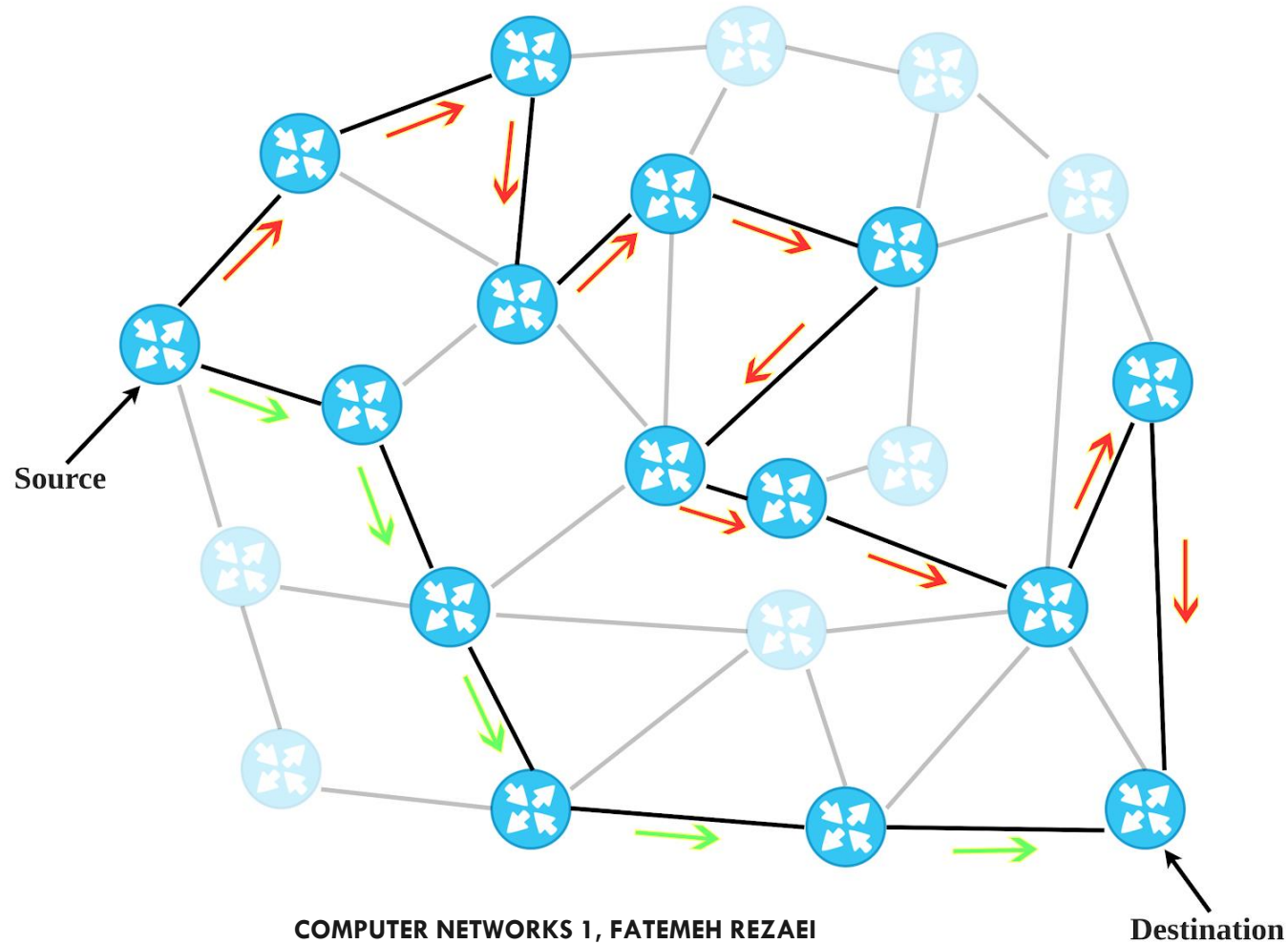
PACKET SEQUENCING

The original message is Green, Blue, Red.
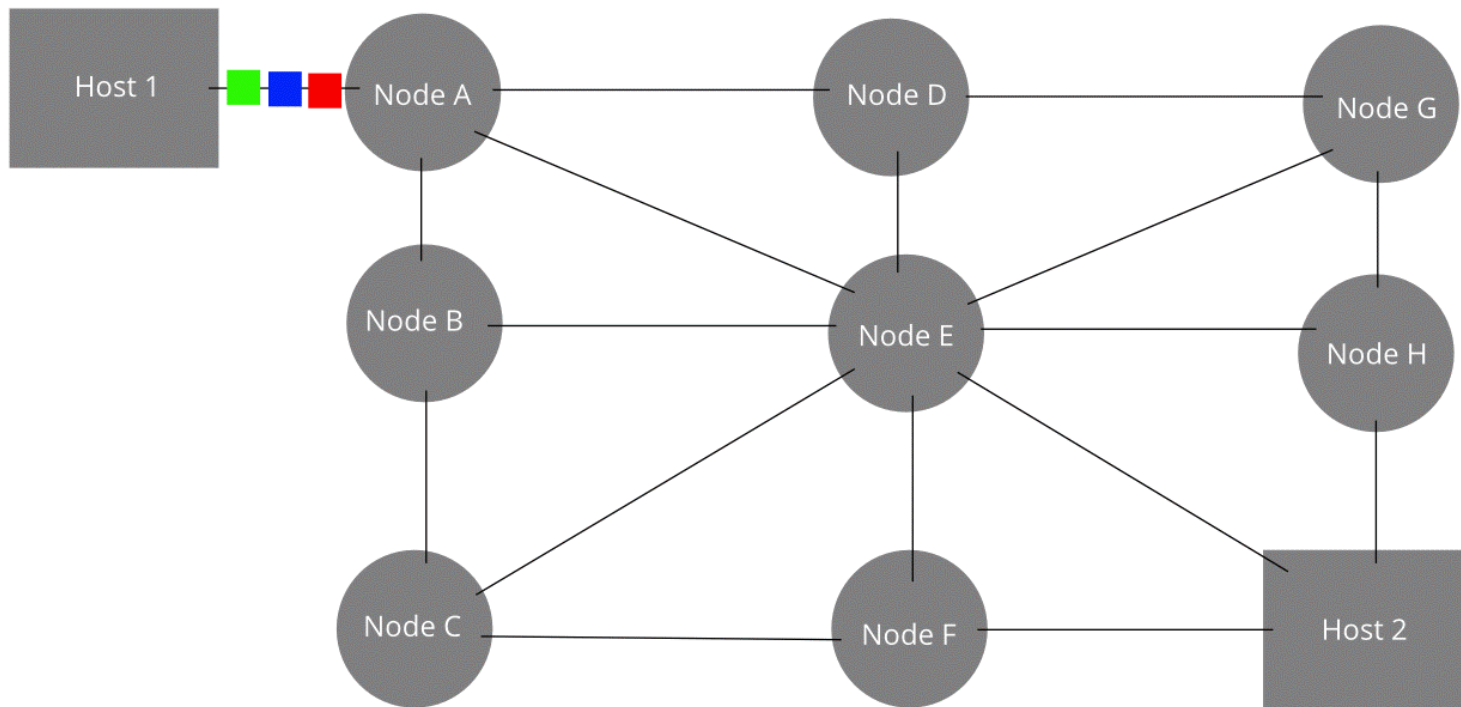
FLOW CONTROL

Flow Control
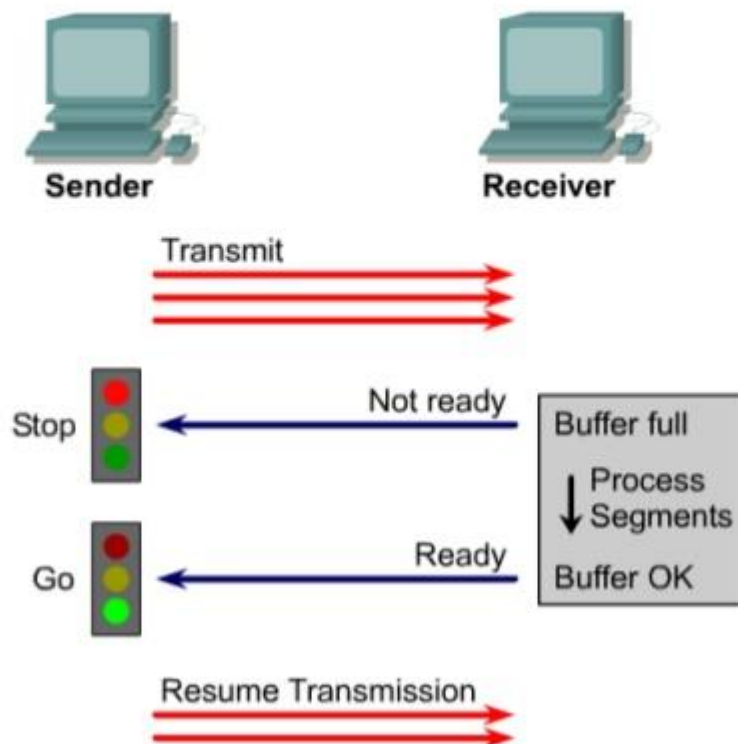
MULTIPLEXING
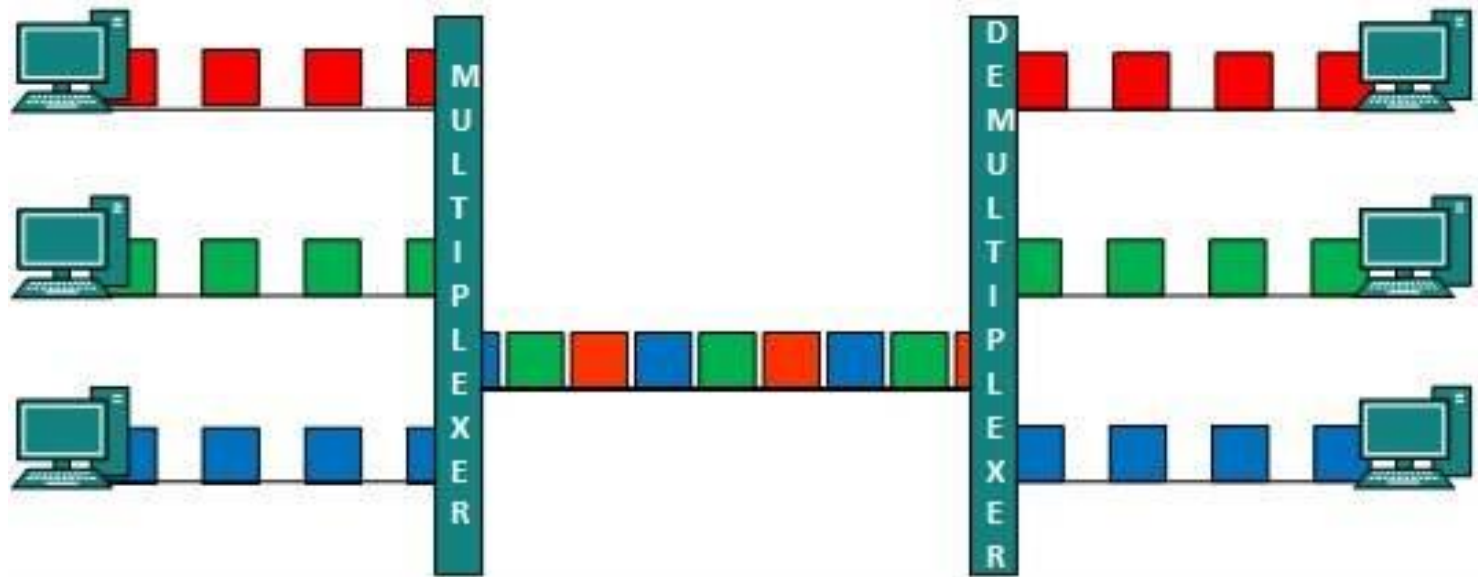
PACKET SCHEDULING
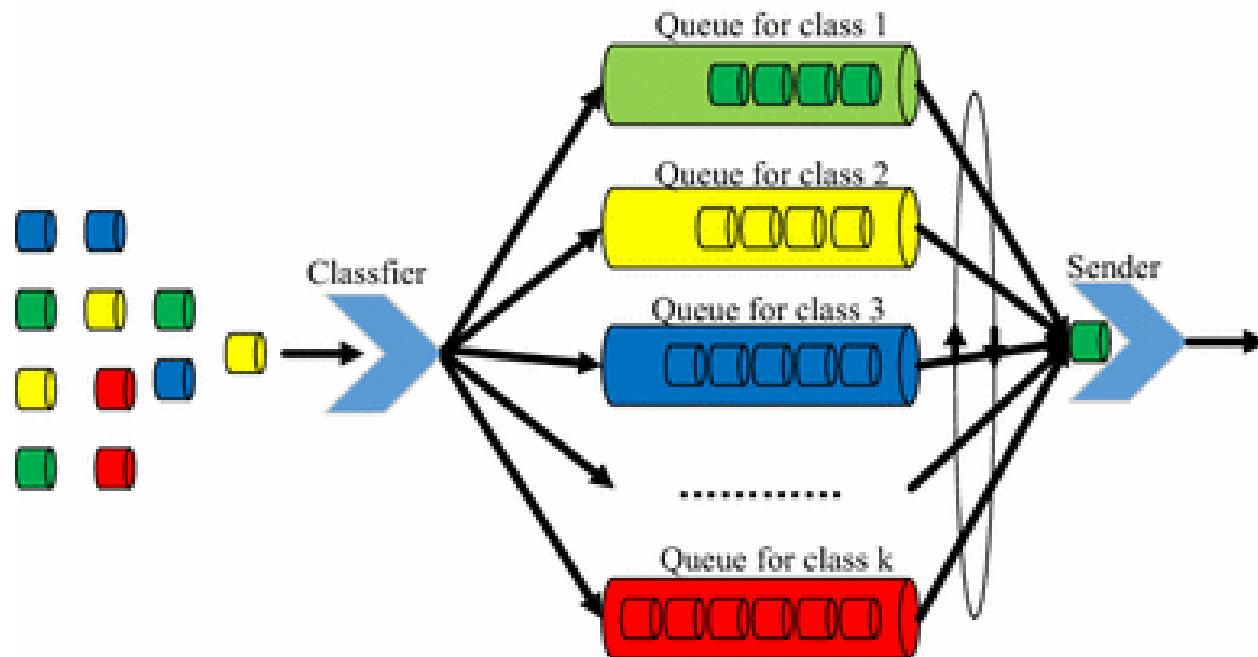
ERROR CONTROL
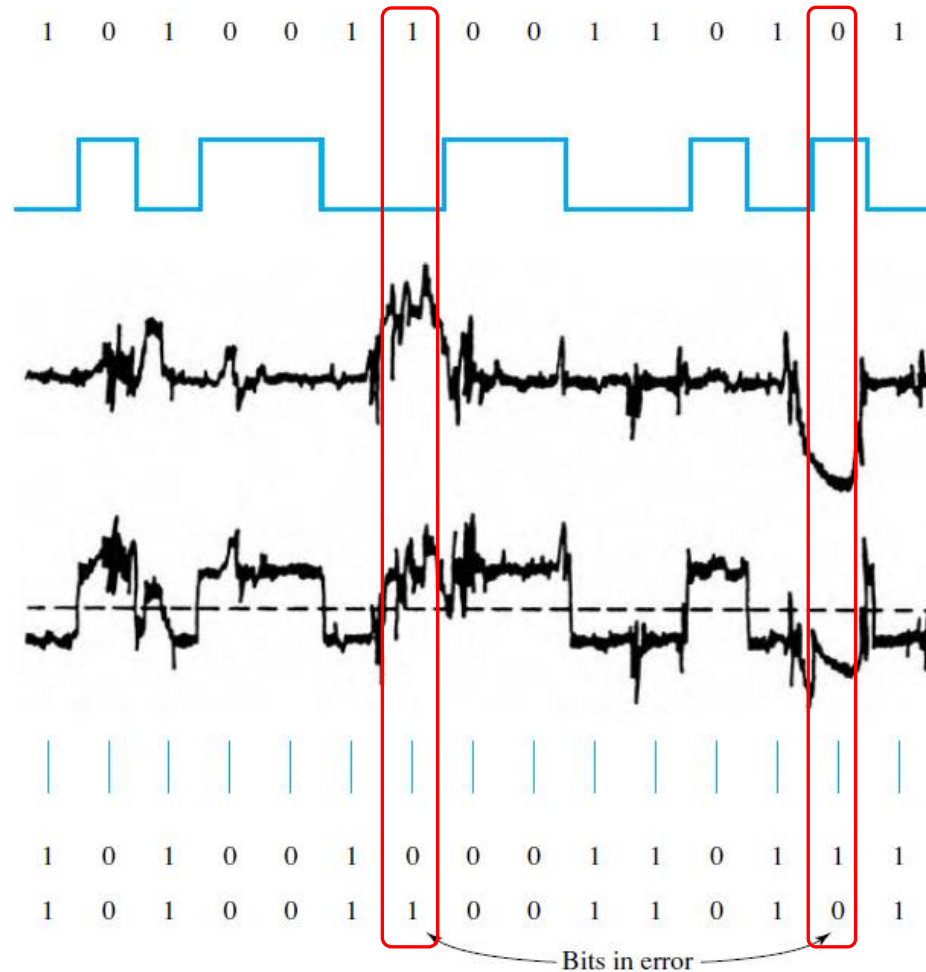
Bits in error

OUTLINE

Computer Networks

Technologies

Categories

Background

Architecture

Protocol Stack

NETWORK ARCHITECTURE EXAMPLE
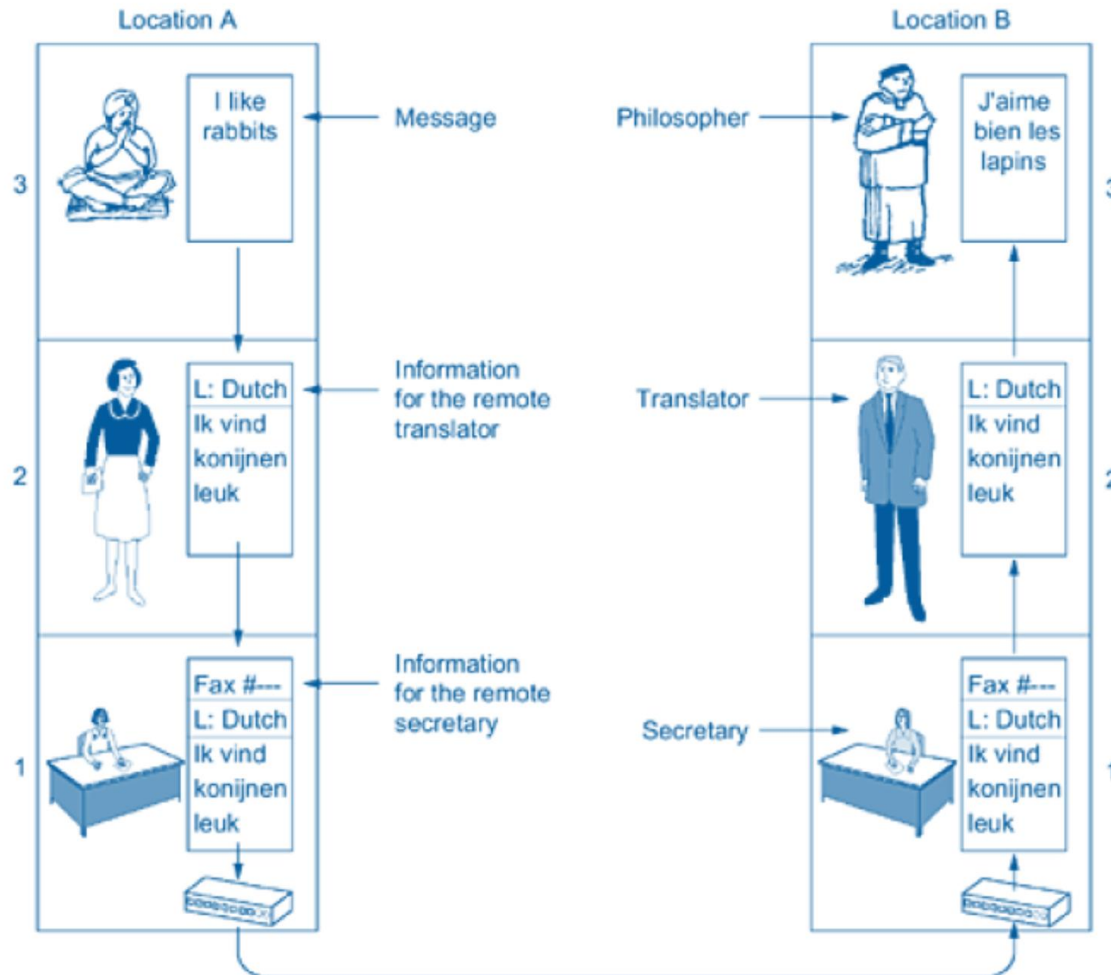
COMPUTER NETWORK ARCHITECTURE
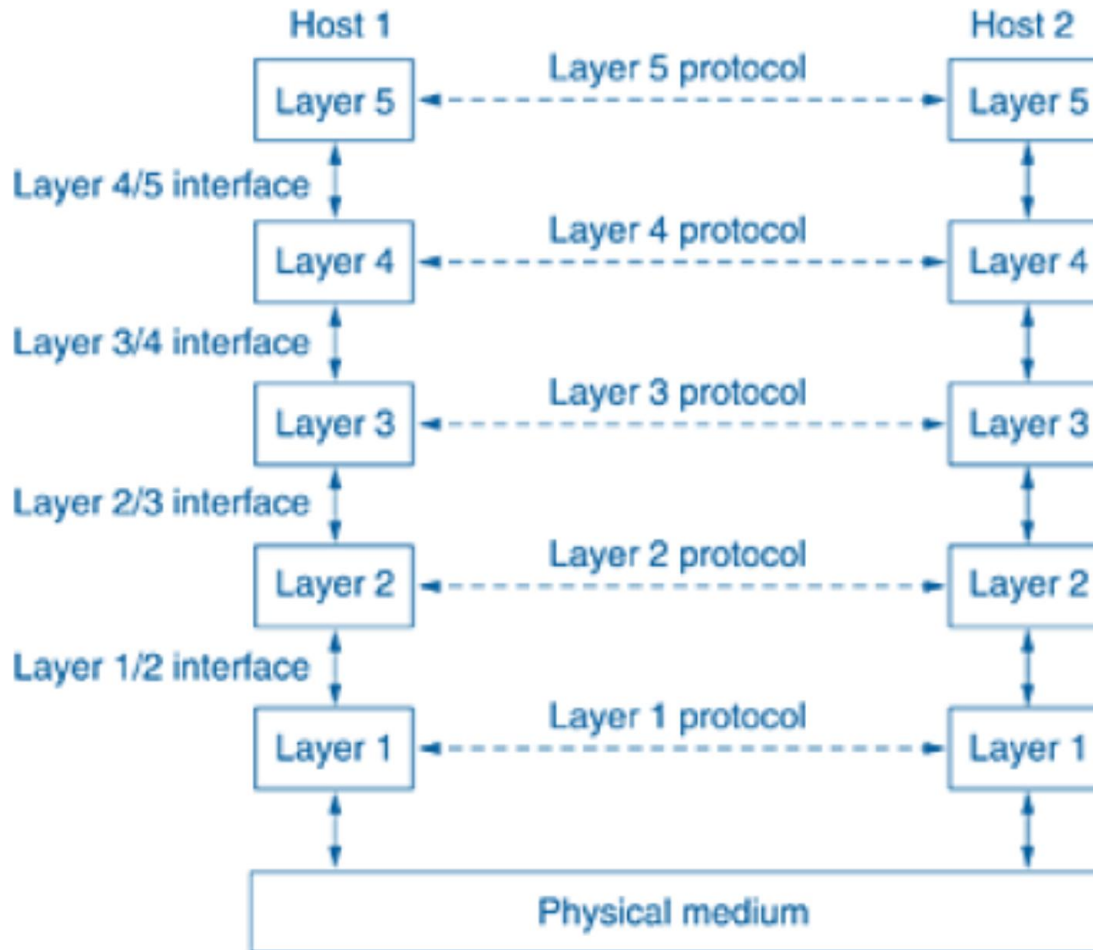
PROTOCOL STACK

Set of layers and protocols

- Simpler
- More flexible implementation

Interface

- Primitive operations and services

Protocol

- An agreement
- On rules and procedures
- Between two communicating parties
- About their communications

Protocol stack

- List of protocols, one per layer

INFORMATION FLOW EXAMPLE
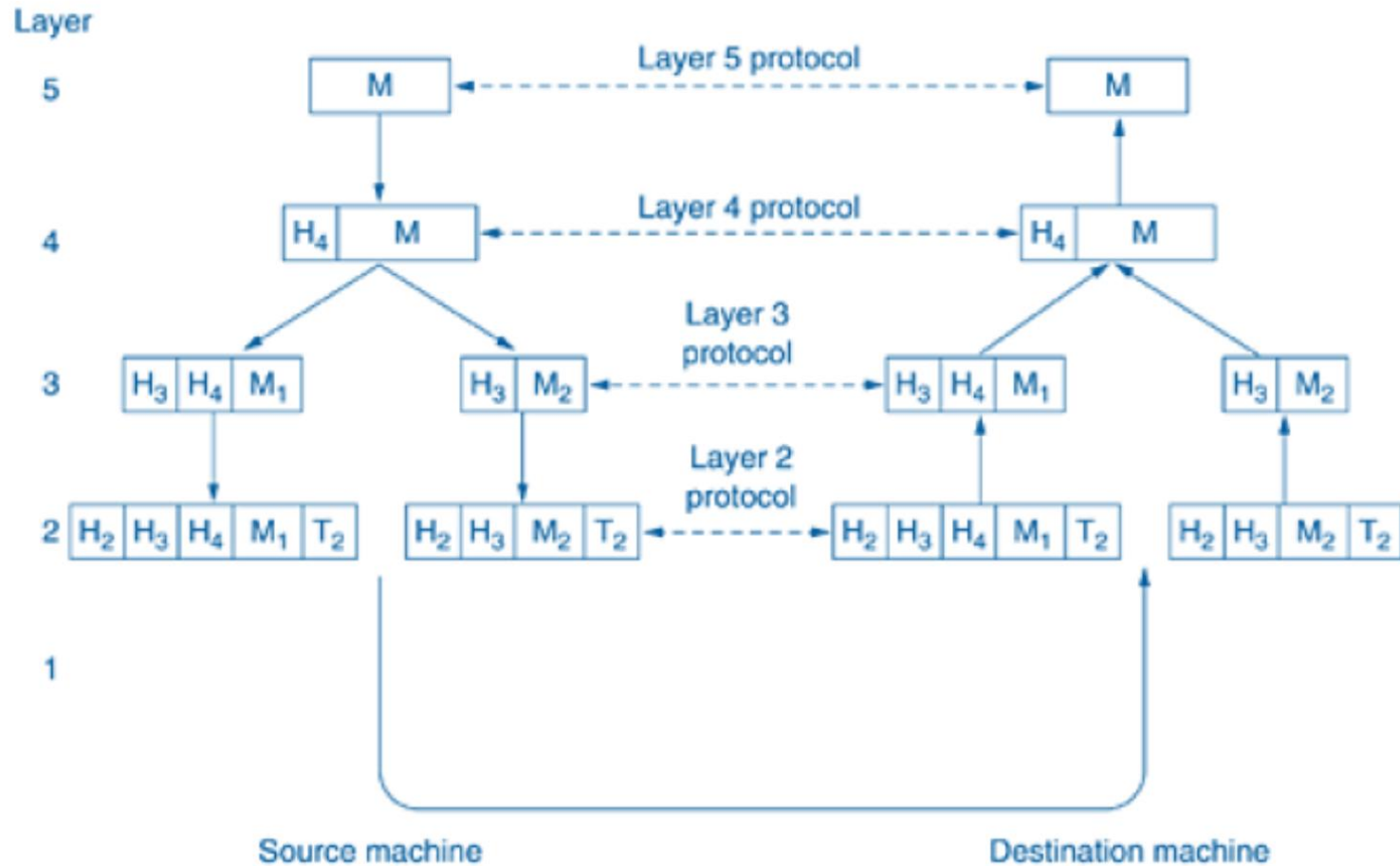
SERVICES AND PROTOCOLS

❑Service

- Set of primitives (operations)
- A layer providing to the above layer

❑Protocol

- Set of rules implementing a service
- Concerning format, meaning of frames, packets, messages
- A protocol may be changed without changing the service
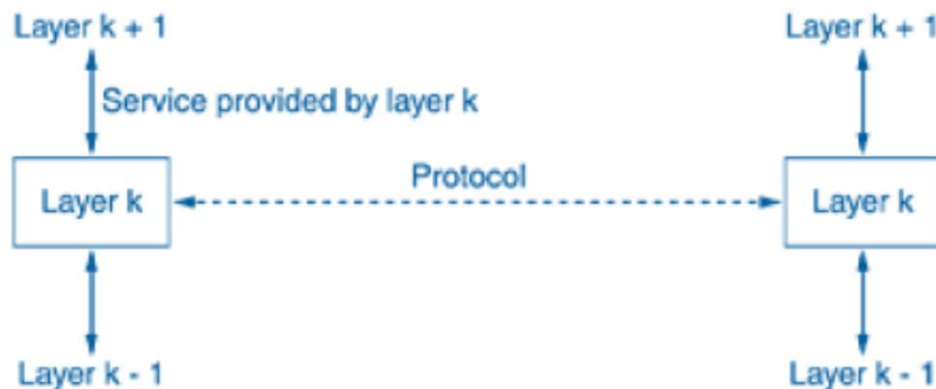
SERVICE TYPES

Service Categories

- Connectionless
  - Postal system
  - Email
- Connection oriented
  - Phone conversation
  - FTP

Service Reliability

- Reliable
  - Never loose data
  - Acknowledgements
  - Retransmission
- Unreliable
  - Data may be lost
  - No acknowledgements
  - Datagram service

OPEN SYSTEM INTERCONNECTION (OSI) REFERENCE MODEL
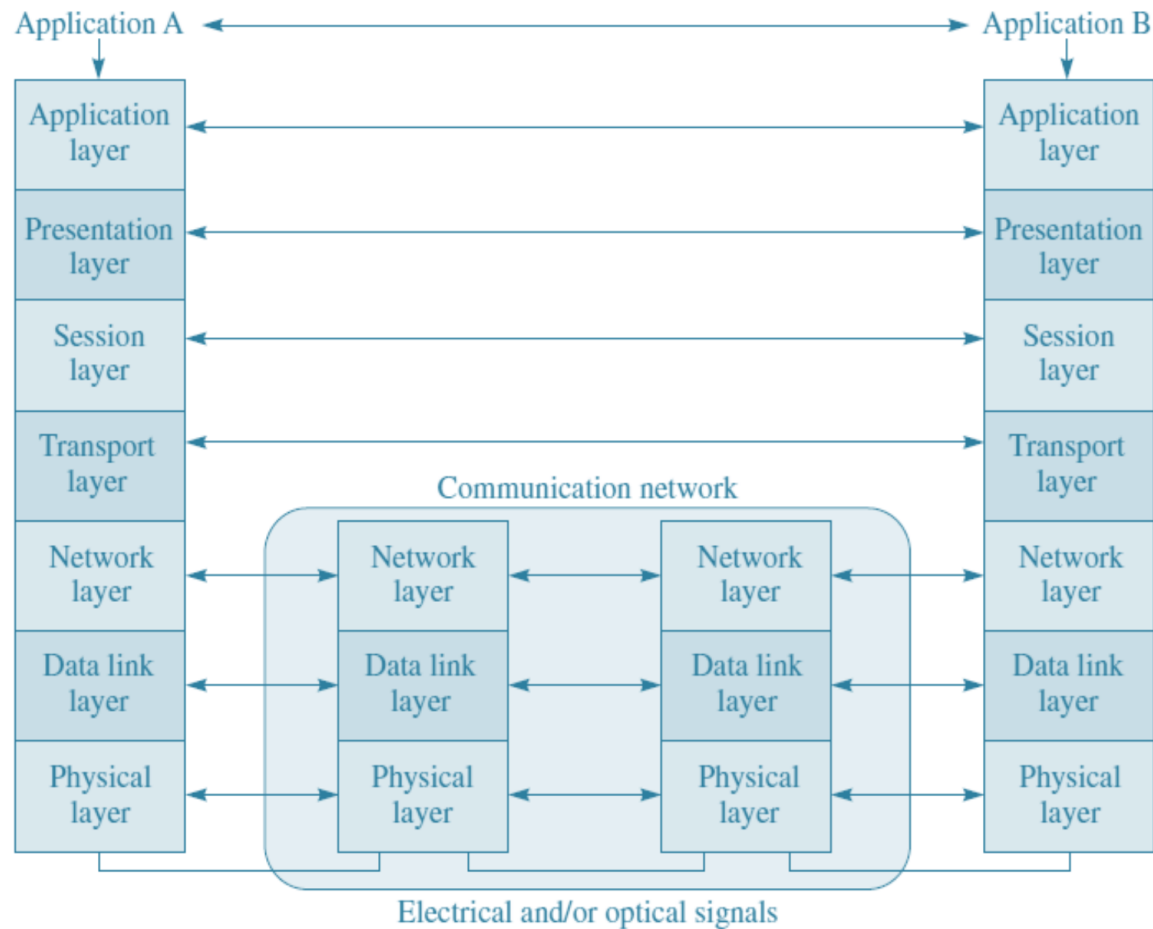
LAYER 1: PHYSICAL LAYER

❑Carries 1's and 0's between two nodes
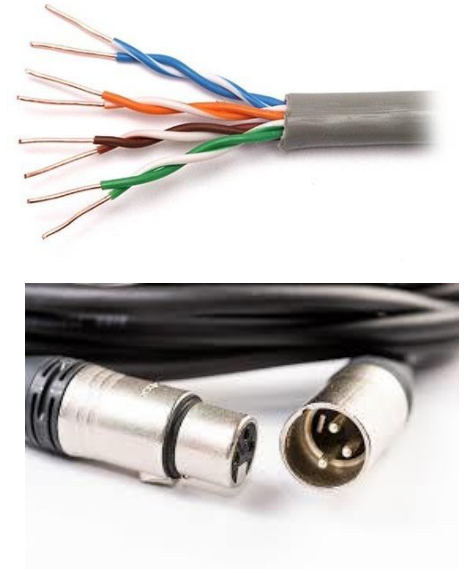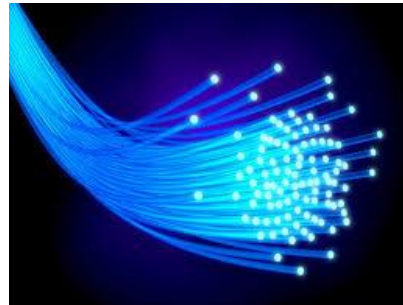
LAYER 2: DATA LINK LAYER

Interfacing with the PHY layer

- Receiving/Transmitting signals from/on the wire/air
- Framing

Responsible for

Packet delivery from hop to hop

- Using Media Access Control (MAC) Addresses

LAYER 3: NETWORK LAYER

packet delivery from end to end

- Using IP addresses
  - Logically identifying every node connected to the Internet

PRACTICAL NETWORKING .NET
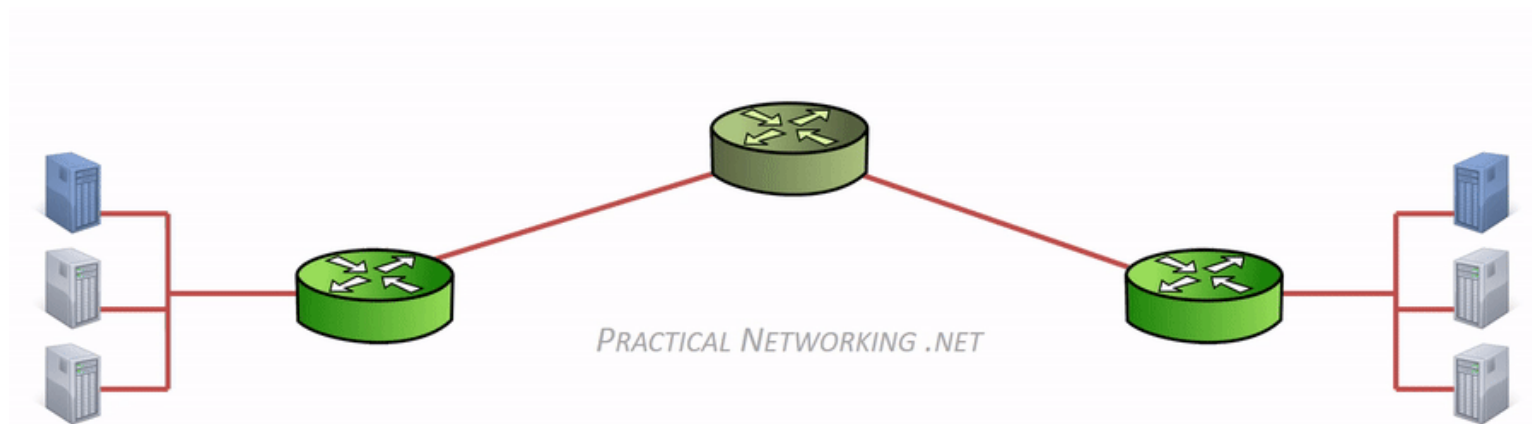
LAYER 4: TRANSPORT LAYER

Responsible for service to service delivery

- Distinguishing network streams

Transport Layer Protocols

- Transmission Control Protocol (TCP)
- User Datagram Protocol (UDP)

LAYER 5: SESSION LAYER

Session management

dialogue control

synchronization after crash
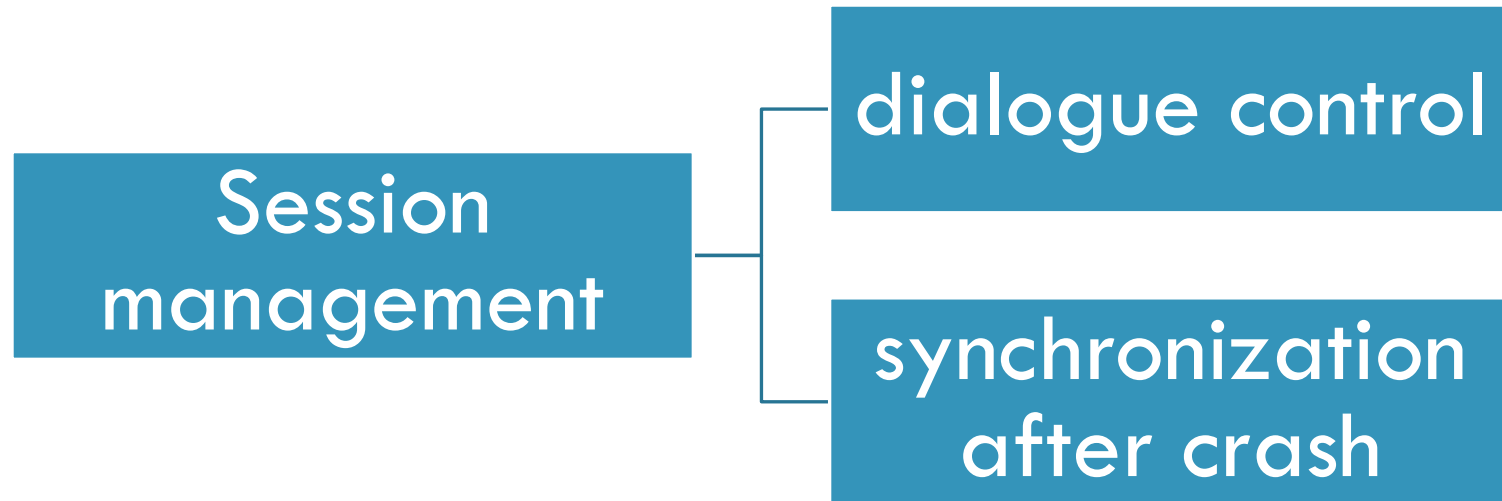
LAYER 6: PRESENTATION LAYER

Concerned with

- syntax
- semantics
- of transmitted information

LAYER 7: APPLICATION LAYER
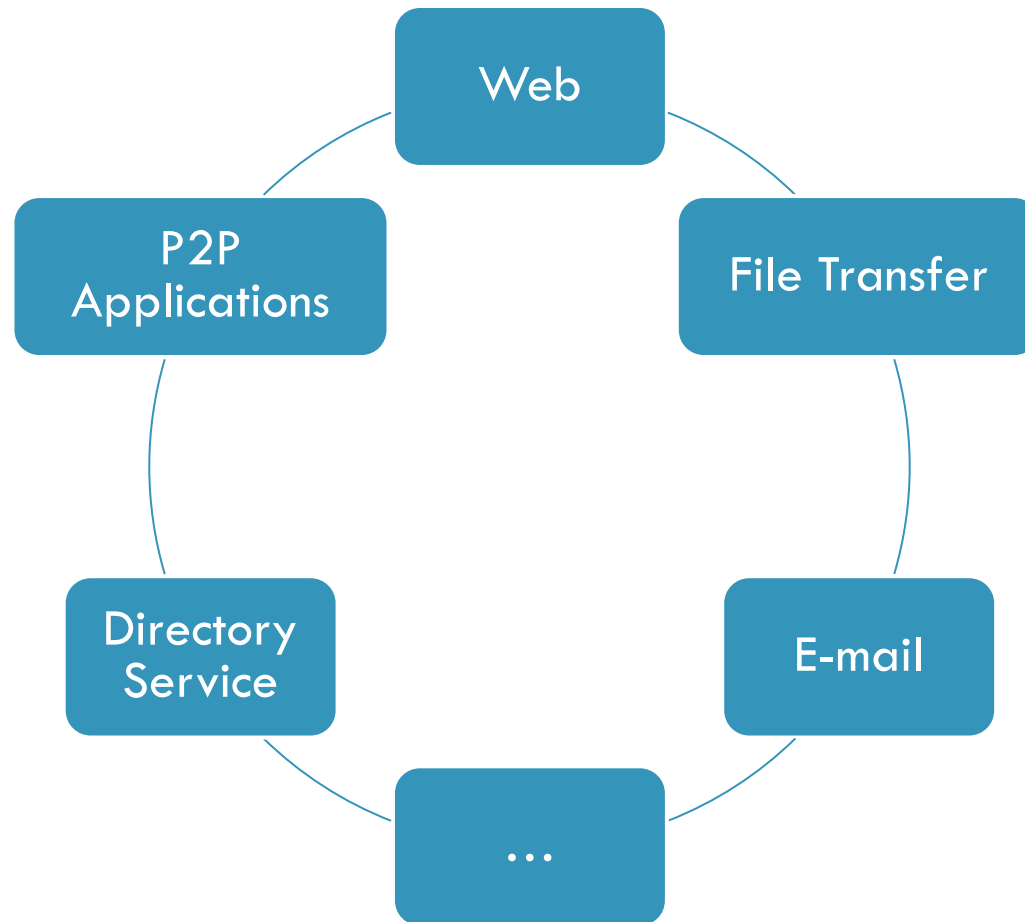
LAYER 5+
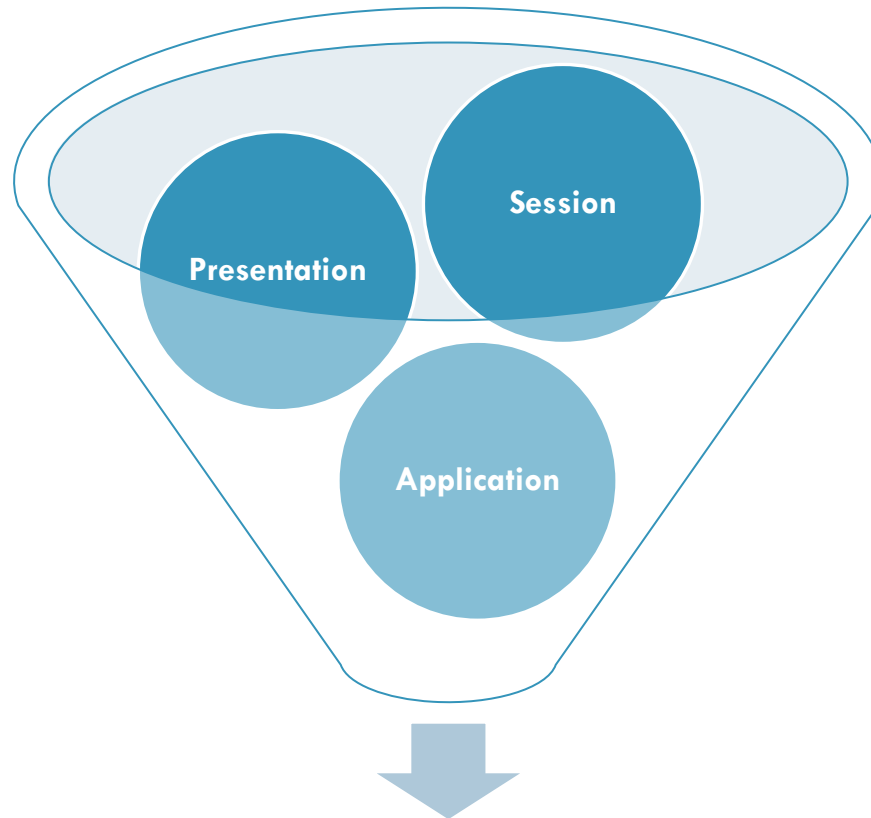
Layer 5+

HEADERS

OSI DATA UNITS

OSI DATA TRANSMISSION PATH

PRACTICAL NETWORKING .NET

7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data Link
1	Physical

7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data Link
1	Physical

TCP/IP MODEL

❑Originated from ARPANET

▪Connecting USA Universities and government institutes
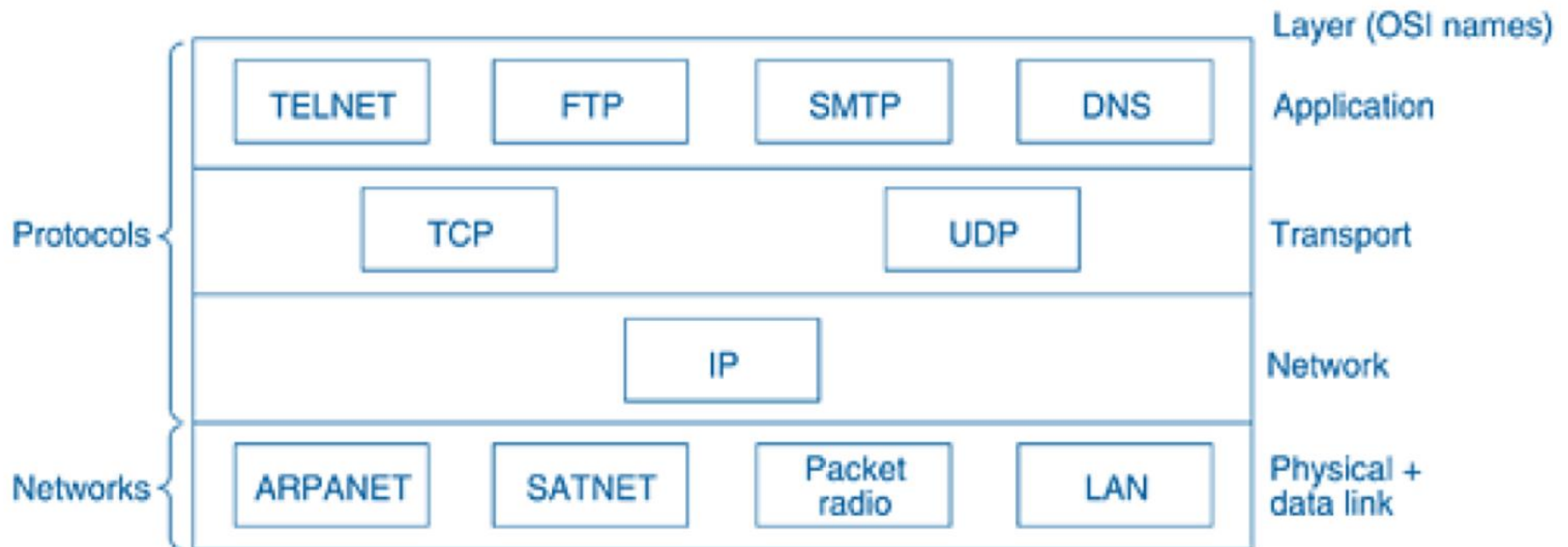
TCP/IP MODEL

Internet layer
- The most important layer

IP: Internet Protocol
- Connectionless
- Packet-switching

(Possible out-of-order delivery)

					Layer (OSI names)
Protocols	TELNET	FTP	SMTP	DNS	Application
	TCP		UDP		Transport
		IP			Network
Networks	ARPANET	SATNET	Packet radio	LAN	Physical + data link

OSI VS. TCP/IP MODELS

❑OSI

- Top-down design methodology

- The concepts clearly distinguishes

  - Services, Interfaces, Protocols

- Network layer supports both connectionless and connection-oriented communication

- Transport layer supports only connection-oriented service !!

❑TCP / IP

- Bottom-up approach
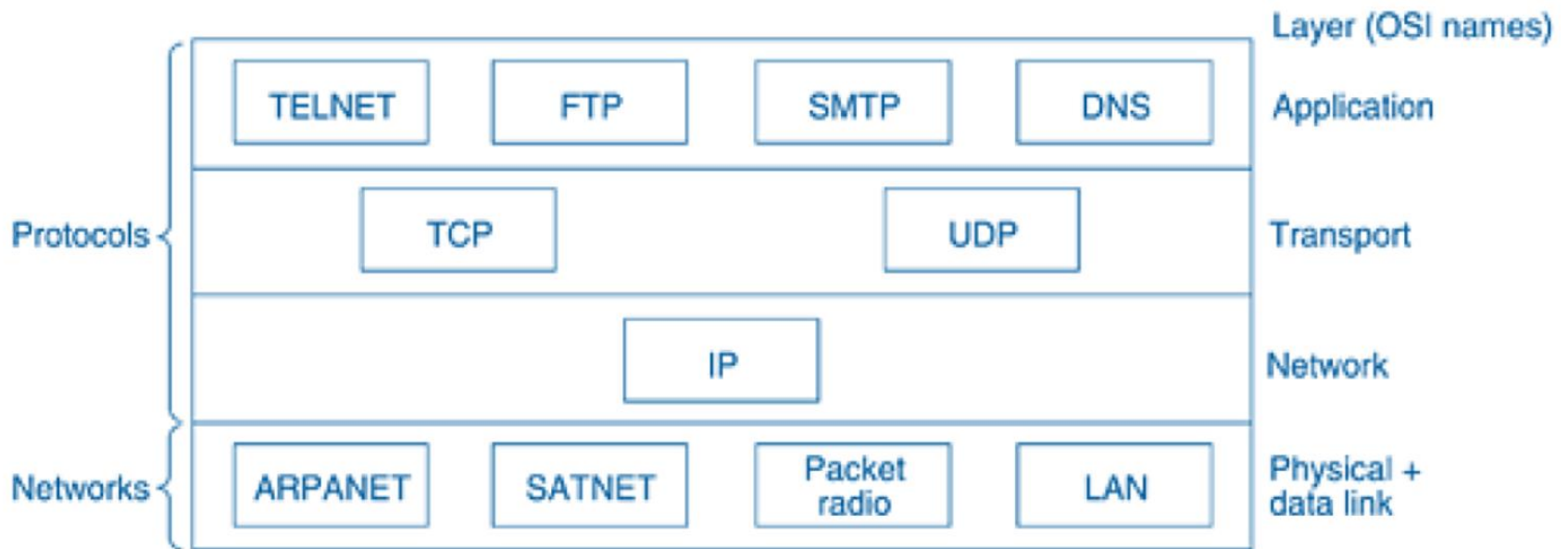
  grew out of practice

- Not a general protocol stack

	OSI		TCP/IP
7	Application		Application
6	Presentation		
5	Session		
4	Transport		Transport
3	Network		Internet
2	Data link		Host-to-network
1	Physical		
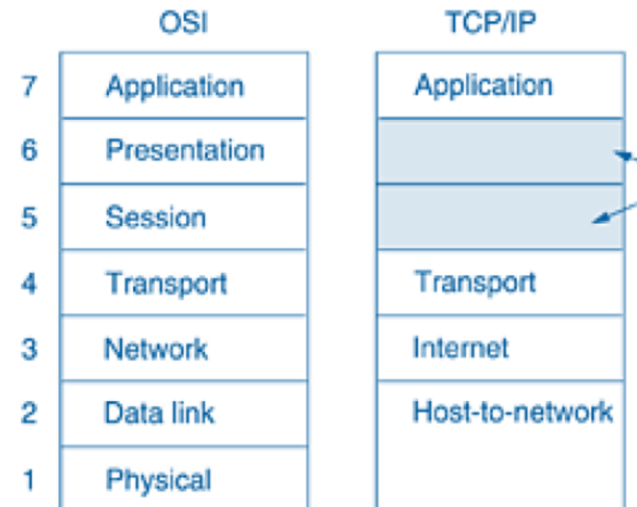
CRITICS ON OSI MODEL

❑Bad timing

❑Bad technology
- Too many layers
- Overloaded (L2, L1) and empty (L5, L6) layers
- Too difficult to understand and implement
- Initially ignored connectionless protocols

❑Bad implementations
- Early implementations were huge, unwieldy, and slow

❑Bad politics
- TCP/IP as part of UNIX, widely available, useful and open
- OSI as a creature of telecom ministers/big telecom companies

5 LAYER NETWORK ARCHITECTURE

Application Layer

Transport Layer

Network Layer

Data Link Layer

Physical Layer

5 LAYER NETWORK ARCHITECTURE

Application Layer

Transport Layer

Network Layer

Data Link Layer

Physical Layer