

A Review of Key Networking Concepts

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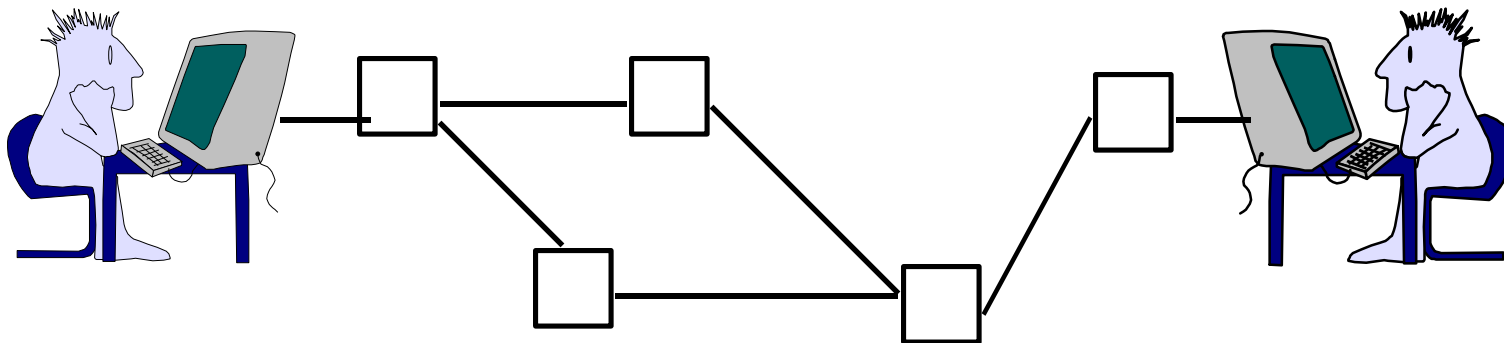
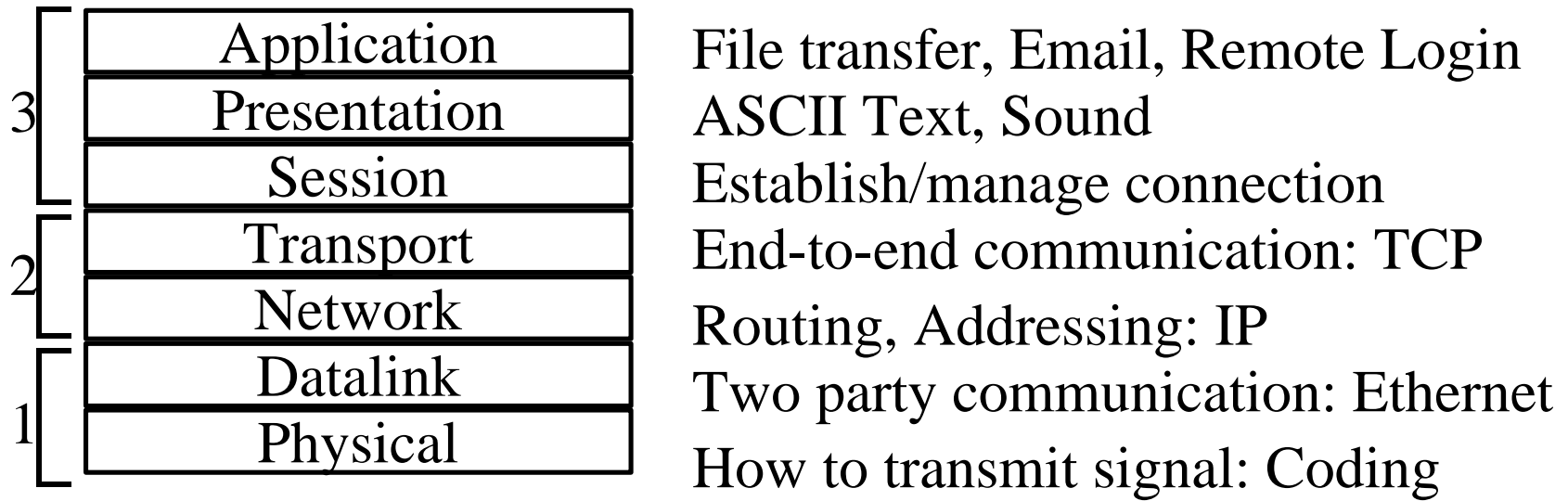
These slides are available at

<http://www.cis.ohio-state.edu/~jain/cis777-99/>



- ❑ ISO/OSI Reference Model
 - ❑ Ethernet/IEEE 802.3 LANs
 - ❑ Interconnecting Devices
- All these concepts are taught in CIS677.

ISO/OSI Reference Model



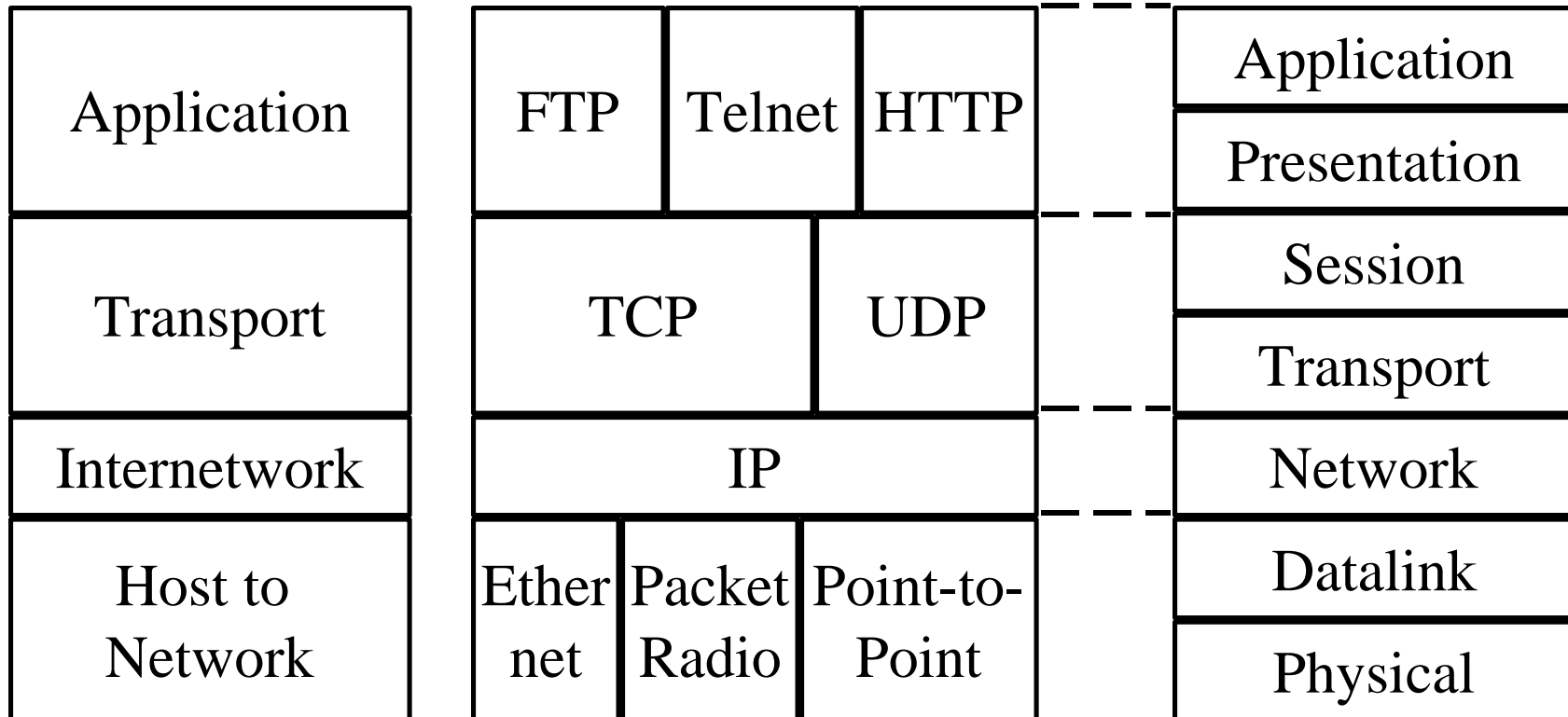
TCP/IP Reference Model

- TCP = Transport Control Protocol
- IP = Internet Protocol (Routing)

TCP/IP Ref Model

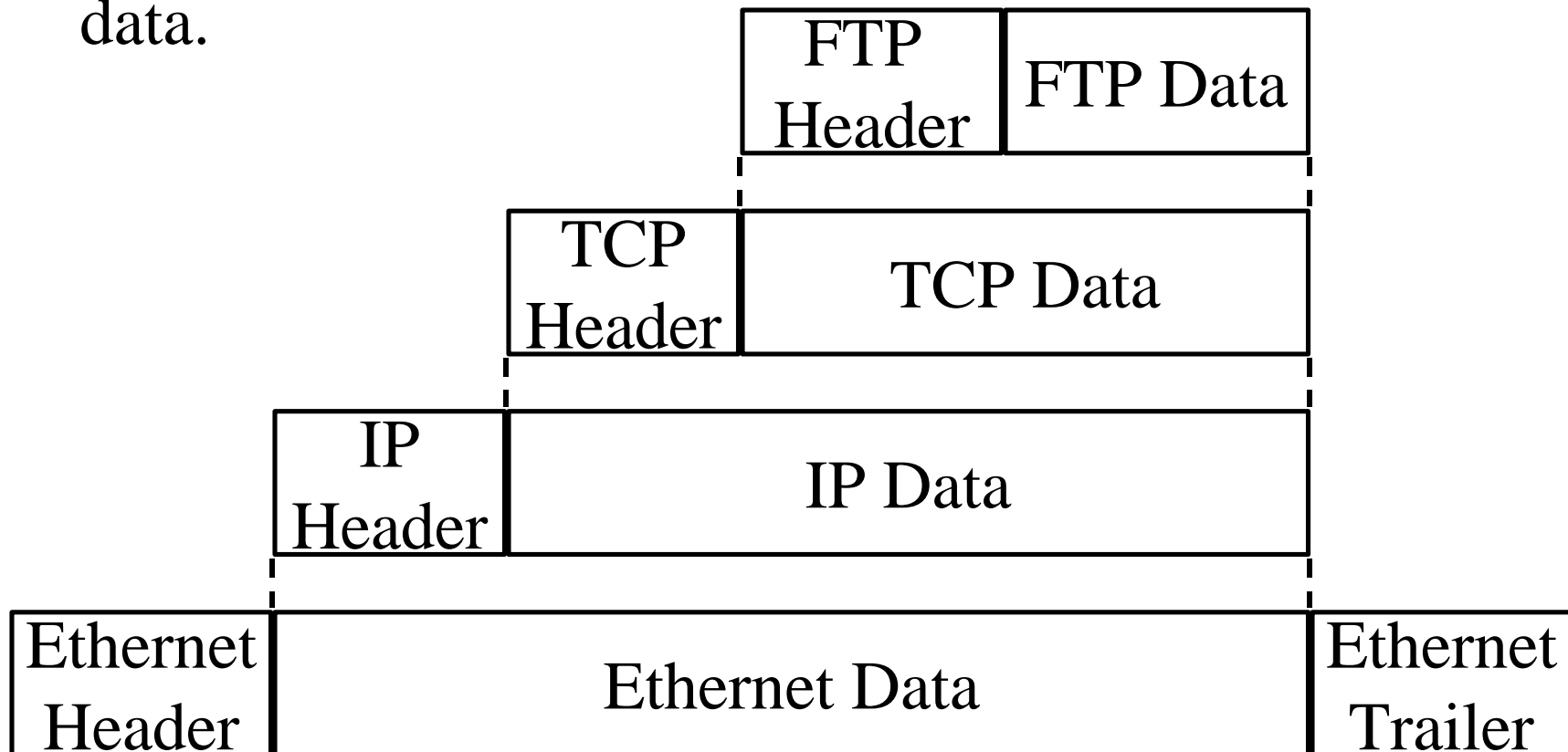
TCP/IP Protocols

OSI Ref Model

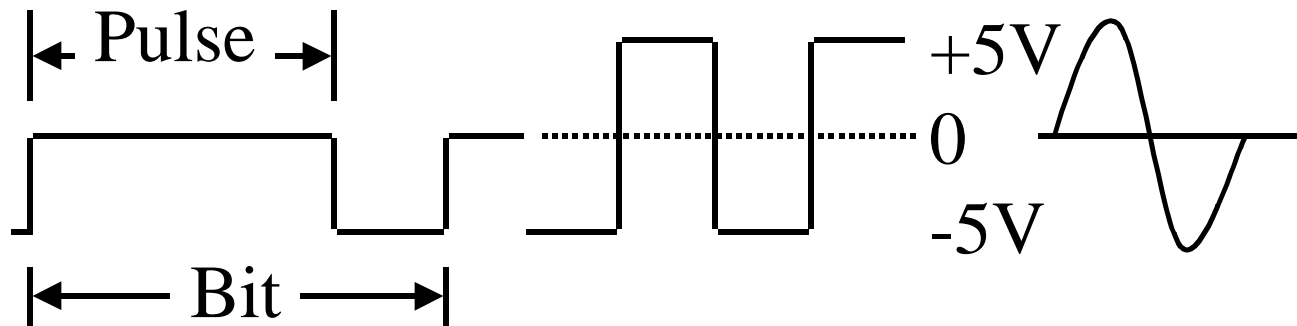


Layered Packet Format

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



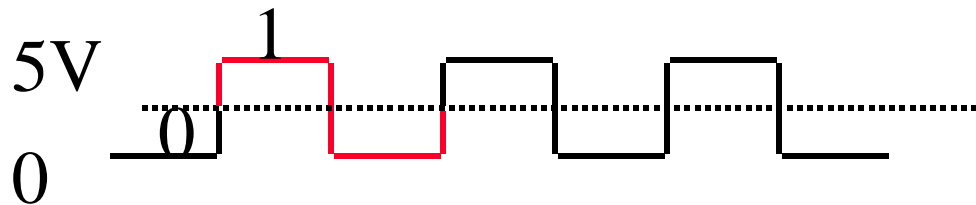
Coding Terminology



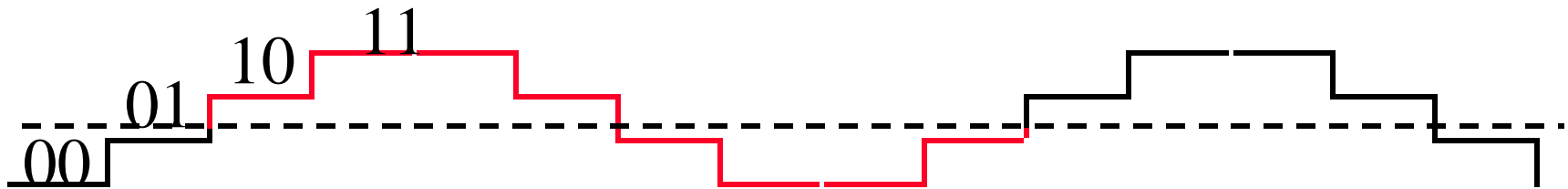
- ❑ Signal element: Pulse
- ❑ Modulation Rate: $1/\text{Duration of the smallest element}$
=Baud rate
- ❑ Data Rate: Bits per second
- ❑ Data Rate = $F_n(\text{Bandwidth, signal/noise ratio, encoding})$

Channel Capacity

- Capacity = Maximum data rate for a channel
- **Nyquist Theorem:**
- Bilevel Encoding: Data rate = $2 \times \text{Bandwidth}$



- Multilevel coding: Data rate = $2 \times \text{Bandwidth} \times \log_2 M$



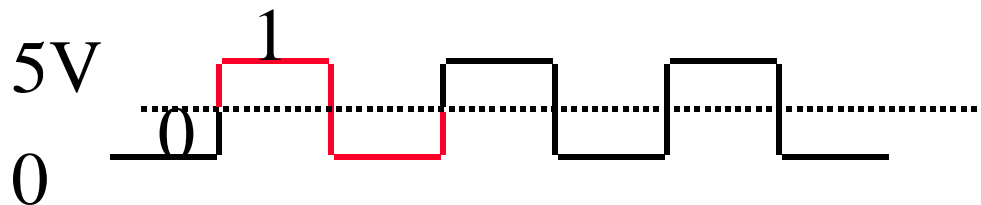
Example: $M=4$, Capacity = $4 \times \text{Bandwidth}$

Channel Capacity (Cont)

- Bilevel Encoding: Worst case: 1010101010

Cycle time = $2 \times$ Bit time

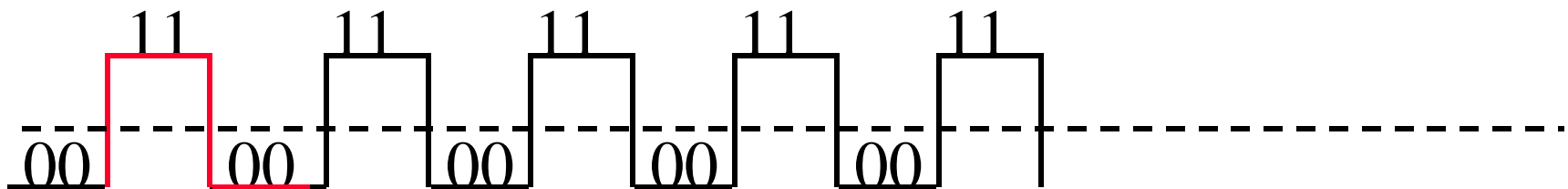
\Rightarrow Data rate = $2 \times$ Bandwidth



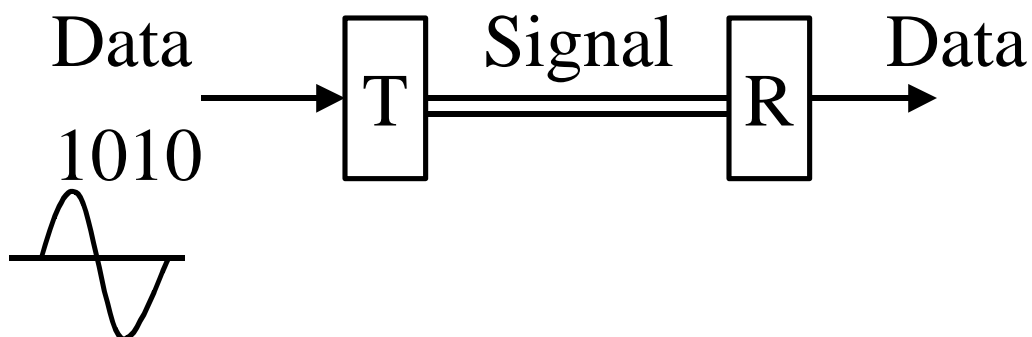
- Multilevel coding: Worst case 0011001100110011

Cycle time = $4 \times$ Bit time

\Rightarrow Data rate = $2 \times$ Bandwidth $\times \log_2 M$



Data vs Signal

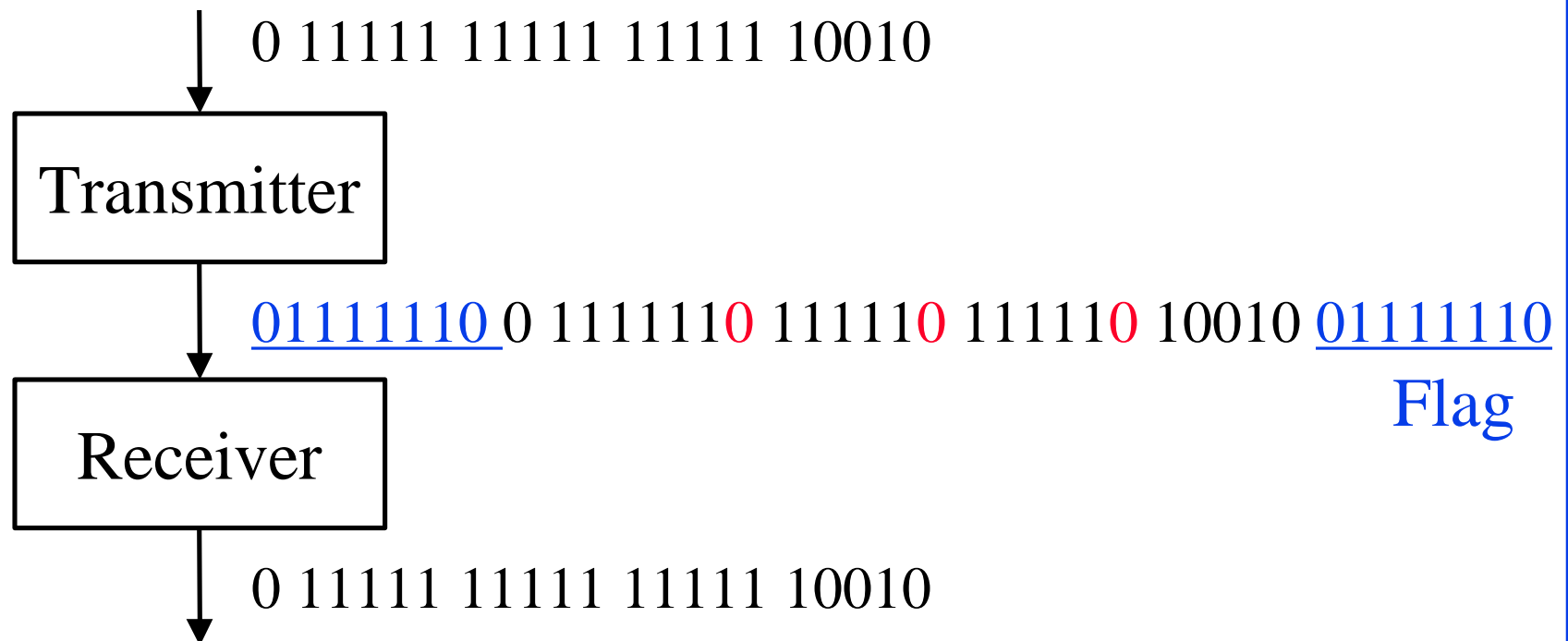


- ❑ Data: Analog (Music), Digital (files)
- ❑ Signal: Analog (POTS, Radio), Digital (ISDN)

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



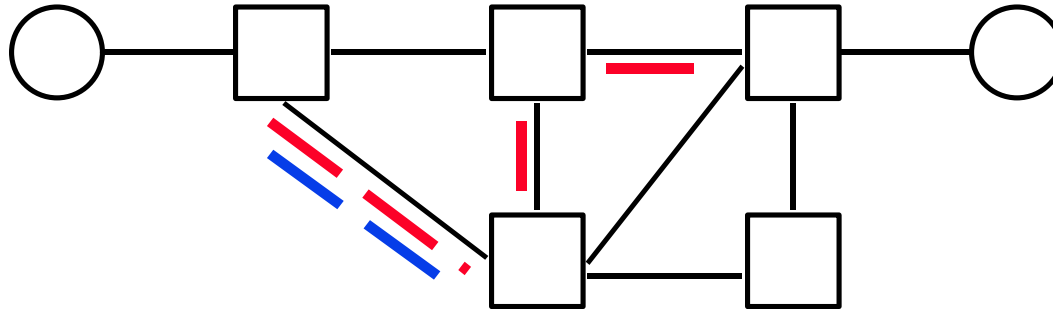
Flow Control

- ❑ 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

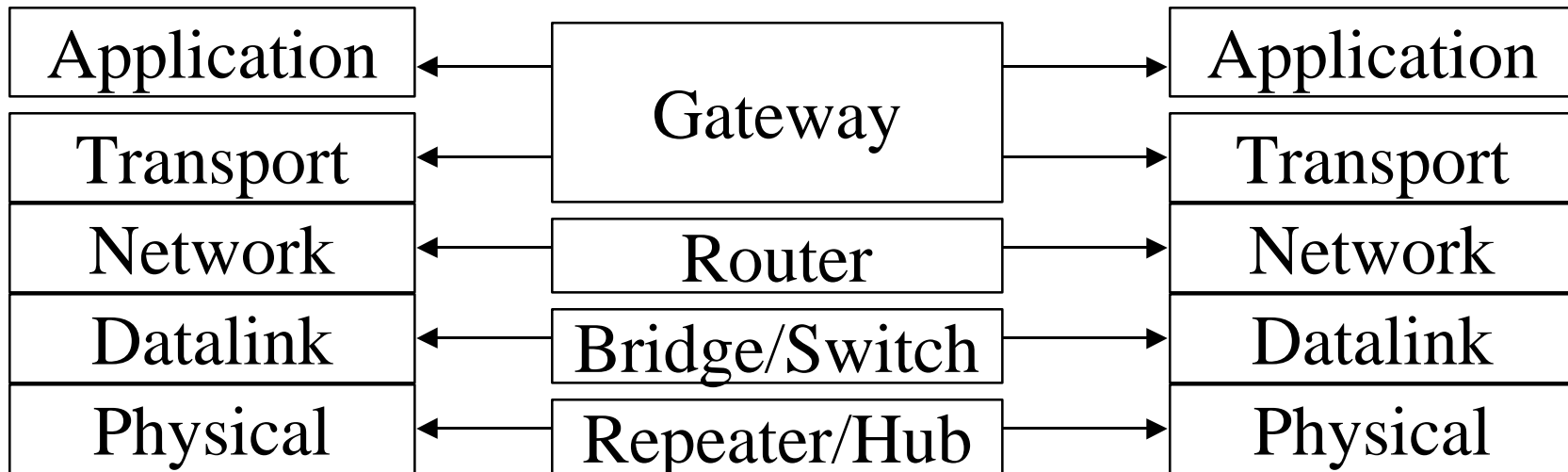
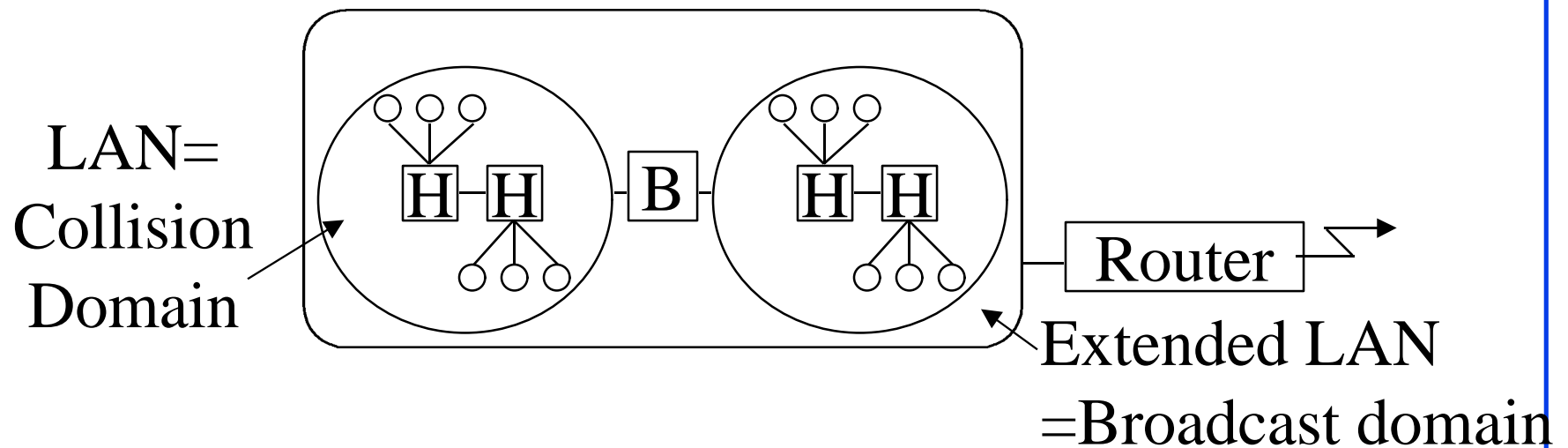
- ❑ Aloha at University of Hawaii:
Transmit whenever you like
Worst case utilization = $1/(2e) = 18\%$
- ❑ CSMA: Carrier Sense Multiple Access
Listen before you transmit
- ❑ CSMA/CD: CSMA with Collision Detection
Listen while transmitting.
Stop if you hear someone else.
- ❑ Ethernet uses CSMA/CD.
Standardized 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



IEEE 802 Address Format

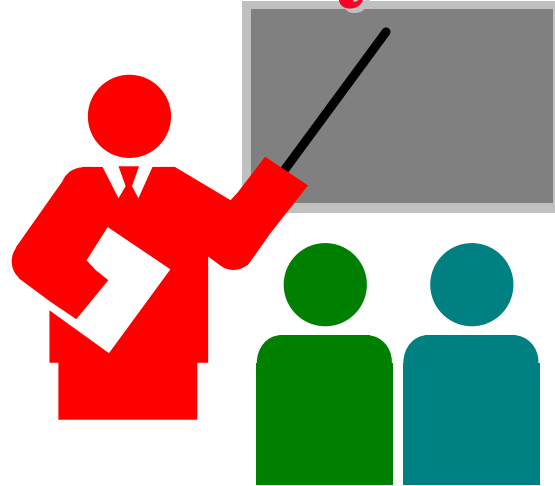
q 48-bit: 1000 0000 : 0000 0001 : 0100 0011
 : 0000 0000 : 1000 0000 : 0000 1100
 = 80:01:43:00:80:0C

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?