A Review of Key Networking Concepts

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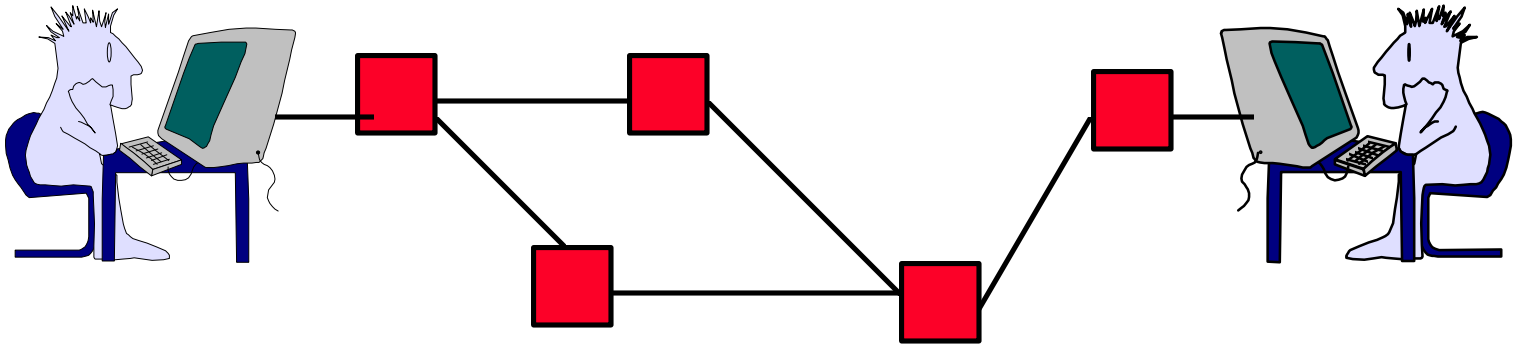
- ISO/OSI Reference Model
- TCP/IP Reference Model
- Differences between ISO and TCP
- Ethernet/IEEE 802.3 LANs
- Interconnecting Devices

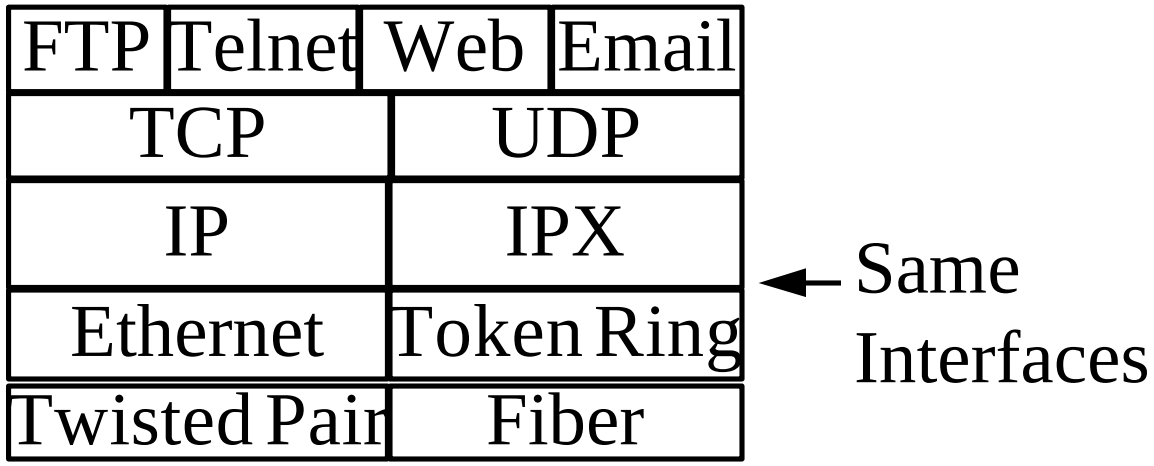
  All these concepts are taught in CIS677.

ISO/OSI Reference Model

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



Layering

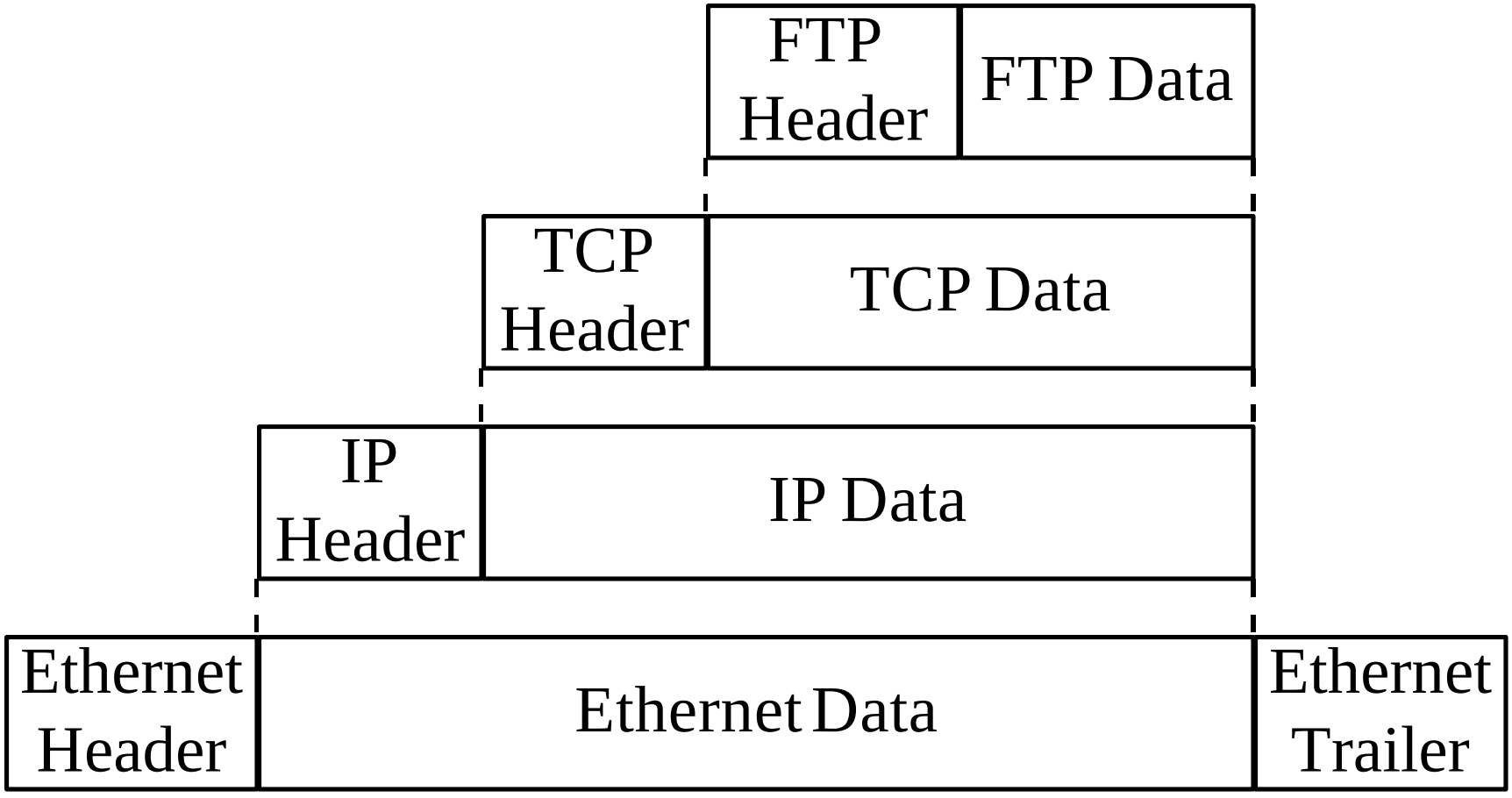


- Protocols of each layer perform a set of functions
- All alternatives for a row have the same interfaces
- Choice of protocols at each layer is independent of those of at other layers.

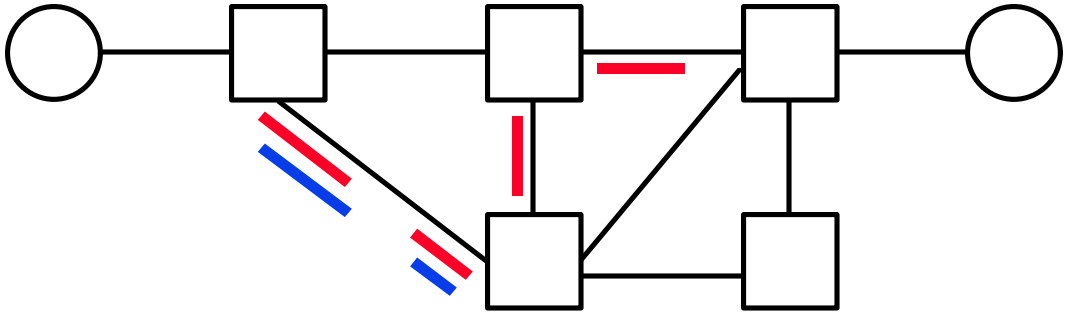
UDP = User Data Protocol, TCP = Transport Control Protocol, IPX = Internetwork Packet Exchange

Layered Packet Format

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



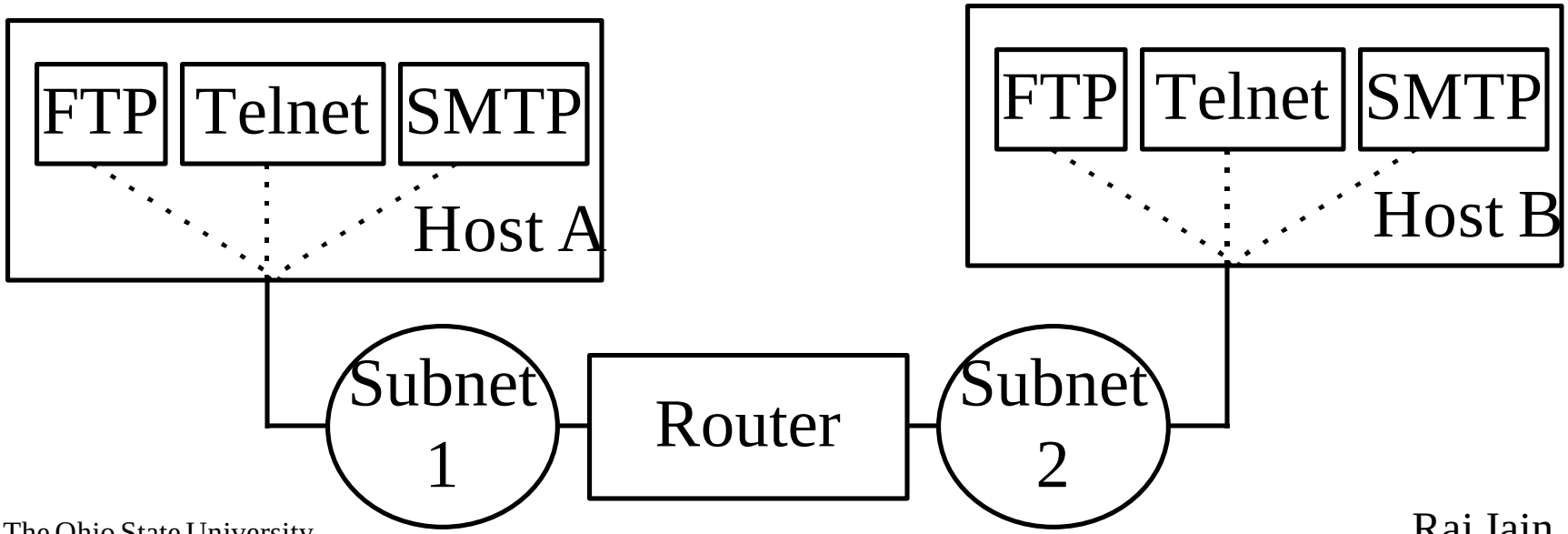
Connection-Oriented vs Connectionless



- 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

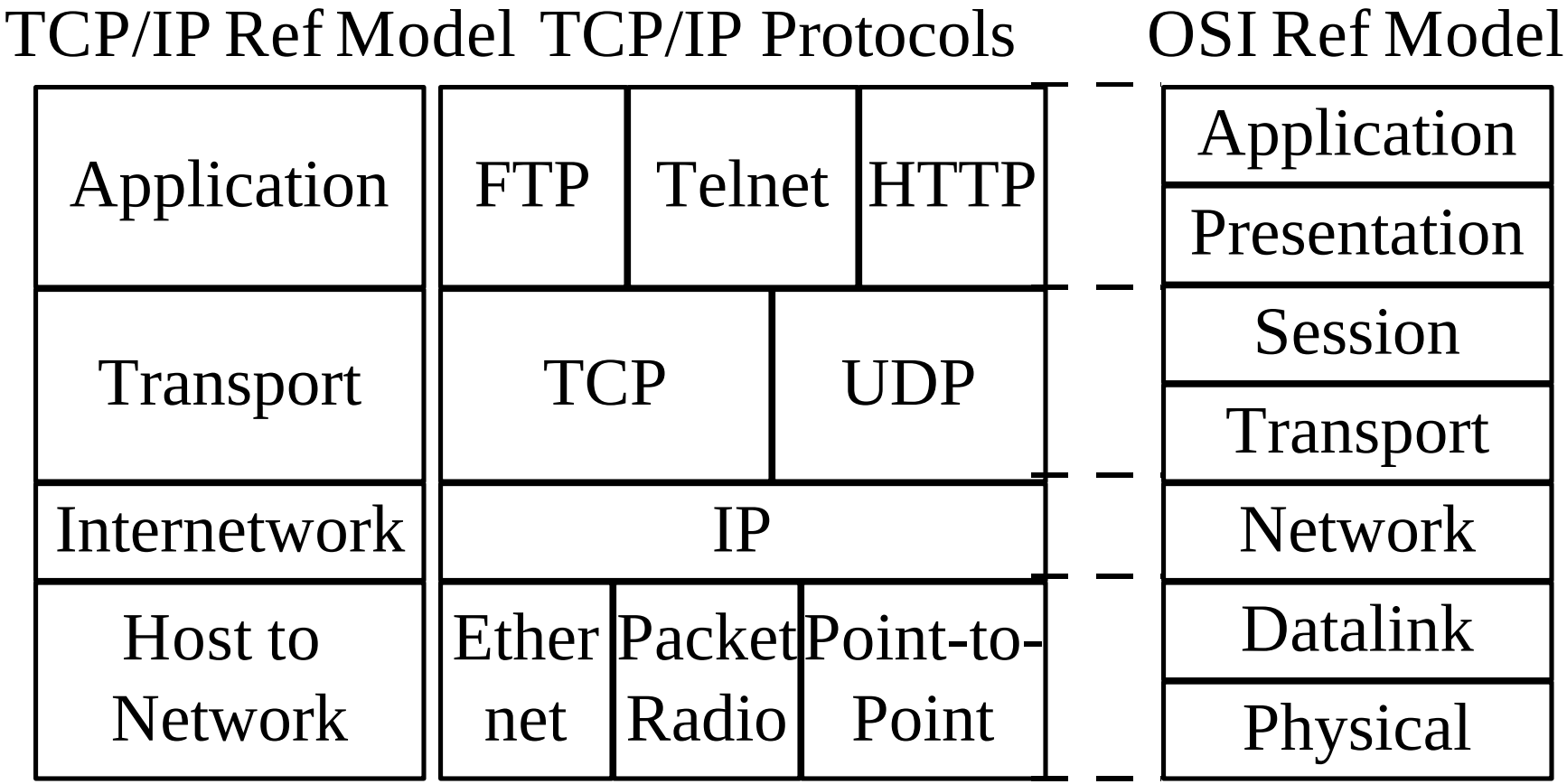
Internetworking Terms

- End-system: Host
- Network: Provides data transfer between end-systems
- Internet: A collection of networks
- Subnetwork: Each component of an internet. Usually one LAN



TCP/IP Reference Model

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



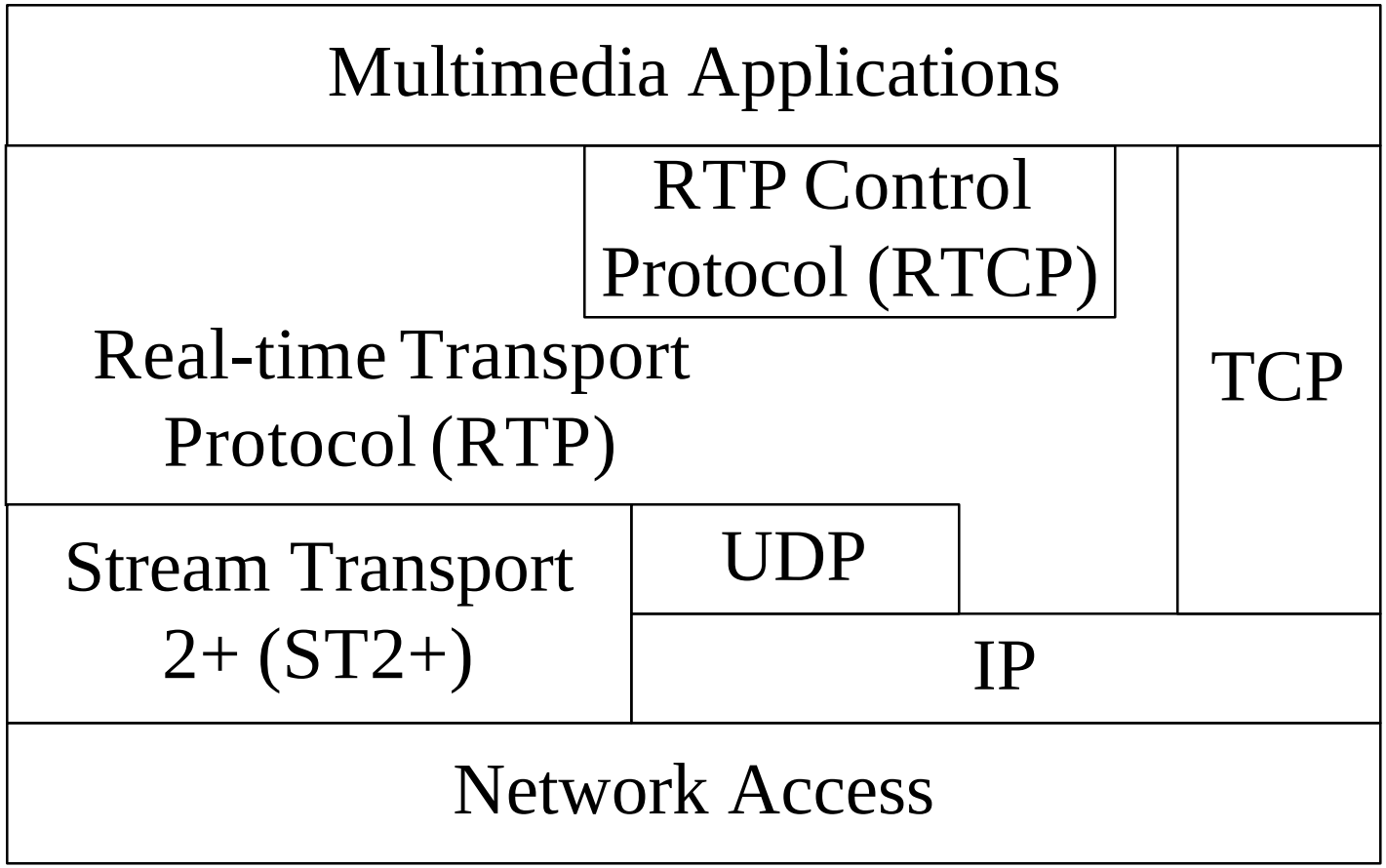
OSI vs TCP Reference Models

- OSI introduced concept of services, interface, protocols, layers. These were force-fitted to TCP later
  $\Rightarrow$ It is not easy to replace protocols in TCP.
- In OSI, reference model was done before protocols.
  In TCP, protocols were done before the model
- OSI: Standardize first, build later
  TCP: Build first, standardize later
- OSI took too long to standardize.
  TCP/IP was already in wide use by the time.
- OSI became too complex.
  TCP/IP is not general. Ad hoc.

Hierarchy

- Can directly use the services of a lower entity even if it is not in an adjacent layer
- Control and data can be separate connections. Control connections may have different reliability requirements than data.
- Lower layer control information can be used for higher layer control, e.g., lower layer close may close all higher layers

Internet Integrated Services Protocols

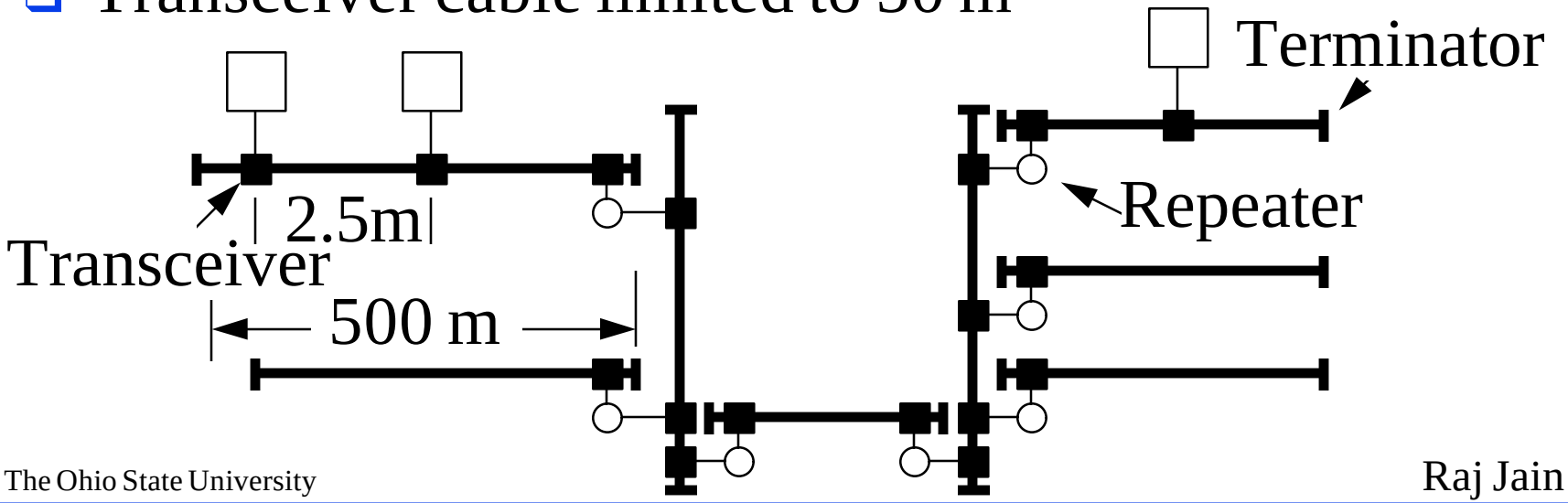


Multiple Access Protocols

- 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.

Original Ethernet Cabling Rules

- Thick coax
- Length of the cable is limited to 2.5 km, no more than 4 repeaters between stations
- No more than 500 m per segment ⇒ 10Base5
- No more than 2.5 m between stations
- Transceiver cable limited to 50 m

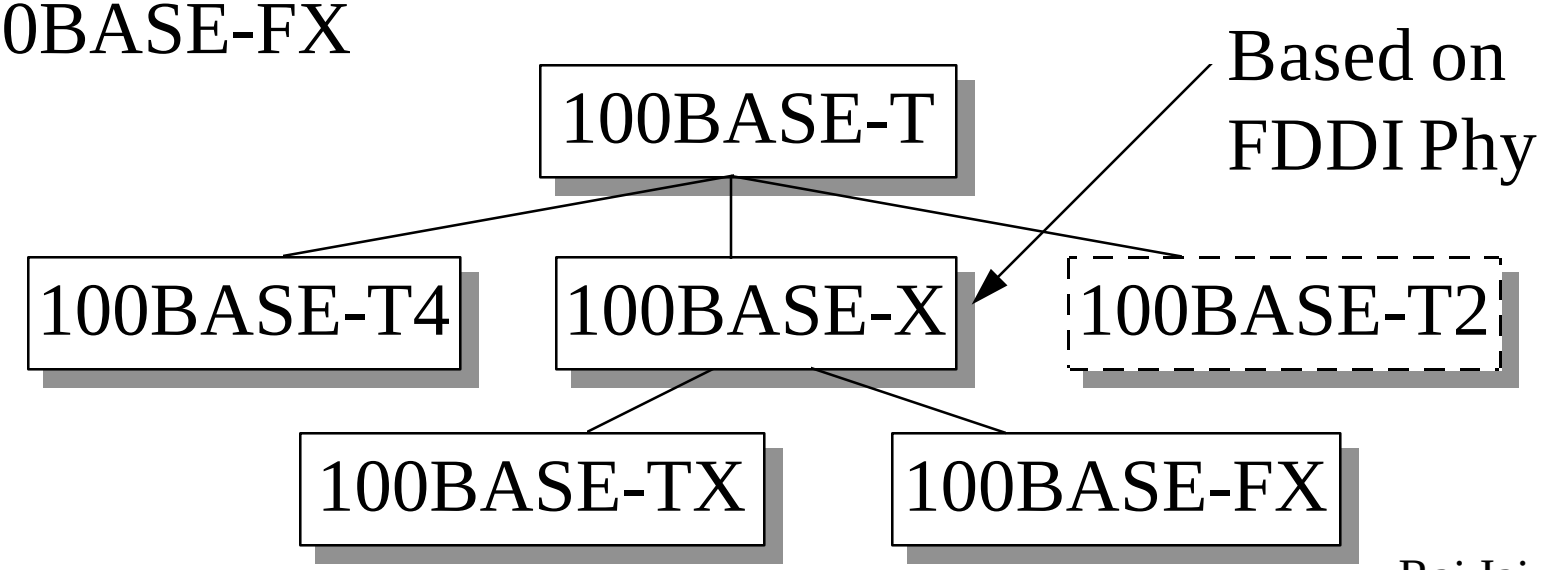


802.3 PHY Standards

- **10BASE5:** 10 Mb/s over coaxial cable (ThickWire)
- **10BROAD36:** 10 Mb/s over broadband cable, 3600 m max segments
- **10BASE2:** 10 Mb/s over thin RG58 coaxial cable (ThinWire), 185 m max segments
- **1BASE5:** 1 Mb/s over 2 pairs of UTP
- **10BASE-T:** 10 Mb/s over 2 pairs of UTP
- **10BASE-F:** Fiber Optic inter-repeater link (FOIRL), 10BASE-FL (link), 10BASE-FB (backbone), or 10BASE-FP (Passive)

Fast Ethernet Standards

- **100BASE-T4:** 100 Mb/s over 4 pairs of CAT-3, 4, 5
- **100BASE-TX:** 100 Mb/s over 2 pairs of CAT-5, STP
- **100BASE-FX:** 100 Mbps CSMA/CD over 2 fibers
- **100BASE-X:** 100BASE-TX or 100BASE-FX
- **100BASE-T:** 100BASE-T4, 100BASE-TX, or 100BASE-FX

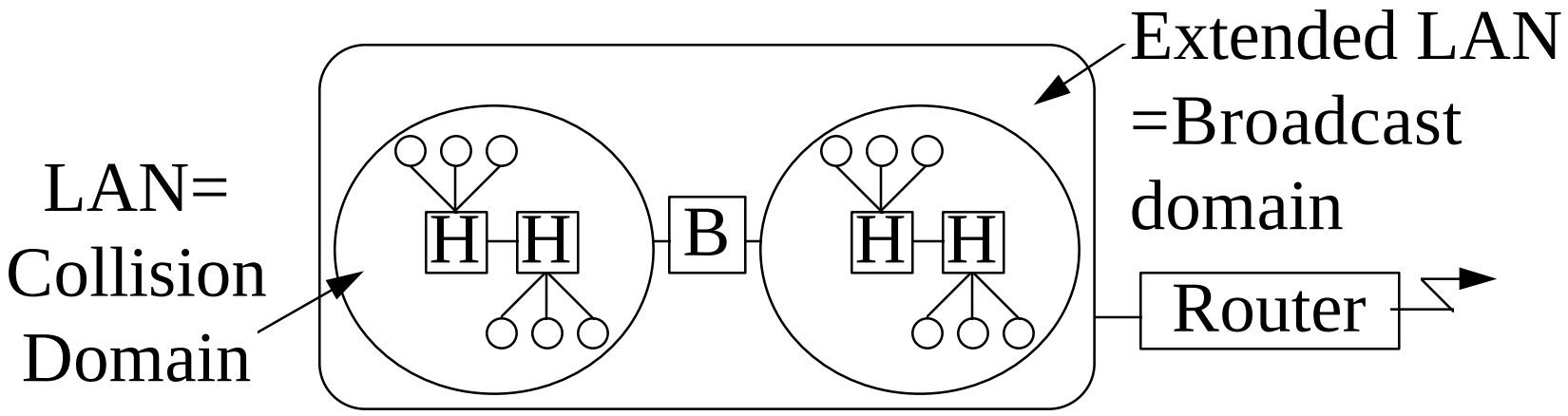


Interconnection Devices

- **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.

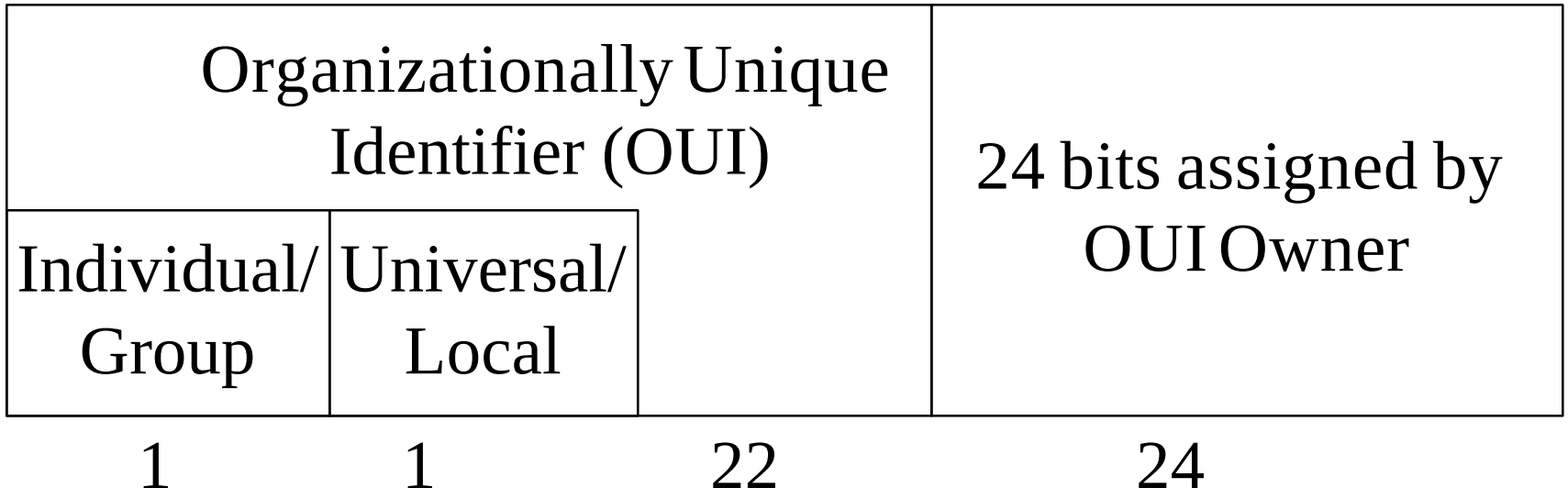
Interconnection Devices



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

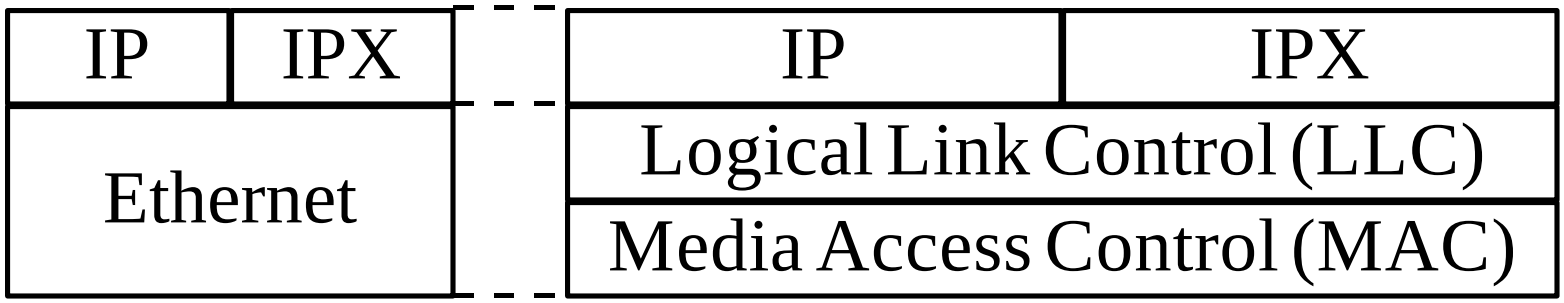
Ethernet (IEEE 802) Address Format

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



- Multicast = "To all bridges on this LAN"
- Broadcast = "To all stations" = 111111....111 = FF:FF:FF:FF:FF:FF

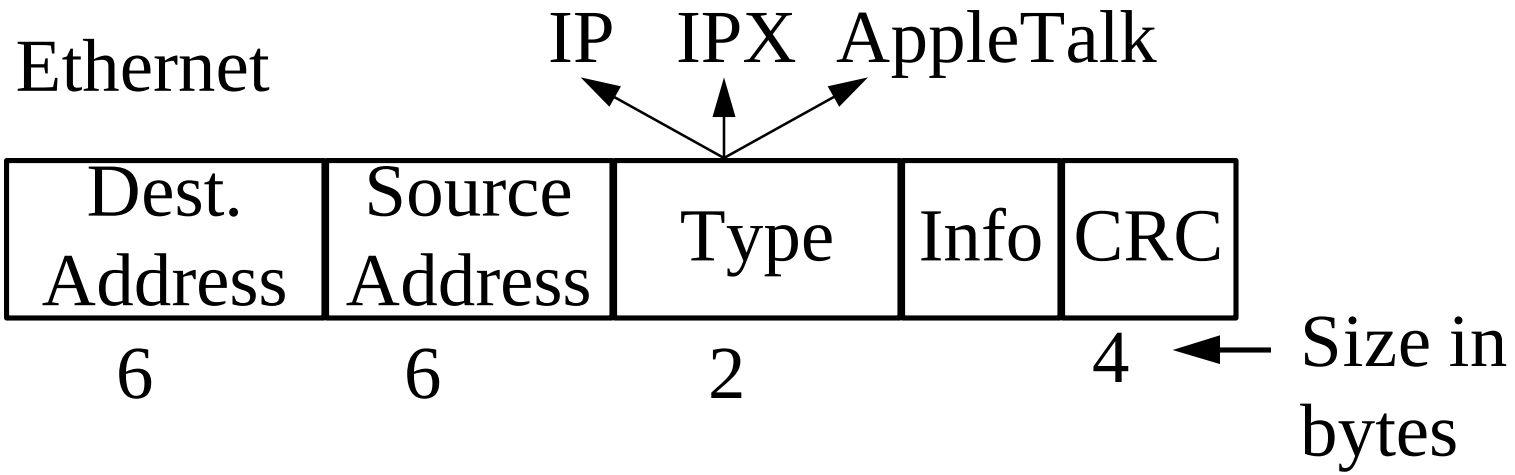
Ethernet vs IEEE 802.3



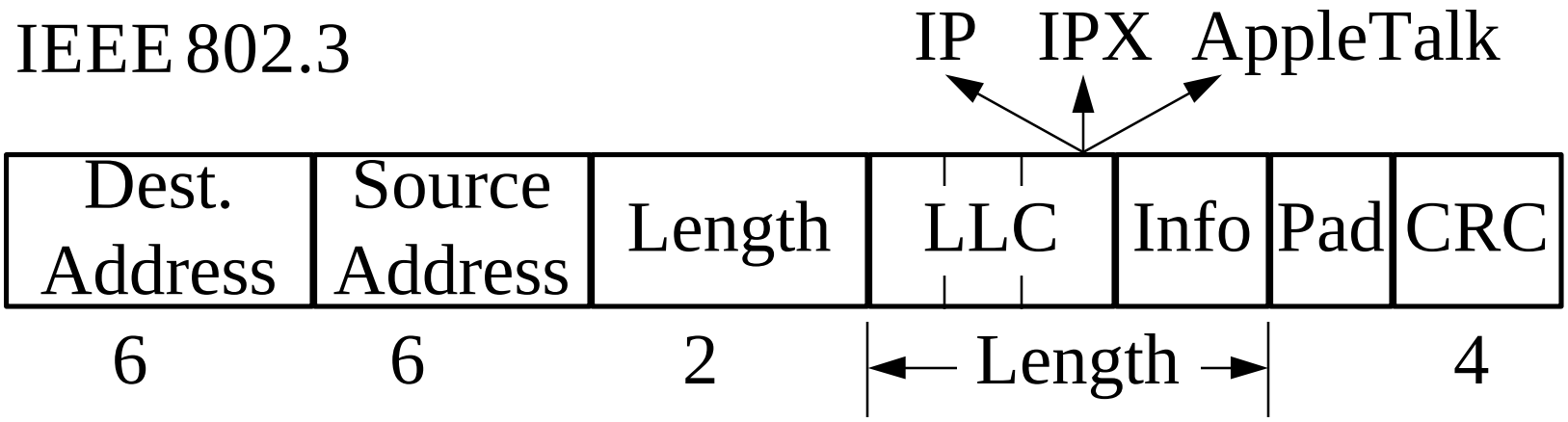
- In 802.3, datalink was divided into two sublayers: LLC and MAC
- LLC provides protocol multiplexing. MAC does not.
- MAC does not need a protocol type field.

Ethernet Frame Format

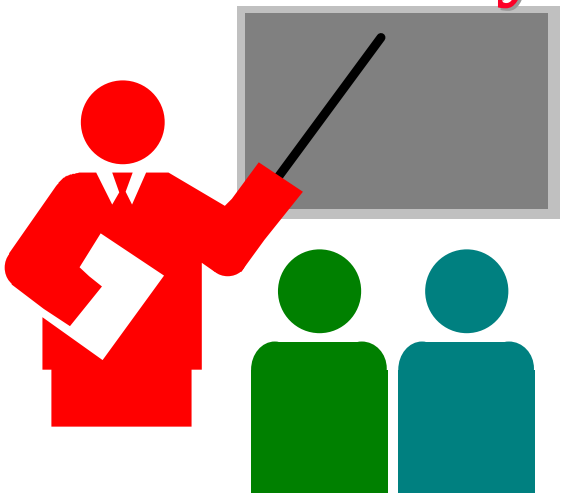
- Ethernet



- IEEE 802.3



Summary



- ISO/OSI reference model has seven layers. TCP/IP Protocol suite has four layers.
- Ethernet/IEEE 802.3 uses CSMA/CD.
- Configuration rules depend upon physical medium 10Base5, 10Base2, 10Base-T, 100Base-TX, etc.
- 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?
  80:01:43:00:00:00
  40:01:43:00:00:01
  Were these addresses assigned by the same manufacturer?