A Review of Key Networking Concepts

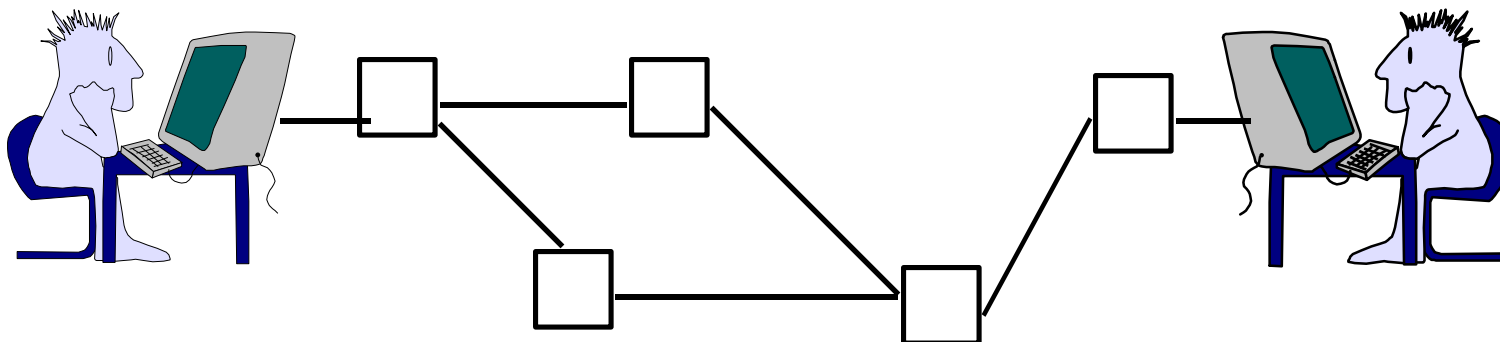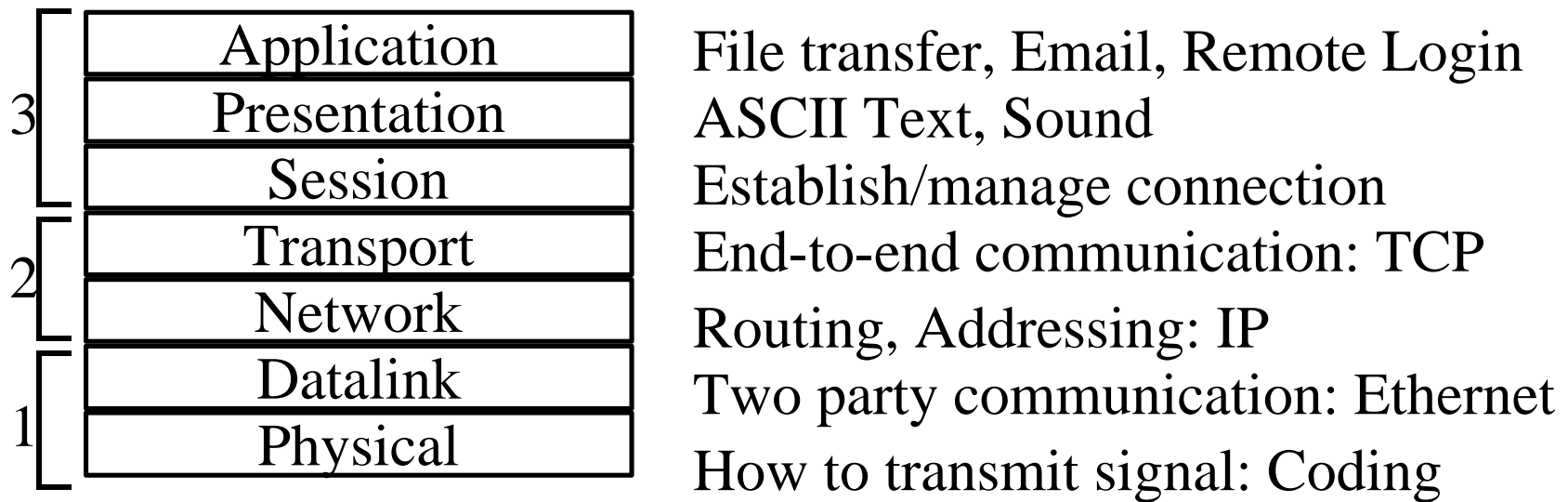Raj Jain

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Overview

- ❑ ISO/OSI Reference Model

- ❑ Ethernet/IEEE 802.3 LANs

- ❑ Interconnecting Devices
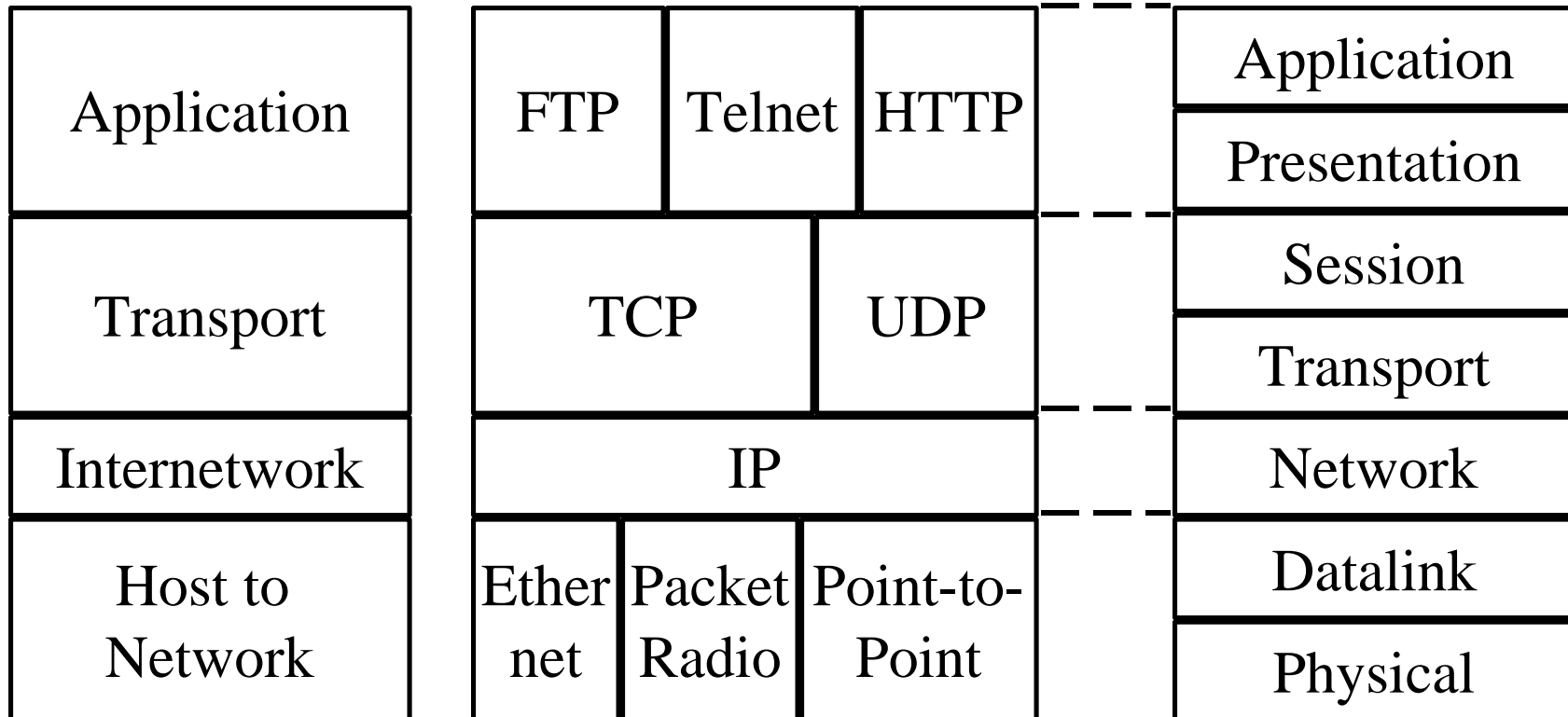 All these concepts are taught in CIS677.

ISO/OSI Reference Model

3	Application	File transfer, Email, Remote Login
	Presentation	ASCII Text, Sound
	Session	Establish/manage connection
2	Transport	End-to-end communication: TCP
	Network	Routing, Addressing: IP
1	Datalink	Two party communication: Ethernet
	Physical	How to transmit signal: Coding

TCP/IP Reference Model

❑ TCP = Transport Control Protocol

❑ IP = Internet Protocol (Routing)

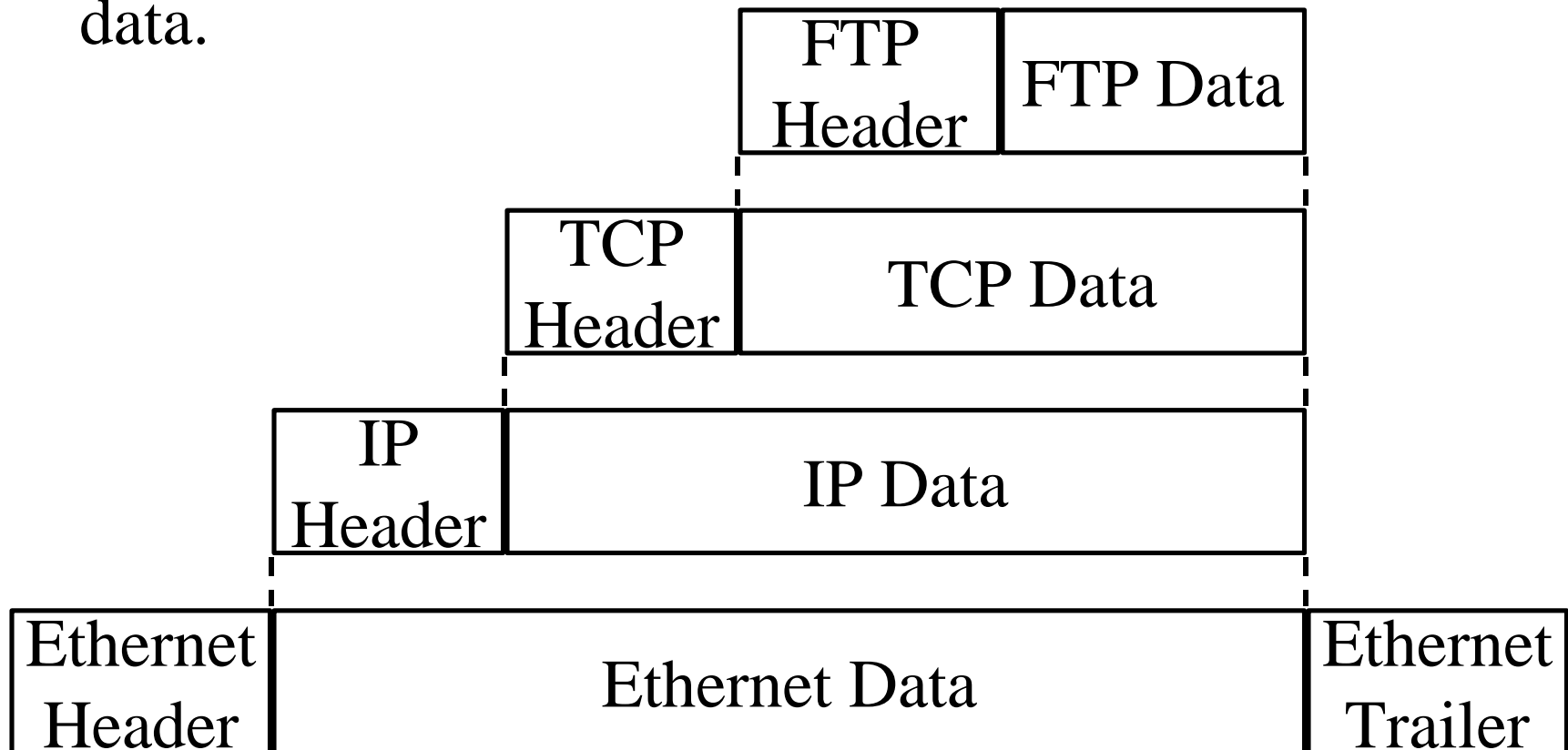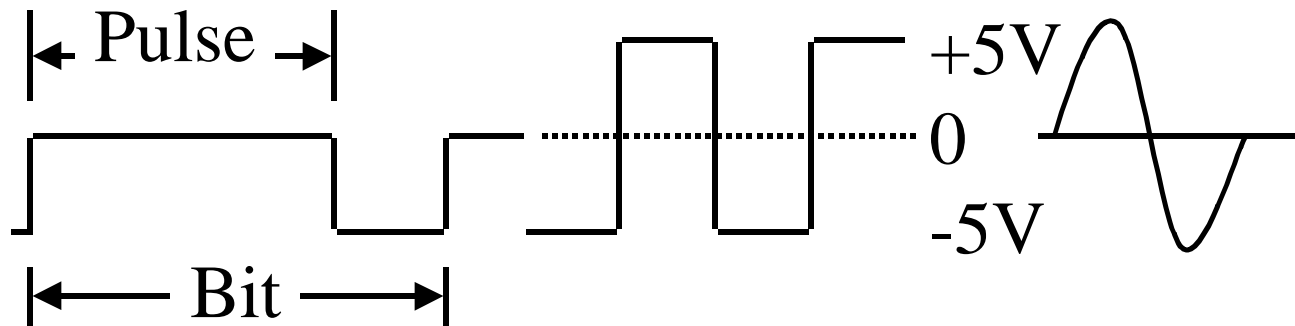| TCP/IP Ref Model	TCP/IP Protocols				OSI Ref Model
Application	FTP	Telnet	HTTP		Application
					Presentation
Transport	TCP		UDP		Session
					Transport
Internetwork	IP				Network
Host to Network	Ether net	Packet Radio	Point-to-Point		Datalink
					Physical

Layered Packet Format

❑ Nth layer control info is passed as N-1th layer data.

FTP Header	FTP Data

TCP Header	TCP Data

IP Header	IP Data

| Ethernet Header	Ethernet Data	Ethernet Trailer

Coding Terminology

Pulse ⟷   +5V

0

-5V

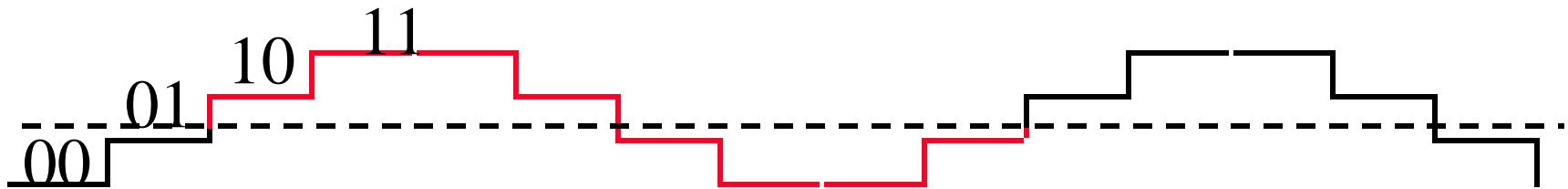|← Bit →|

❑ Signal element: Pulse

❑ Modulation Rate: 1/Duration of the smallest element =Baud rate

❑ Data Rate: Bits per second

❑ Data Rate = Fn(Bandwidth, signal/noise ratio, encoding)

Channel Capacity

❑ Capacity = Maximum data rate for a channel

❑ **Nyquist Theorem**:

❑ Bilevel Encoding: Data rate = $2 \times$ Bandwidth

5V

1

0

0
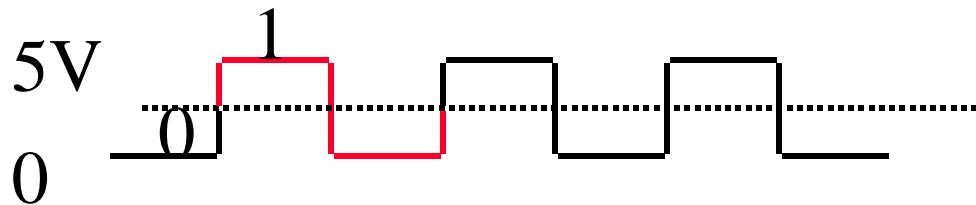
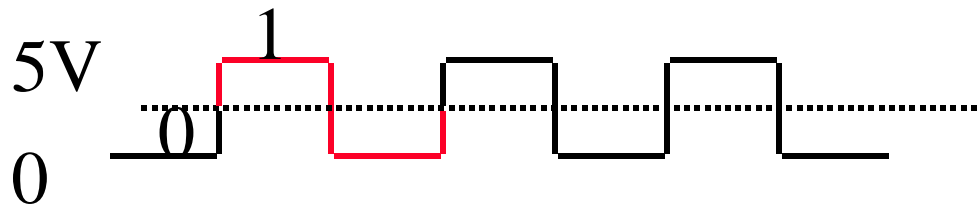q Multilevel coding: Data rate = $2 \times$ Bandwidth $\times \log_2$ M

11

10

01

00

Example: M=4, Capacity = $4 \times$ Bandwidth

Channel Capacity (Cont)

❑ Bilevel Encoding: Worst case: 1010101010
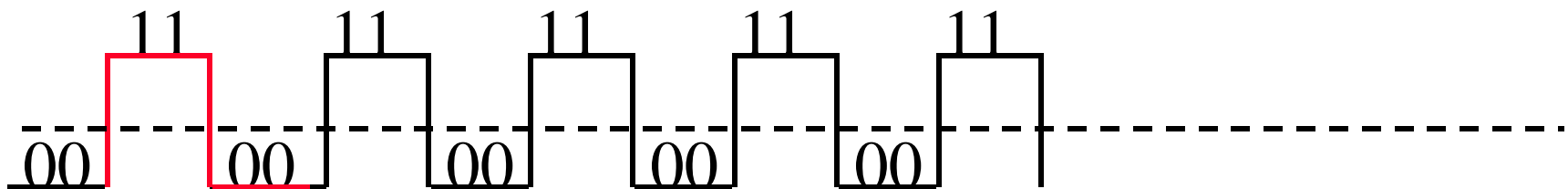   Cycle time $= 2 \times$ Bit time
   $\Rightarrow$ Data rate $= 2 \times$ Bandwidth
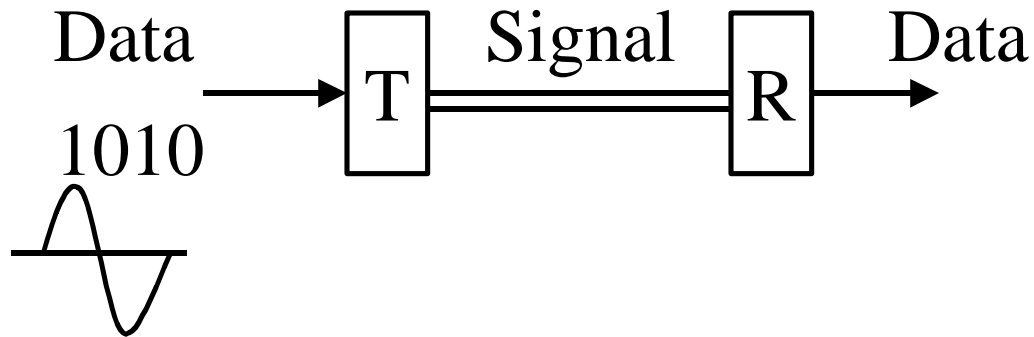

q Multilevel coding: Worst case 0011001100110011
   Cycle time $= 4 \times$ Bit time
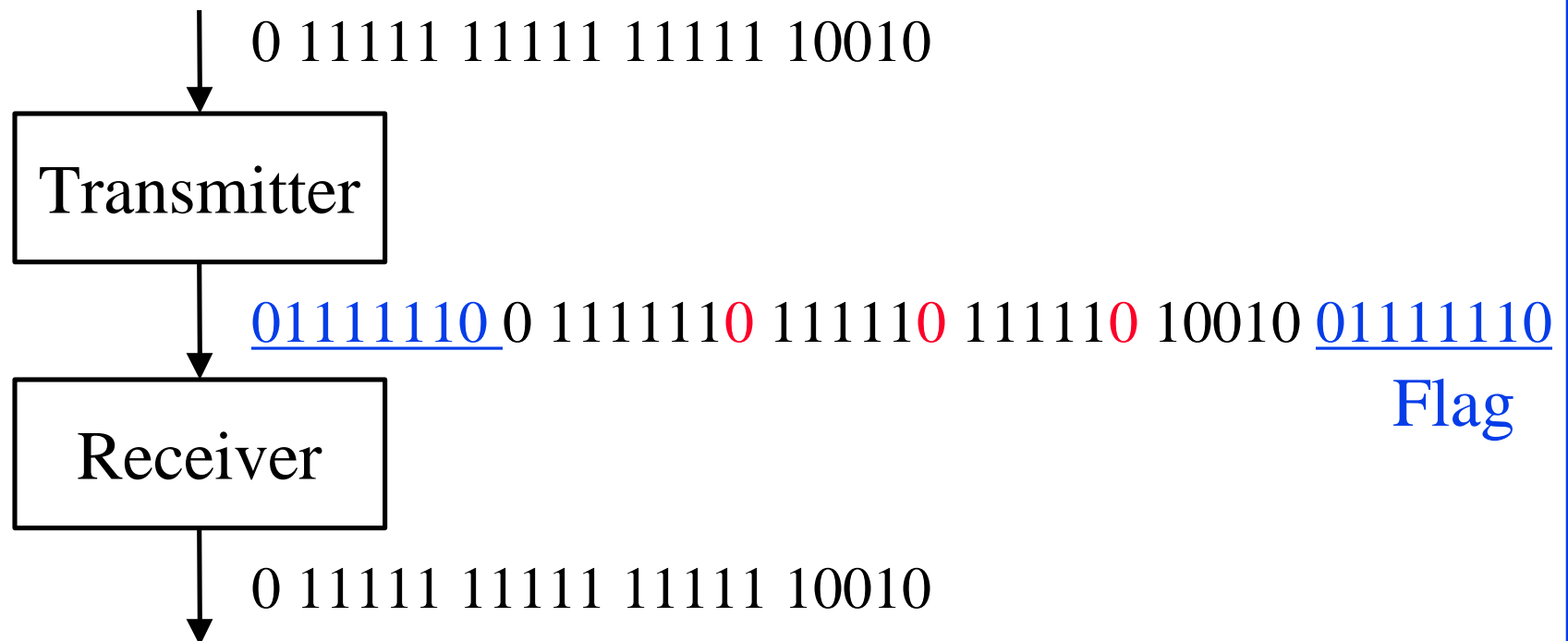 $\Rightarrow$ Data rate $= 2 \times$ Bandwidth $\times \log_2 M$

Data vs Signal

Data   T   Signal   R   Data

1010

❑ Data: Analog (Music), Digital (files)

❑ Signal: Analog (POTS, Radio), Digital (ISDN)

Data	Signal		Examples
Analog	Analog	Modulation	AM, FM
Digital	Analog	Coding/Keying	ASK, FSK, PSK
Analog	Digital	Modulation	PCM, ADPCM
Digital	Digital	Coding	Manchester, NRZ

Bit Stuffing

❑ Delimit with special bit pattern (bit flags)

❑ Stuff bits if pattern appears in data

❑ Remove stuffed bits at destination

0 11111 11111 11111 10010

Transmitter

01111110 0 1111110 111110 111110 10010 01111110

Flag

Receiver

0 11111 11111 11111 10010

Flow Control

❑ Flow Control = Sender does not flood the receiver, but maximizes throughput

❑ Sender throttled until receiver grants permission

❑ Methods:
  ○ Stop and wait
  ○ Sliding window

Error Control

❑ Error Control = Deliver frames without error, in the proper order to network layer

❑ Error control Mechanisms:

○ Ack/Nak: Provide sender some feedback about other end

○ Time-out: for the case when entire packet or ack is lost

○ Sequence numbers: to distinguish retransmissions from originals

❑ ARQ: Stop and Wait, Selective Reject, Go-back n

Connection-Oriented vs Connectionless
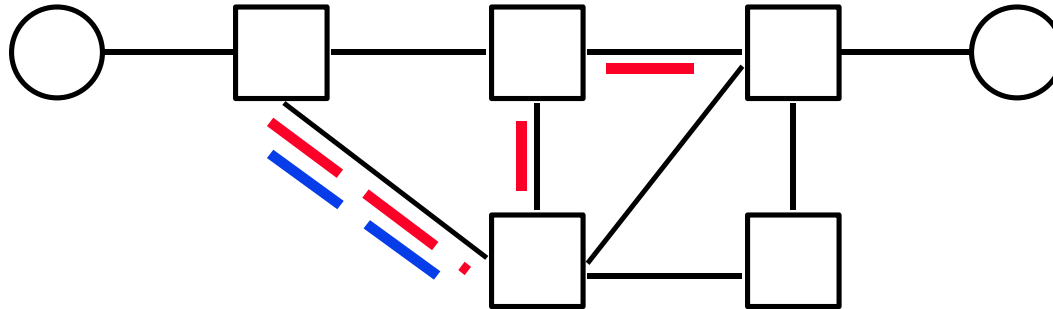
❑ Connection-Oriented: Telephone System

- ○ Path setup before data is sent
- ○ Data need not have address. Circuit number is sufficient.

❑ Connectionless: Postal System.

- ○ Complete address on each packet
- ○ The address decides the next hop at each router

Multiple Access Protocols

(a) Multiple Access

(b) Carrier-Sense Multiple Access with Collision Detection

Multiple Access Protocols

❑ Aloha at University of Hawaii:
   Transmit whenever you like
   Worst case utilization = $1/(2e)$ =18%

❑ CSMA: Carrier Sense Multiple Access
   Listen before you transmit

❑ CSMA/CD: CSMA with Collision Detection
   Listen while transmitting.
   Stop if you hear someone else.

❑ Ethernet uses CSMA/CD.
   Standardized by IEEE 802.3 committee.
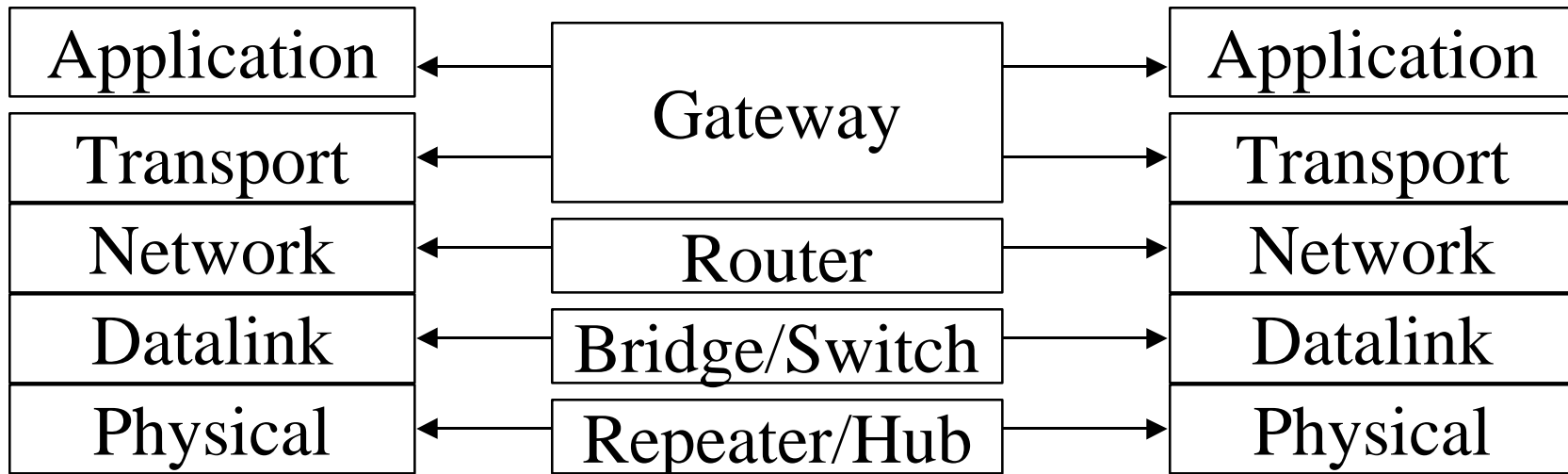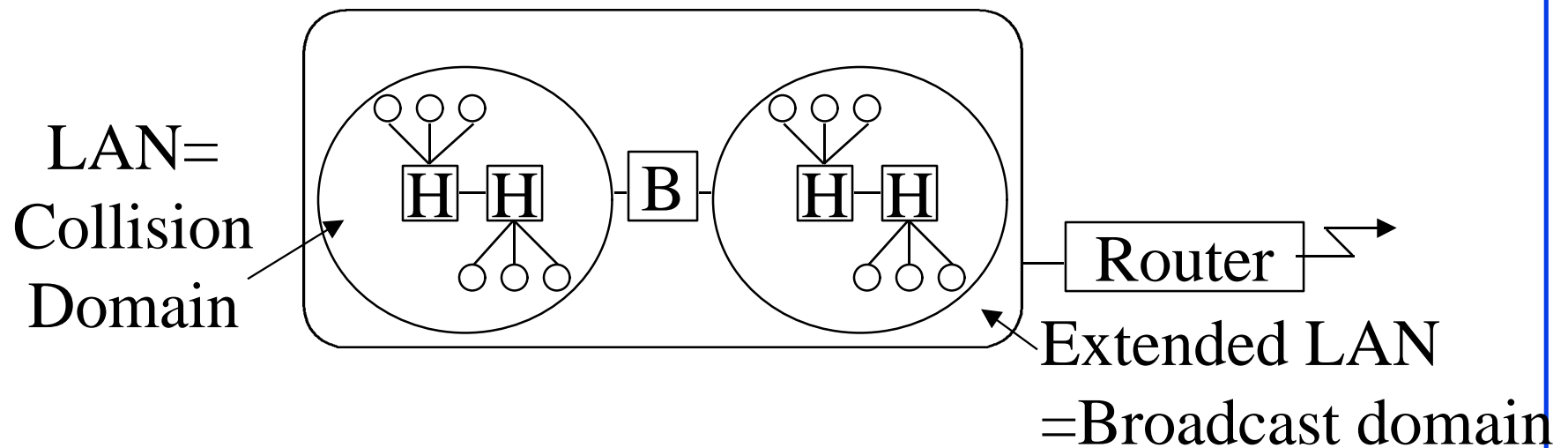
Interconnection Devices

❑ **Repeater**: PHY device that restores data and collision signals

❑ **Hub:** Multiport repeater + fault detection and recovery

❑ **Bridge:** Datalink layer device connecting two or more collision domains. MAC multicasts are propagated throughout "extended LAN."

❑ **Router:** Network layer device. IP, IPX, AppleTalk. Does not propagate MAC multicasts.

❑ **Switch**: Multiport bridge with parallel paths

These are functions. Packaging varies.

Interconnection Devices

LAN=
Collision
Domain

H-H B H-H

Router

Extended LAN
=Broadcast domain

| Application	Gateway		Application
Transport			Transport
Network	Router		Network
Datalink	Bridge/Switch		Datalink
Physical	Repeater/Hub		Physical

IEEE 802 Address Format

q 48-bit:1000 0000 : 0000 0001 : 0100 0011

: 0000 0000 : 1000 0000 : 0000 1100

= 80:01:43:00:80:0C

Organizationally Unique Identifier (OUI)			24 bits assigned by OUI Owner
Individual/ Group	Universal/ Local		
1	1	22	24

❑ Multicast = "To all bridges on this LAN"

❑ Broadcast = "To all stations"
= 111111....111 = FF:FF:FF:FF:FF:FF

Summary
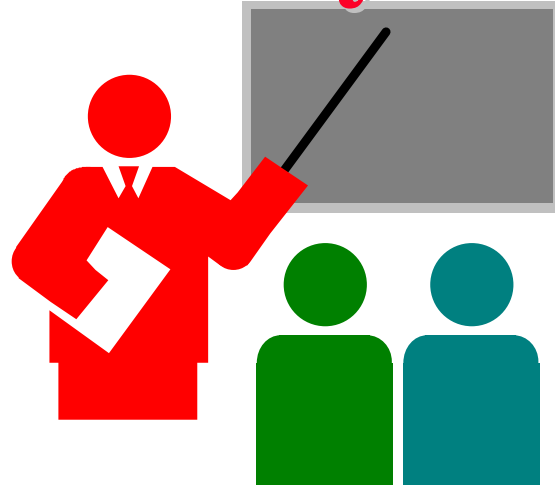
❑ ISO/OSI reference model has seven layers. TCP/IP Protocol suite has four layers.

❑ Ethernet/IEEE 802.3 uses CSMA/CD.

❑ Addresses: Local vs Global, Unicast vs Broadcast.

Homework

❏ For each of the following addresses: indicate whether it is a multicast and whether it is a locally assigned address?
80:02:45:00:00:00
40:02:45:00:00:01
Were these addresses assigned by the same manufacturer?