A Review of Key Networking Concepts

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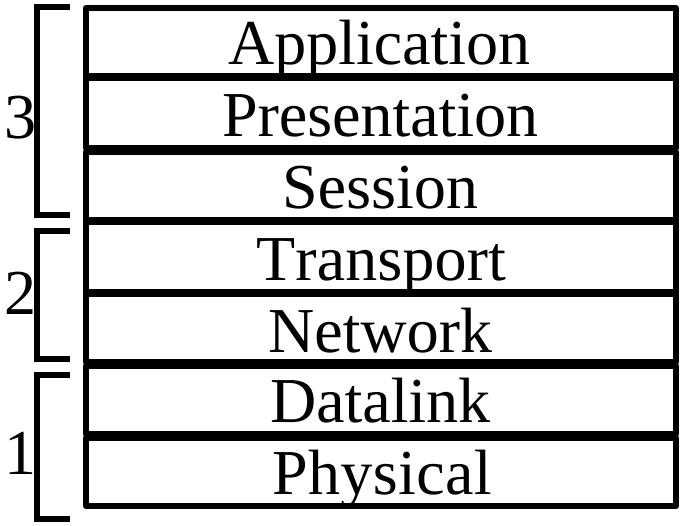
These slides are available at

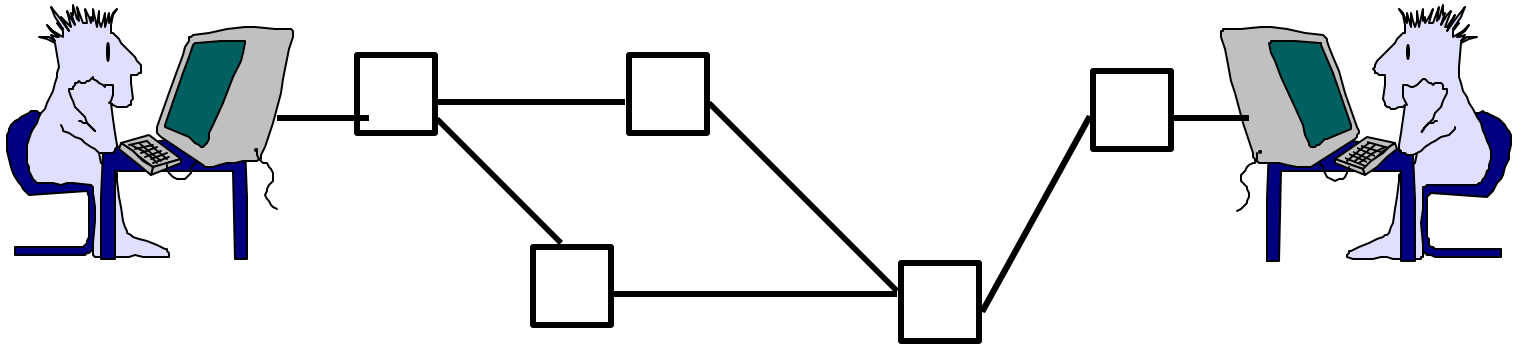
http://www.cis.ohio-state.edu/~jain/cis788-99/

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

ISO/OSI Reference Model

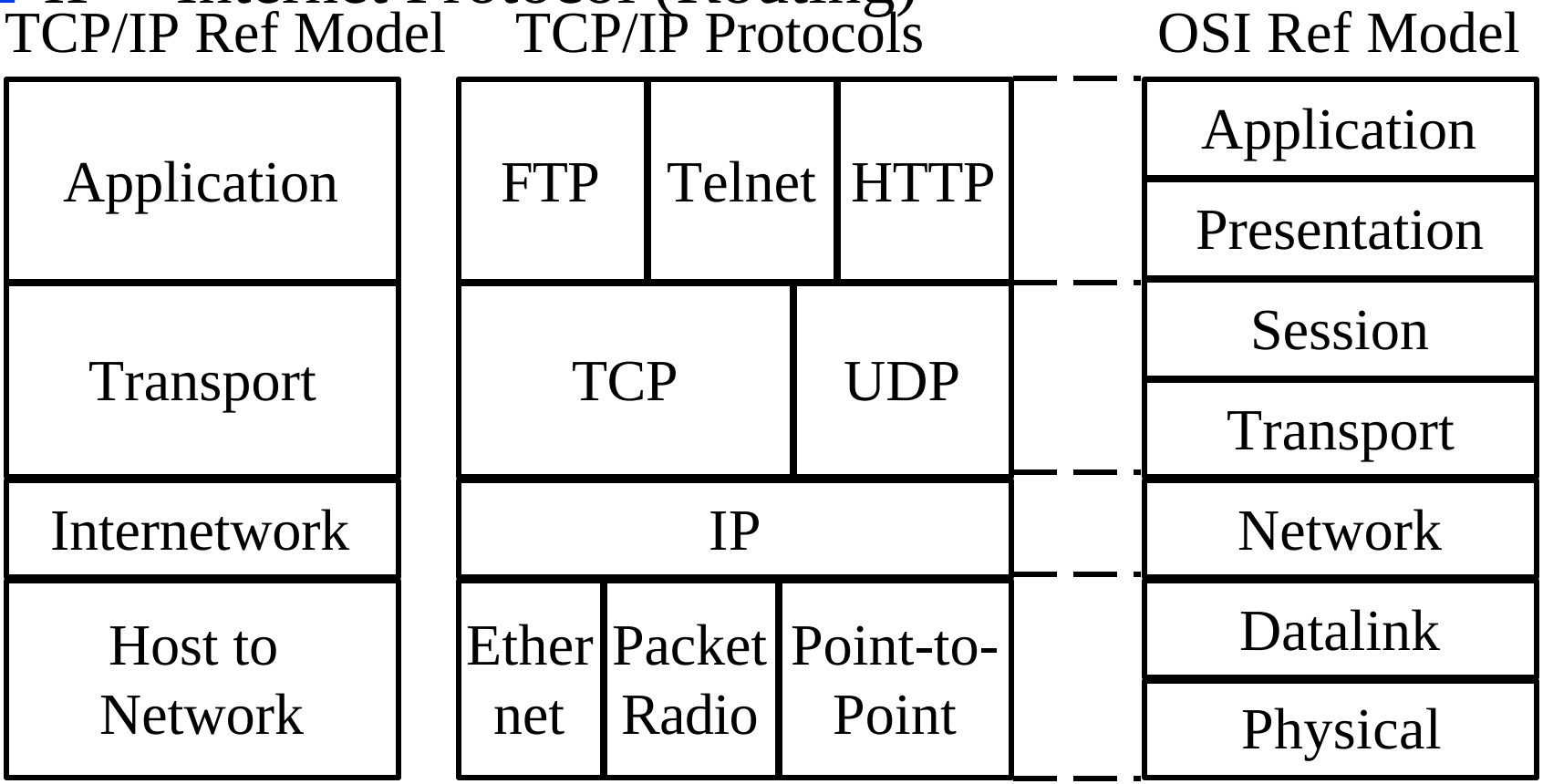


File transfer, Email, Remote Login
ASCII Text, Sound
Establish/manage connection
End-to-end communication: TCP
Routing, Addressing: IP
Two party communication: Ethernet
How to transmit signal: Coding



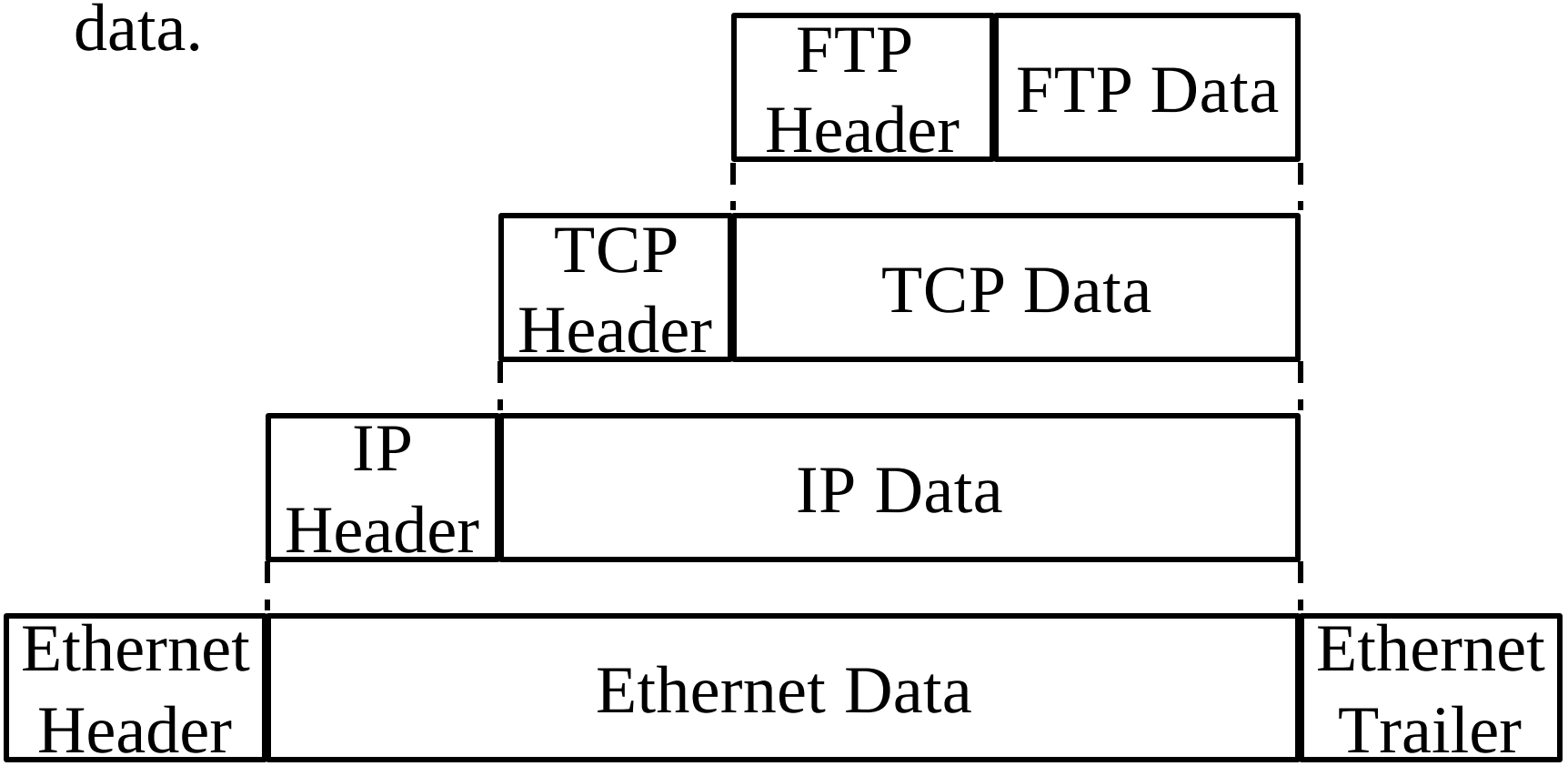
TCP/IP Reference Model

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



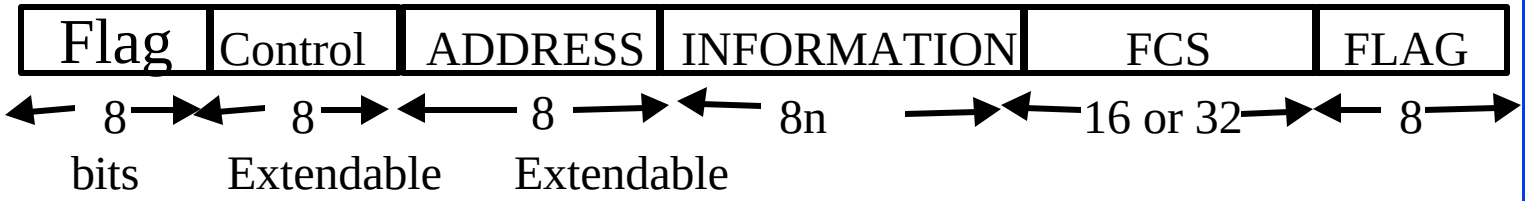
Layered Packet Format

- 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

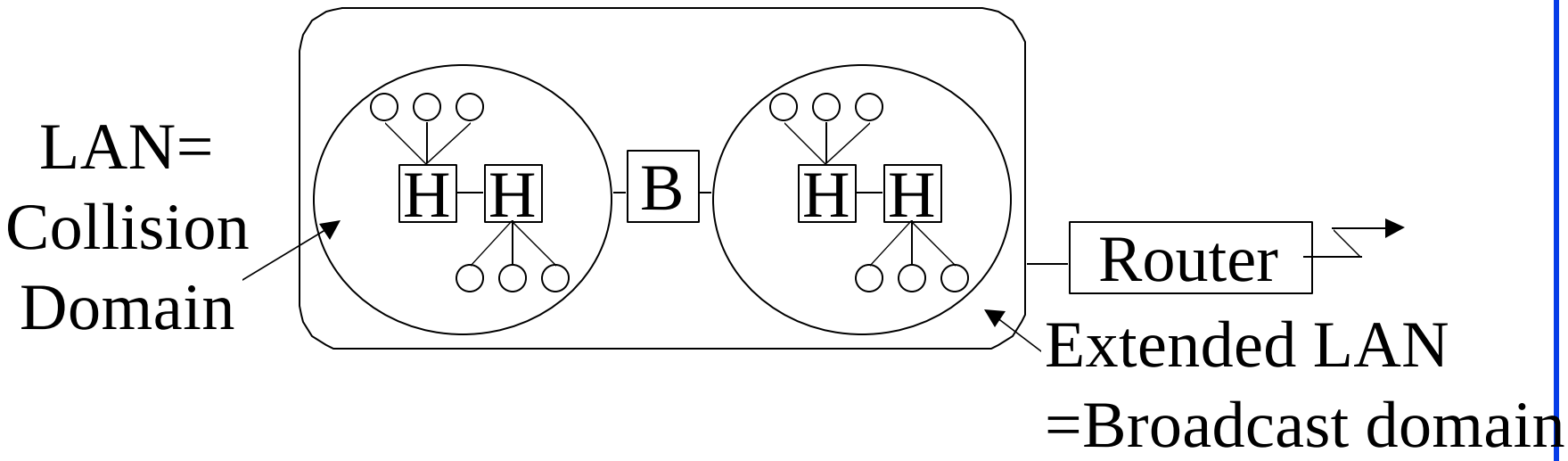
1	2	3	4	5	6	7	8
0	N(S)			P/F	N(R)		
1	0	S		P/F	N(R)		
1	1	M		P/F	M		

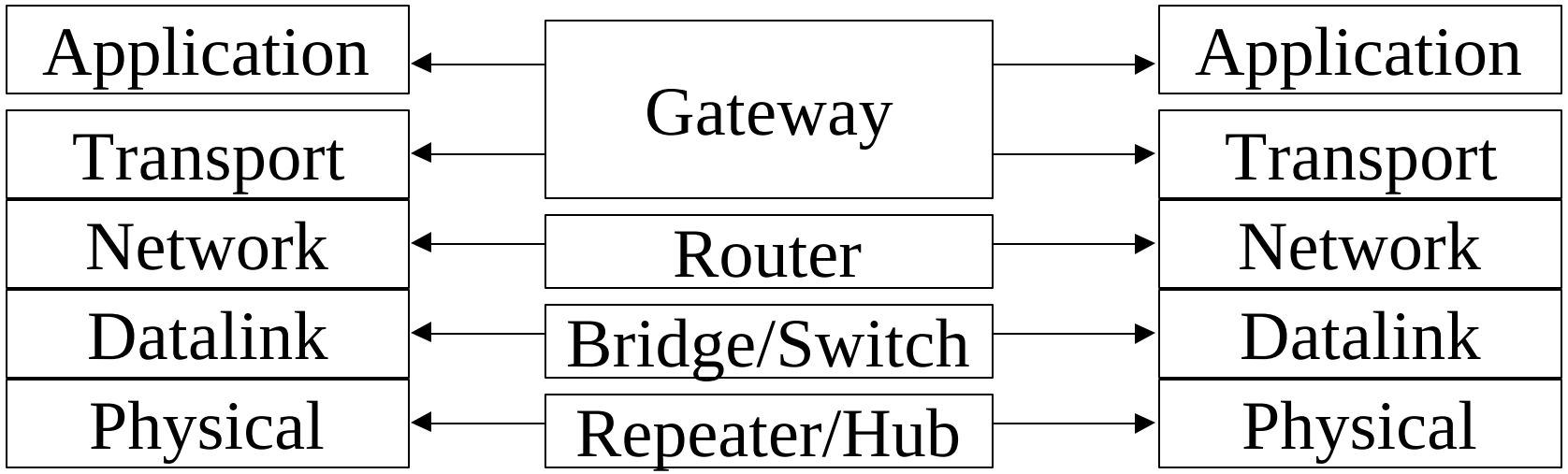
N(S)= Send sequence number N(R)= Recieve sequence number
S= Supervisory function bits M= Unnumbered bits P/F= Poll/final bit

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 ⇒ 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





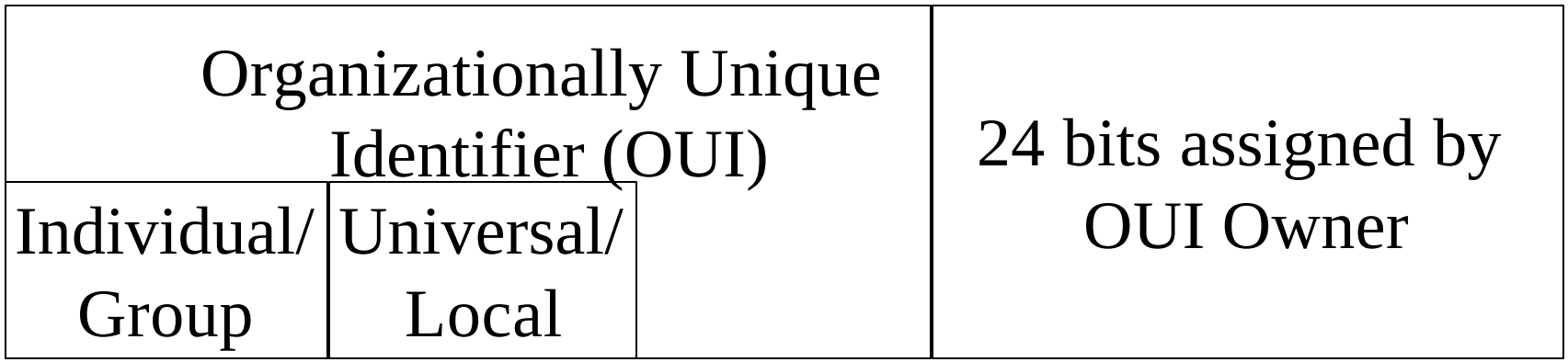
Interconnection Devices

- **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.

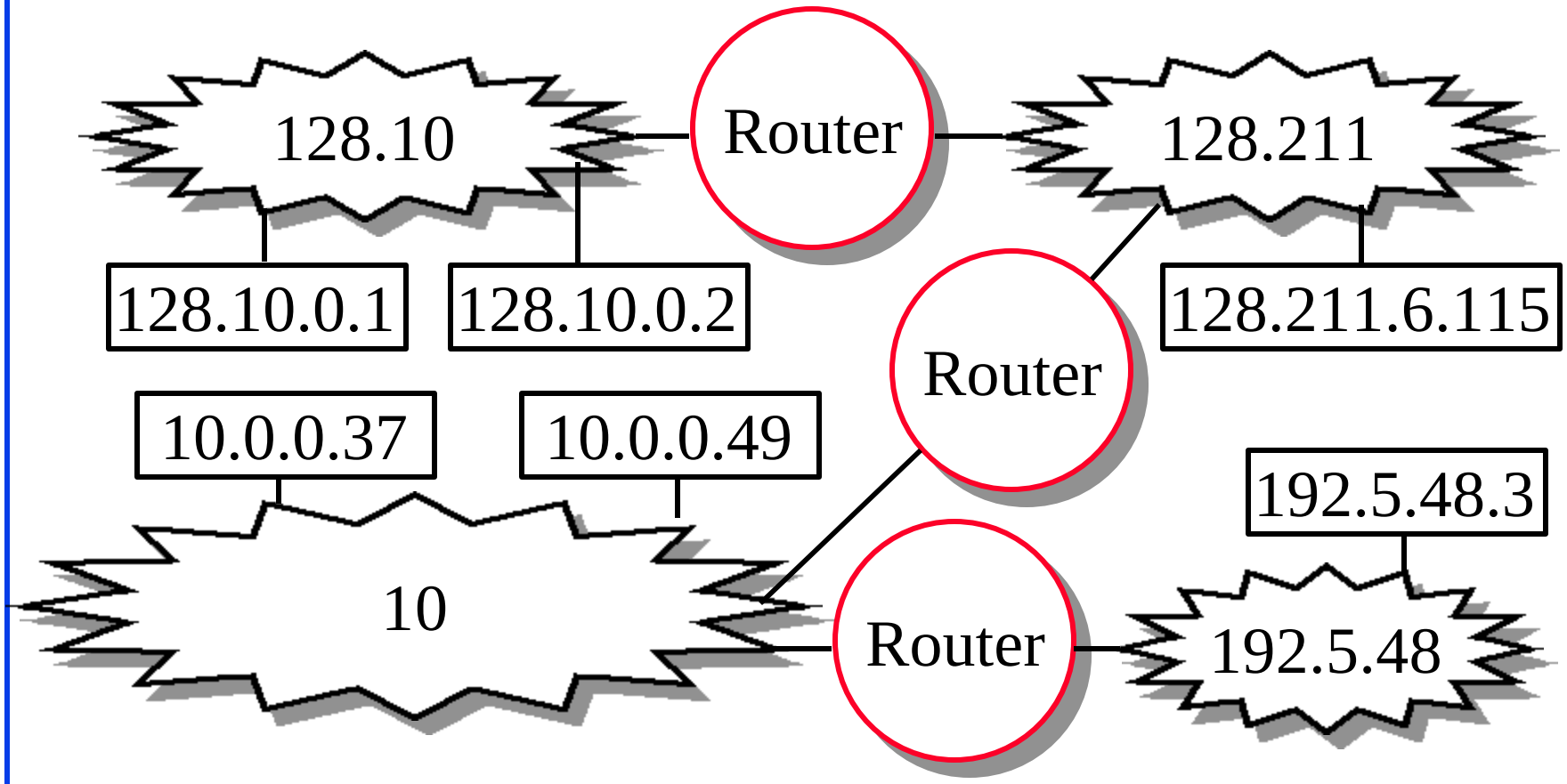
IEEE 802 Address Format

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



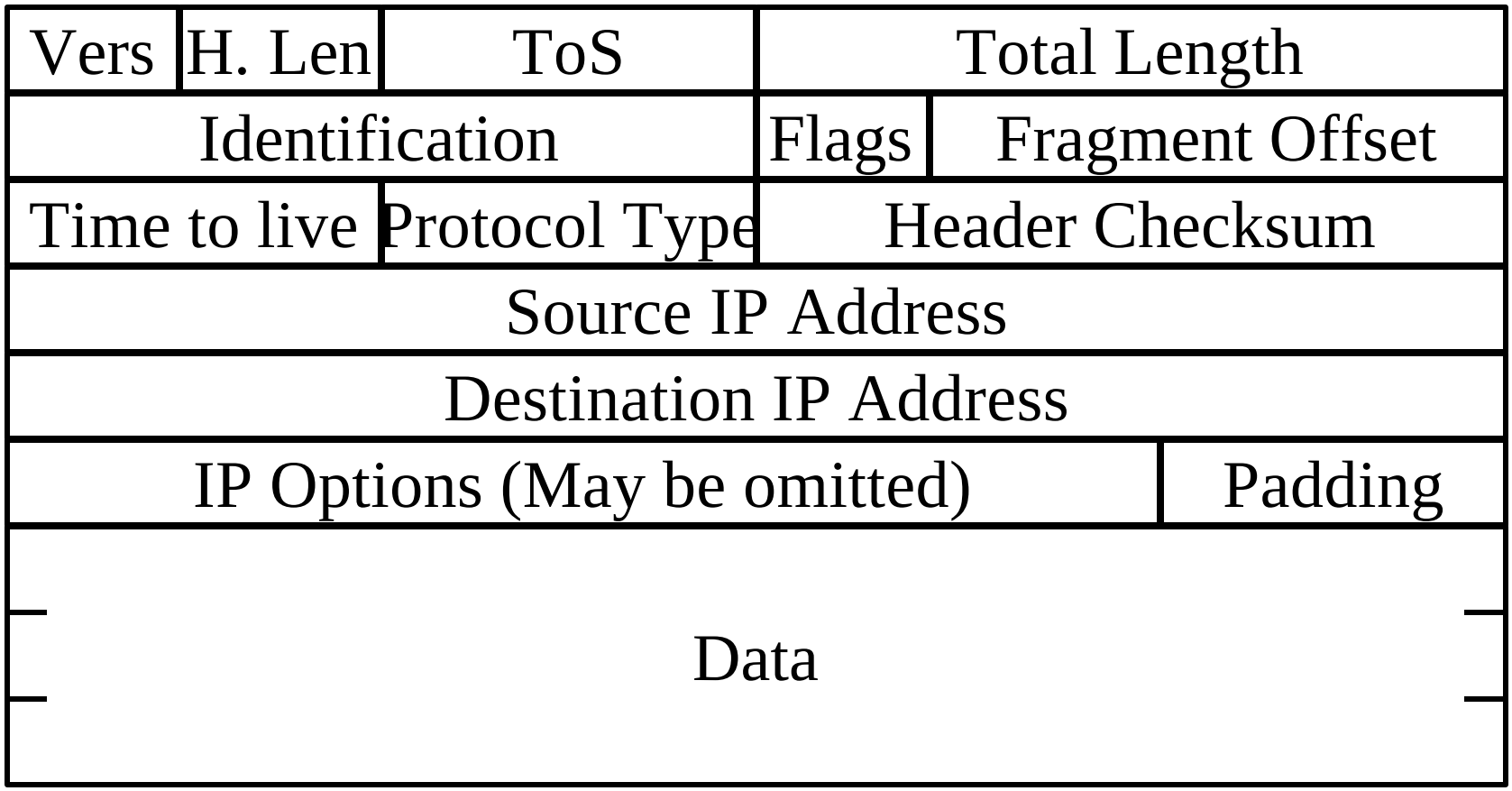
- Multicast = "To all bridges on this LAN"
- Broadcast = "To all stations"
  = 111111....111 = FF:FF:FF:FF:FF:FF

IP Addressing Example



- All hosts on a network have the same network prefix

IP Datagram Format



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

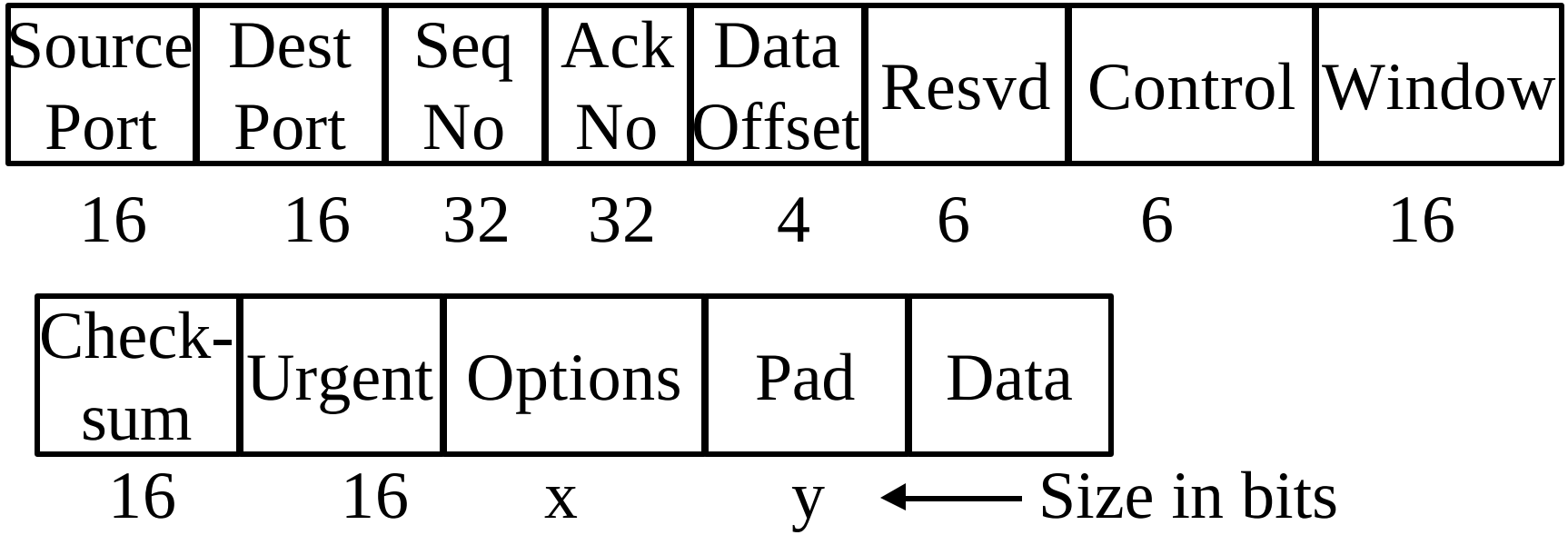
IP Header (Cont)

- 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

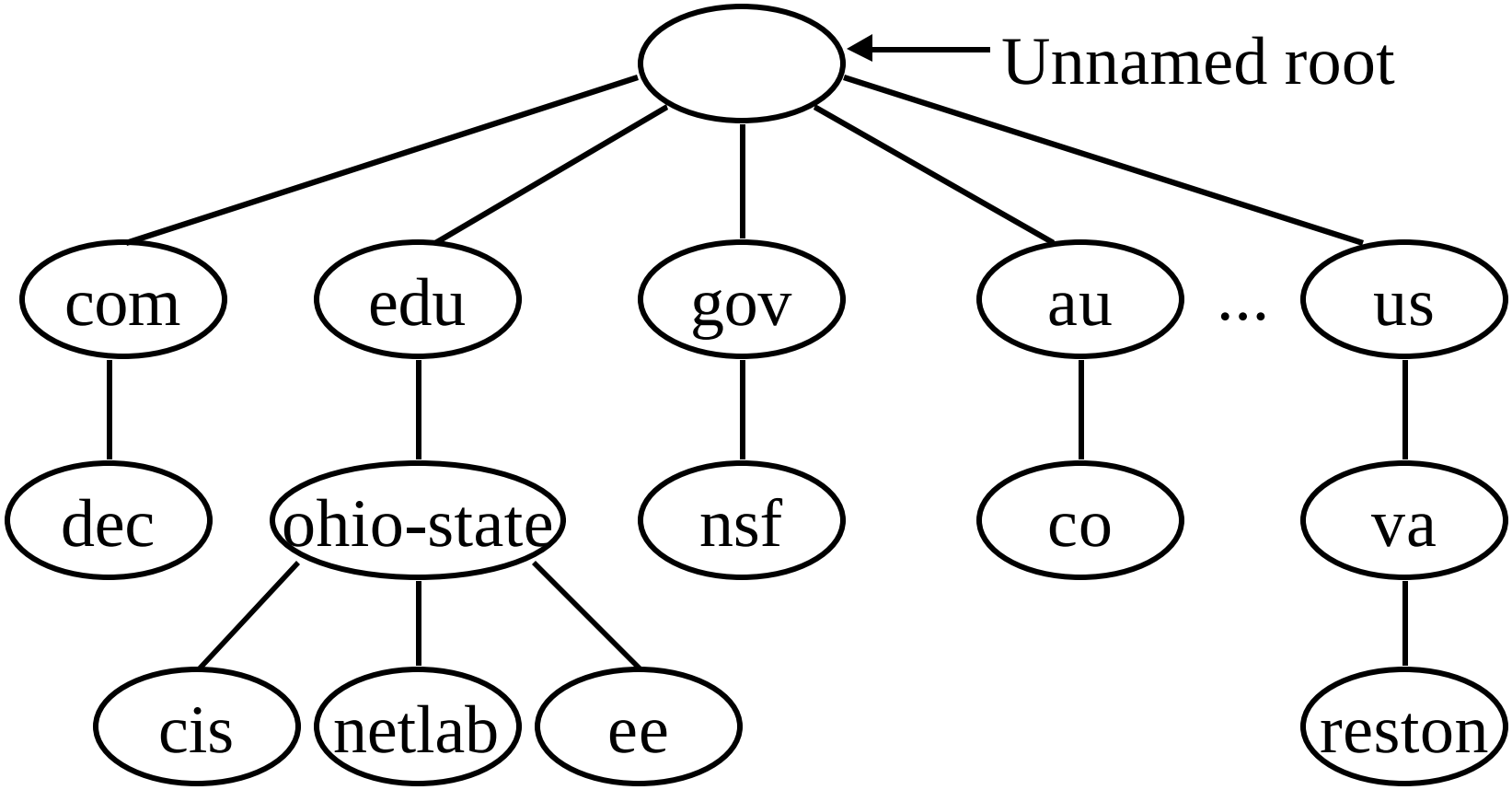
URG	ACK	PSH	RST	SYN	FIN

- 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

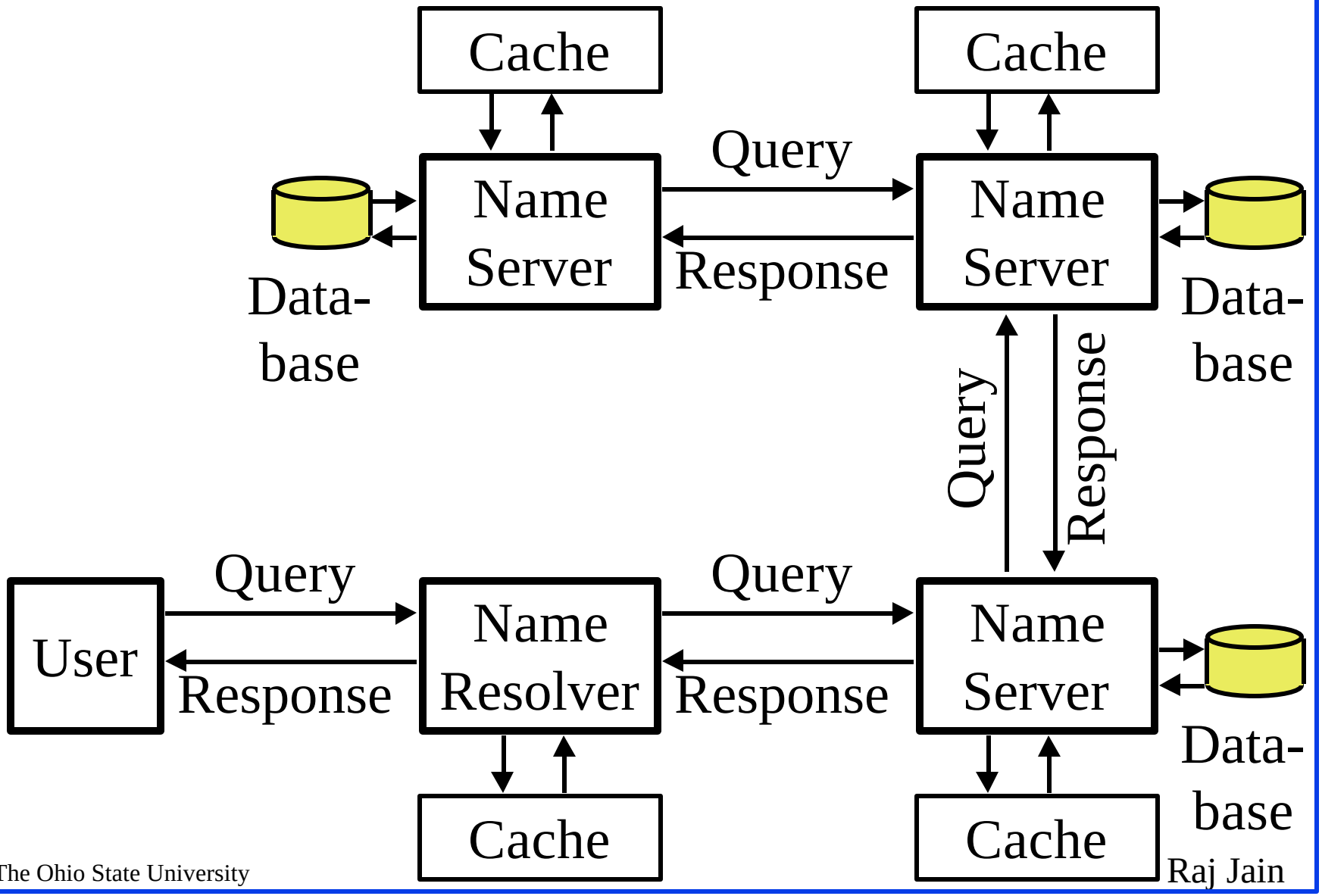
Domain Name System



Humans can remember names. Computers use addresses

Cobra.netlab.ohio-state.edu = 164.107.61.202

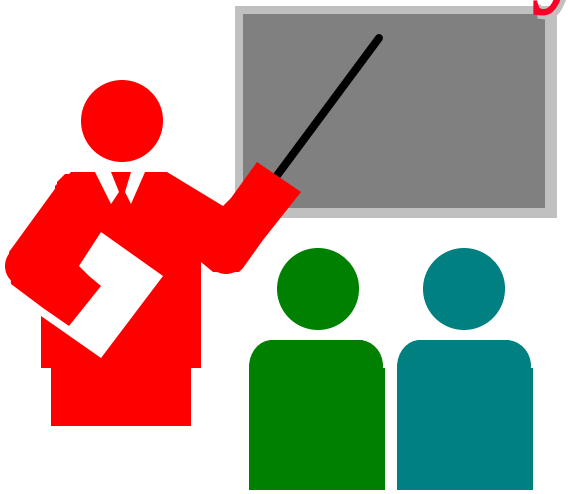
Name Resolution



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?