

A Review of Key Networking Concepts

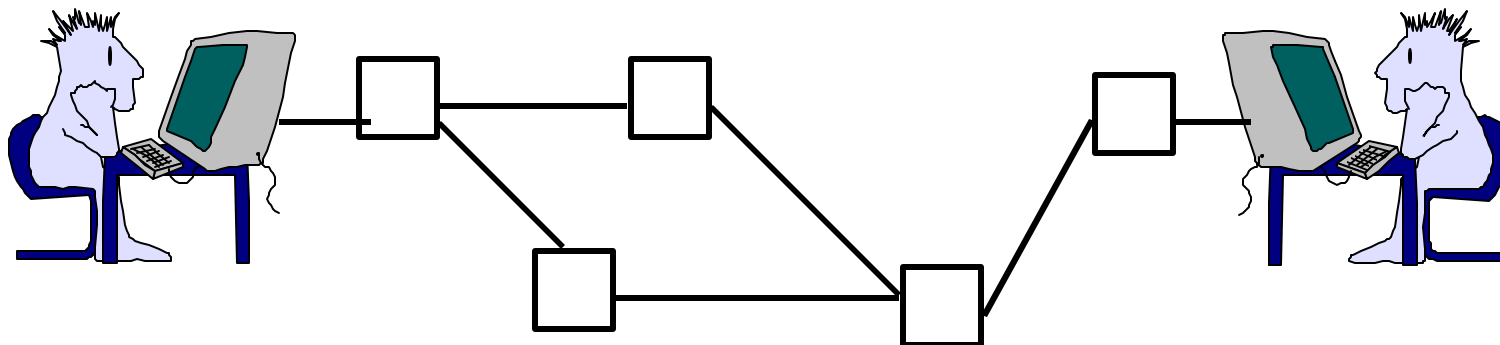
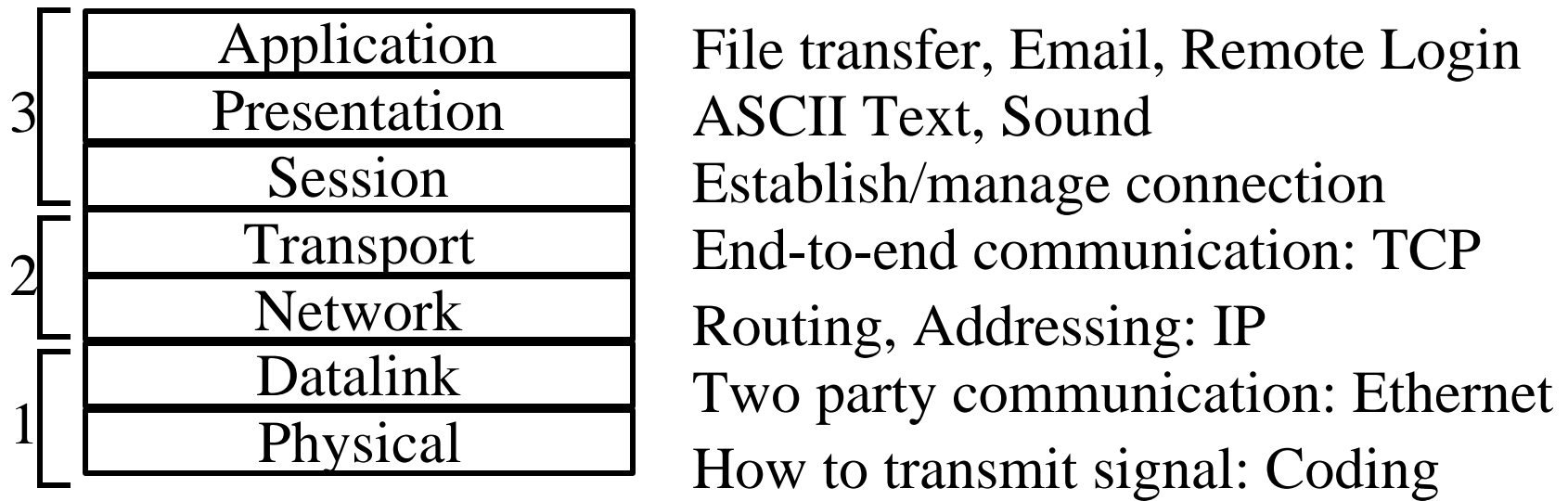
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- ❑ ISO/OSI Reference Model
- ❑ HDLC
- ❑ Ethernet/IEEE 802.3 LANs
- ❑ IP, ARP
- ❑ TCP
- ❑ DNS

ISO/OSI Reference Model



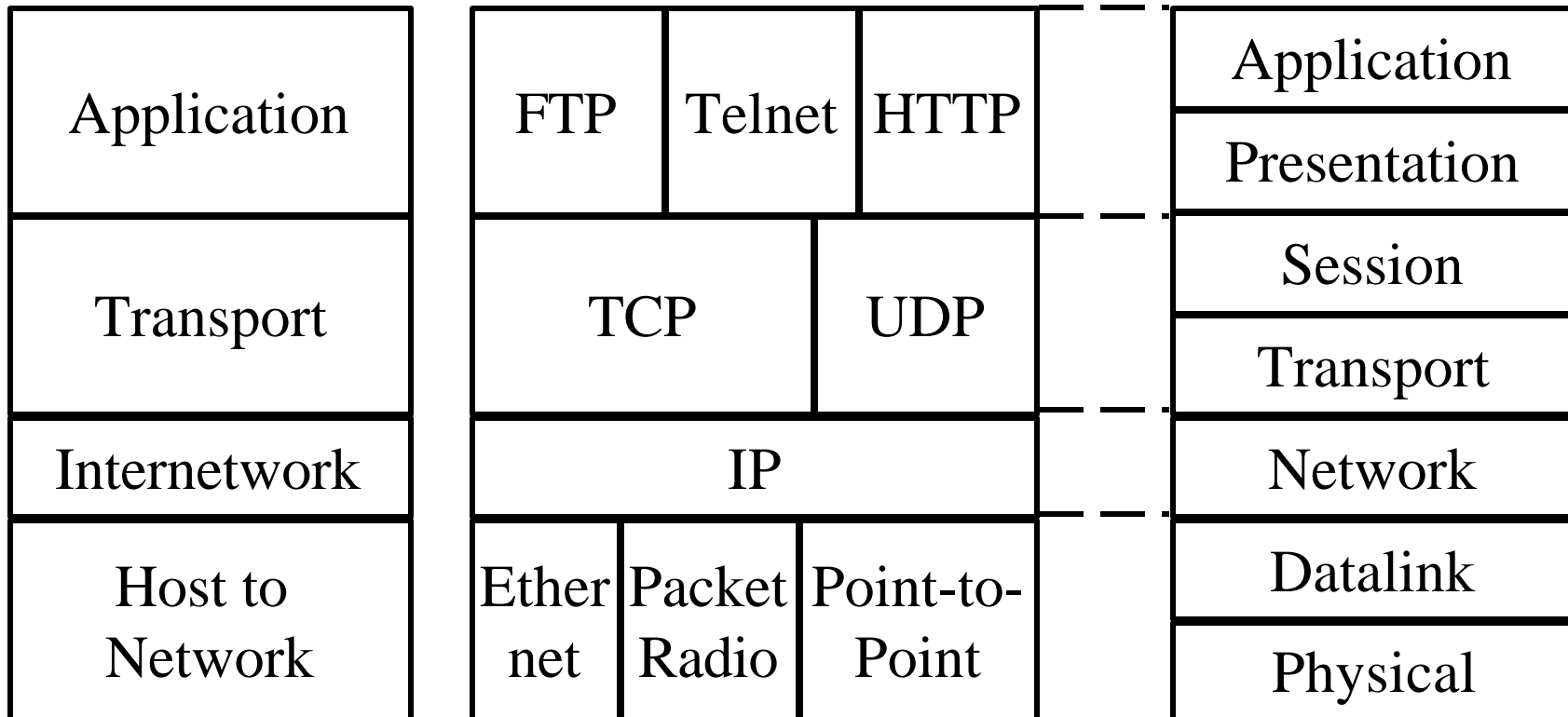
TCP/IP Reference Model

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

TCP/IP Ref Model

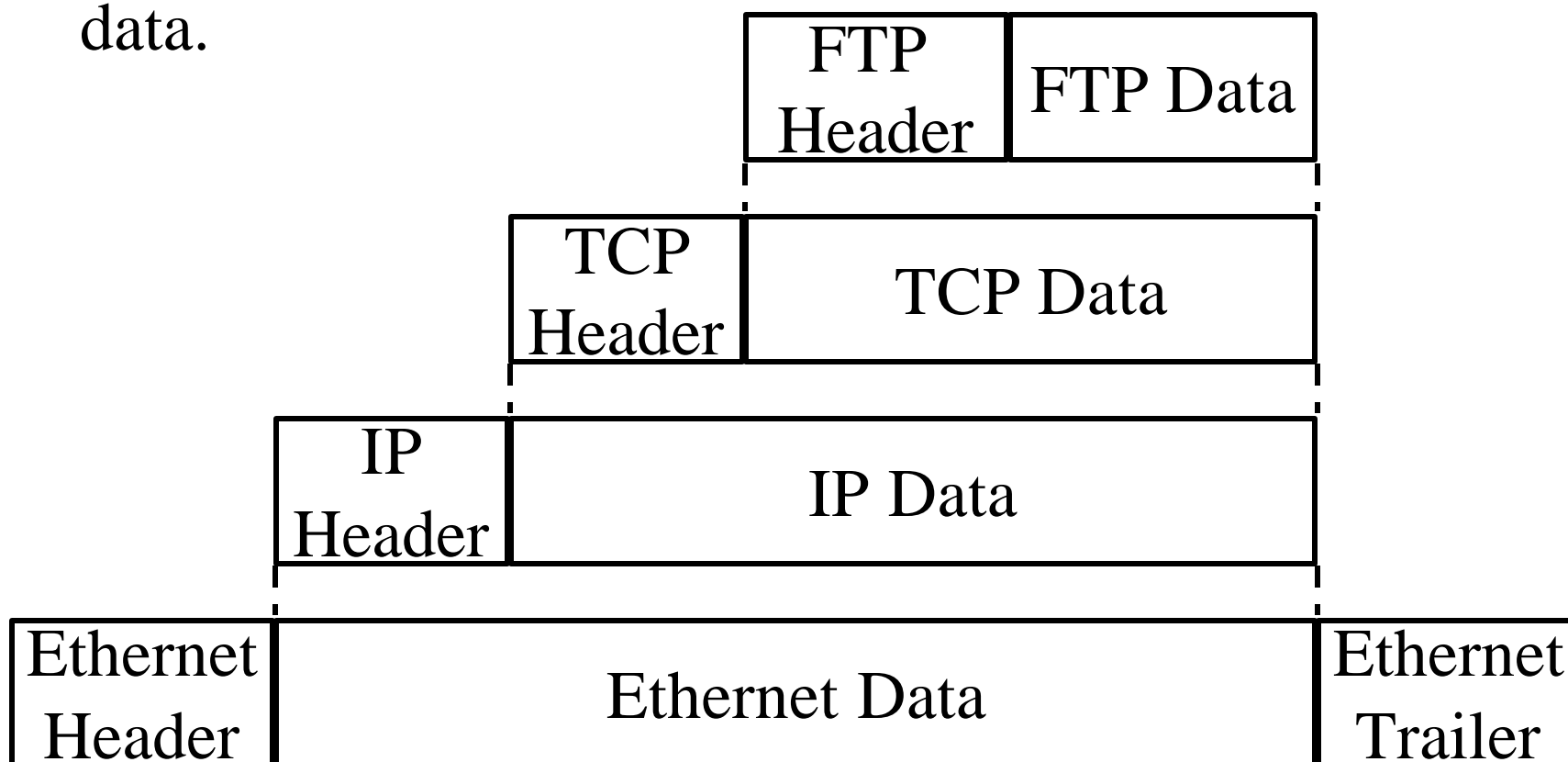
TCP/IP Protocols

OSI Ref Model



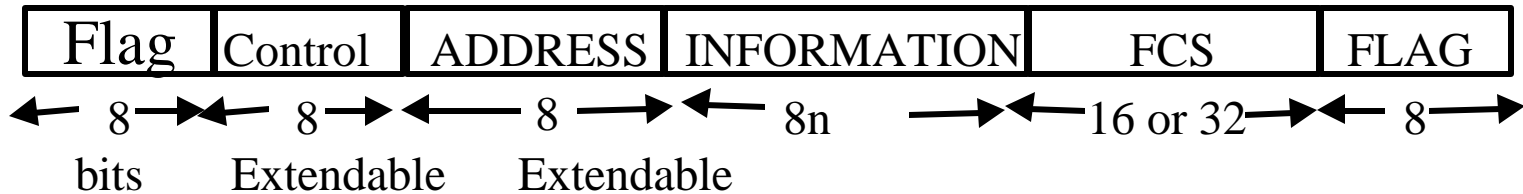
Layered Packet Format

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



HDLC Frame Structure

Frame
Format



Control Field Format

I: Information
S: Supervisory
U: Unnumbered

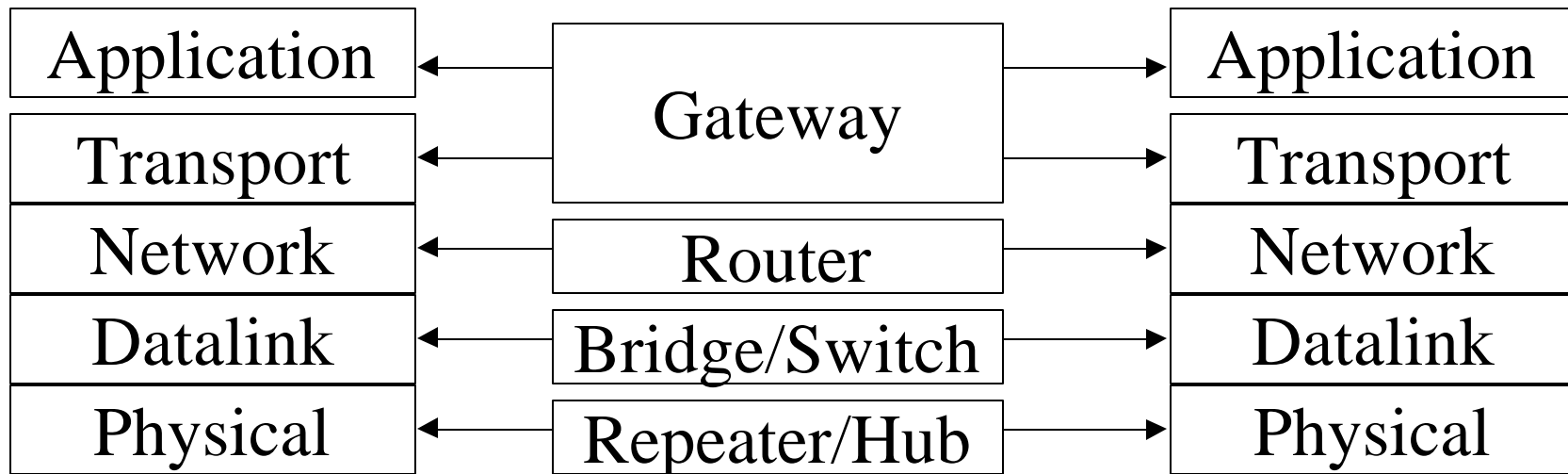
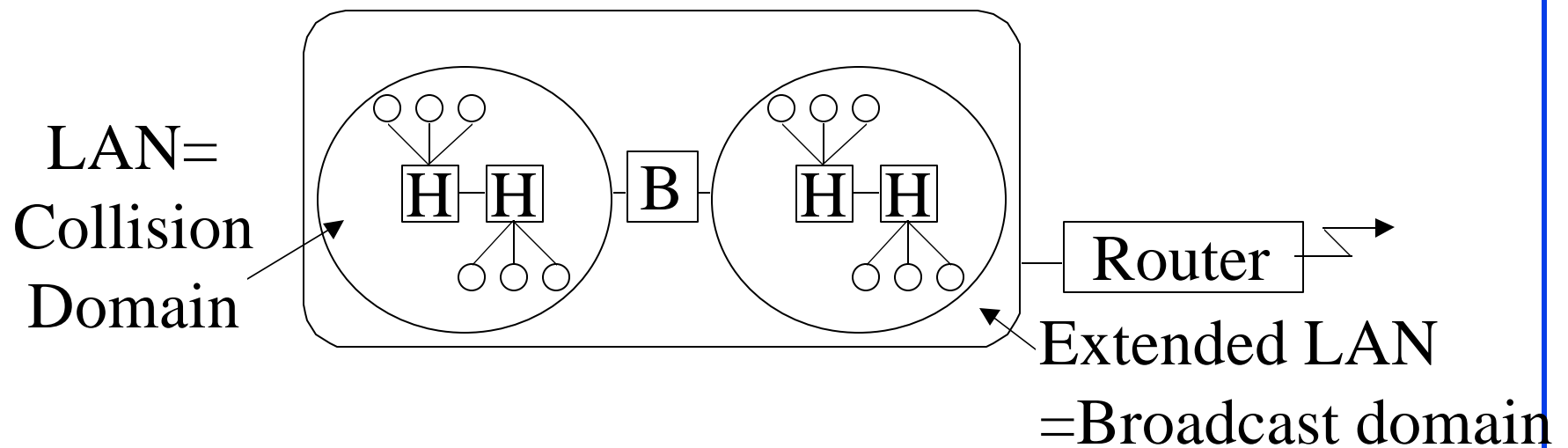
	1	2	3	4	5	6	7	8
I	0	N(S)			P/F	N(R)		
S	1	0	S		P/F	N(R)		
U	1	1	M		P/F	M		

N(S)= Send sequence number N(R)= Recieve sequence number
S= Supervisory function bits M= Unnumbered bits P/F= Poll/final bit

HDLC Frames

- ❑ Information Frames: User data
 - Piggybacked Acks: Next frame expected
 - Poll/Final = Command/Response
- ❑ Supervisory Frames: Flow and error control
 - Go back N and Selective Reject
 - Final \Rightarrow No more data to send
- ❑ Unnumbered Frames: Control
 - Mode setting commands and responses
 - Information transfer commands and responses
 - Recovery commands and responses
 - Miscellaneous commands and responses

Interconnection Devices



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.

IEEE 802 Address Format

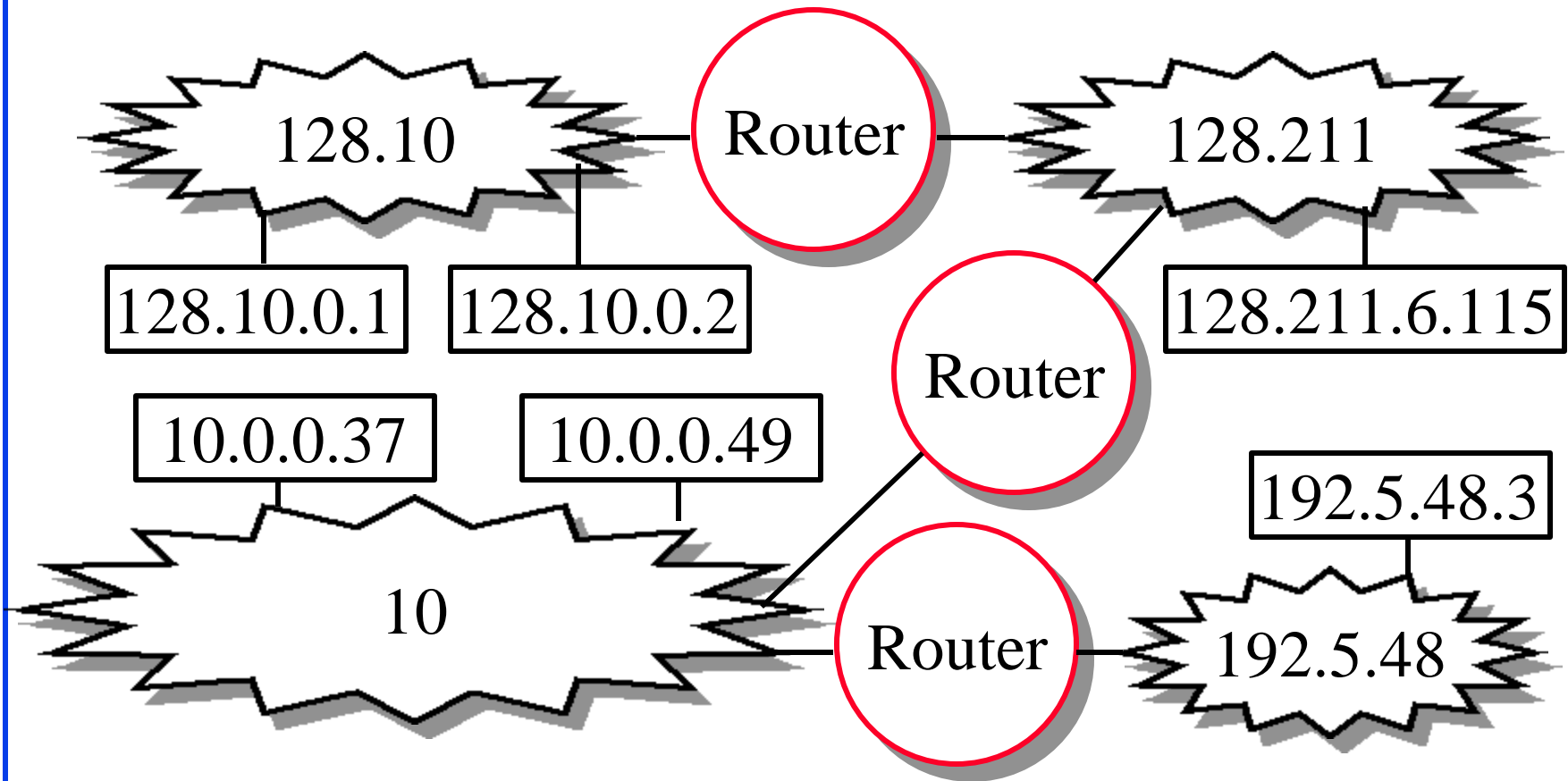
q 48-bit: 1000 0000 : 0000 0001 : 0100 0011
 : 0000 0000 : 1000 0000 : 0000 1100
 = 80:01:43:00:80:0C

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

IP Addressing Example



- All hosts on a network have the same network prefix

IP Datagram Format

Vers	H. Len	ToS	Total Length	
Identification			Flags	Fragment Offset
Time to live	Protocol Type		Header Checksum	
Source IP Address				
Destination IP Address				
IP Options (May be omitted)				Padding
Data				

IP Header Format

- ❑ Version (4 bits)
- ❑ Internet header length (4 bits): in 32-bit words.
Min header is 5 words or 20 bytes.
- ❑ Type of service (8 bits): Reliability, precedence, delay, and throughput
- ❑ Total length (16 bits): header + data in bytes
Total must be less than 64 kB.
- ❑ Identifier (16 bits): Helps uniquely identify the datagram during its life for a given source, destination address

IP Header (Cont)

- ❑ Flags (3 bits):
 - More flag - used for fragmentation
 - No-fragmentation
 - Reserved
- ❑ Fragment offset (13 bits): In units of 8 bytes
- ❑ Time to live (8 bits): Specified in router hops
- ❑ Protocol (8 bits): Next level protocol to receive the data
- ❑ Header checksum (16 bits): 1's complement sum of all 16-bit words in the header

IP Header (Cont)

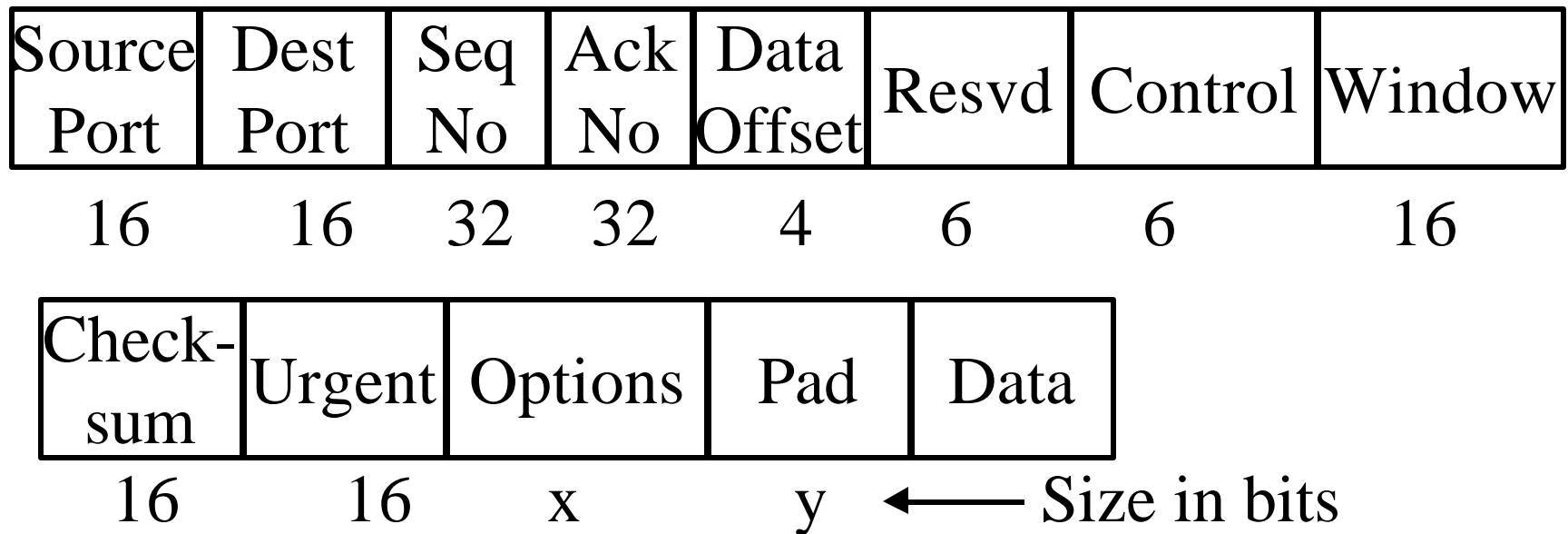
- ❑ Source Address (32 bits): Original source.
Does not change along the path.
- ❑ Destination Address (32 bits): Final destination.
Does not change along the path.
- ❑ Options (variable): Security, source route, record route, stream id (used for voice) for reserved resources, timestamp recording
- ❑ Padding (variable):
Makes header length a multiple of 4
- ❑ Data (variable): Data + header $\leq 65,535$ bytes

Address Resolution Protocol



- ❑ Problem: Given an IP address find the MAC address
- ❑ Solution: Message Exchange: ARP
 - The host broadcasts a request:
“What is the MAC address of 127.123.115.08?”
 - The host whose IP address is 127.123.115.08 replies back: “The MAC address for 127.123.115.08 is $8A-5F-3C-23-45-56_{16}$ ”

TCP Header Format



TCP Header

- ❑ Source Port (16 bits): Identifies source user process
20 = FTP, 23 = Telnet, 53 = DNS, 80 = HTTP, ...
- ❑ Destination Port (16 bits)
- ❑ Sequence Number (32 bits): Sequence number of the first byte in the segment. If SYN is present, this is the initial sequence number (ISN) and the first data byte is ISN+1.
- ❑ Ack number (32 bits): Next byte expected
- ❑ Data offset (4 bits): Number of 32-bit words in the header
- ❑ Reserved (6 bits)

TCP Header (Cont)

- Control (6 bits): Urgent pointer field significant,
Ack field significant,
Push function,
Reset the connection,
Synchronize the sequence numbers,
No more data from sender

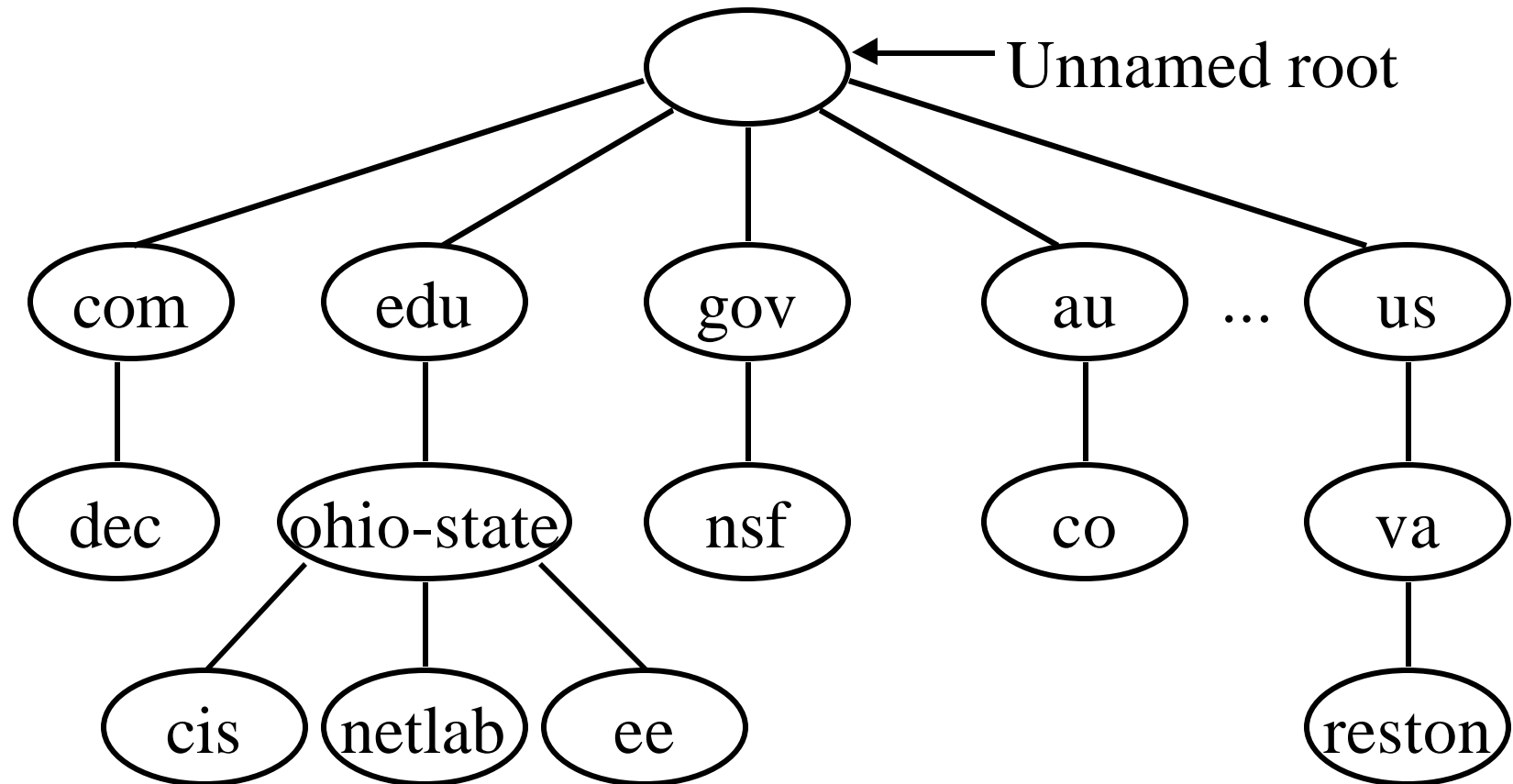


- Window (16 bits): Will accept [Ack] to [Ack]+[window]

TCP Header (Cont)

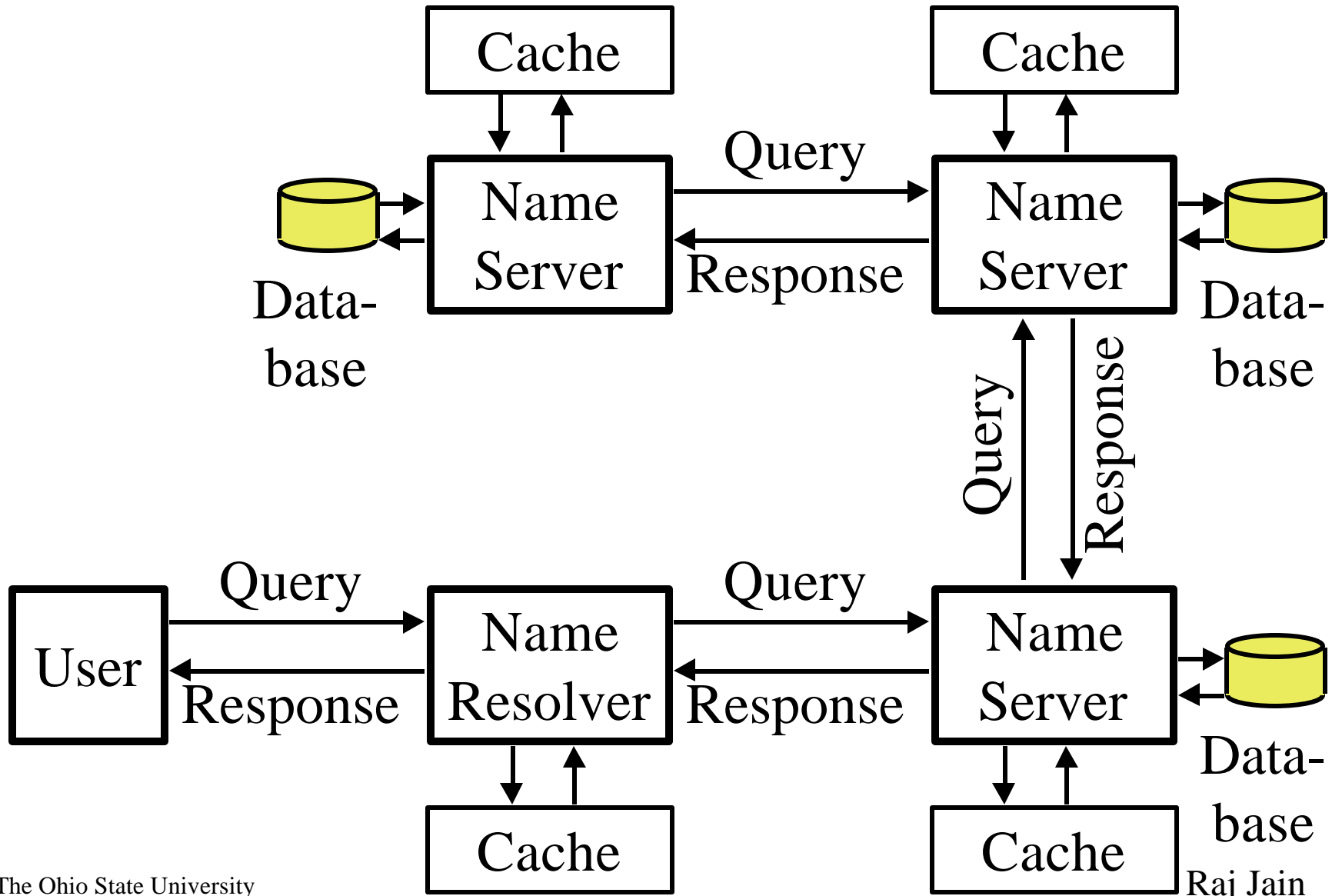
- ❑ Checksum (16 bits): covers the segment plus a pseudo header. Includes the following fields from IP header: source and dest adr, protocol, segment length. Protects from IP misdelivery.
- ❑ Urgent pointer (16 bits): Points to the byte following urgent data. Lets receiver know how much data it should deliver right away.
- ❑ Options (variable):
Max segment size (does not include TCP header, default 536 bytes), Window scale factor, Selective Ack permitted, Timestamp, No-Op, End-of-options

Domain Name System



Humans can remember names. Computers use addresses
Cobra.netlab.ohio-state.edu = 164.107.61.202

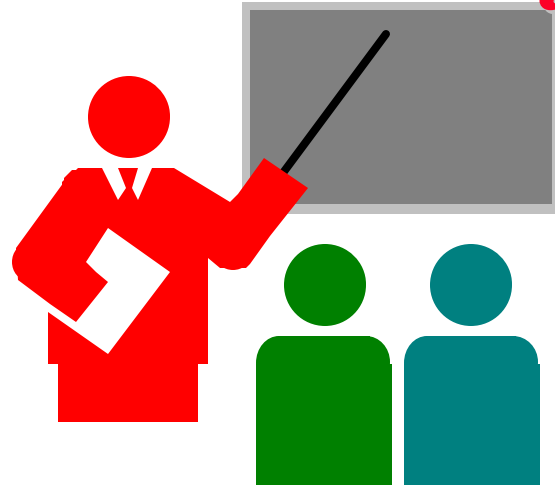
Name Resolution



Name Resolution (Cont)

- ❑ Each computer has a name resolver routine, e.g., `gethostbyname` in UNIX
- ❑ Each resolver knows the name of a local DNS server
- ❑ Resolver sends a DNS request to the server
- ❑ DNS server either gives the answer, forwards the request to another server, or gives a referral
- ❑ Referral = Next server to whom request should be sent

Summary



- ❑ ISO/OSI reference model has seven layers. TCP/IP Protocol suite has four layers.
- ❑ Ethernet/IEEE 802.3 uses CSMA/CD.
- ❑ IP addresses are 32 bit long
- ❑ ARP converts IP addresses to datalink addresses
- ❑ TCP applications are identified by port numbers

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?