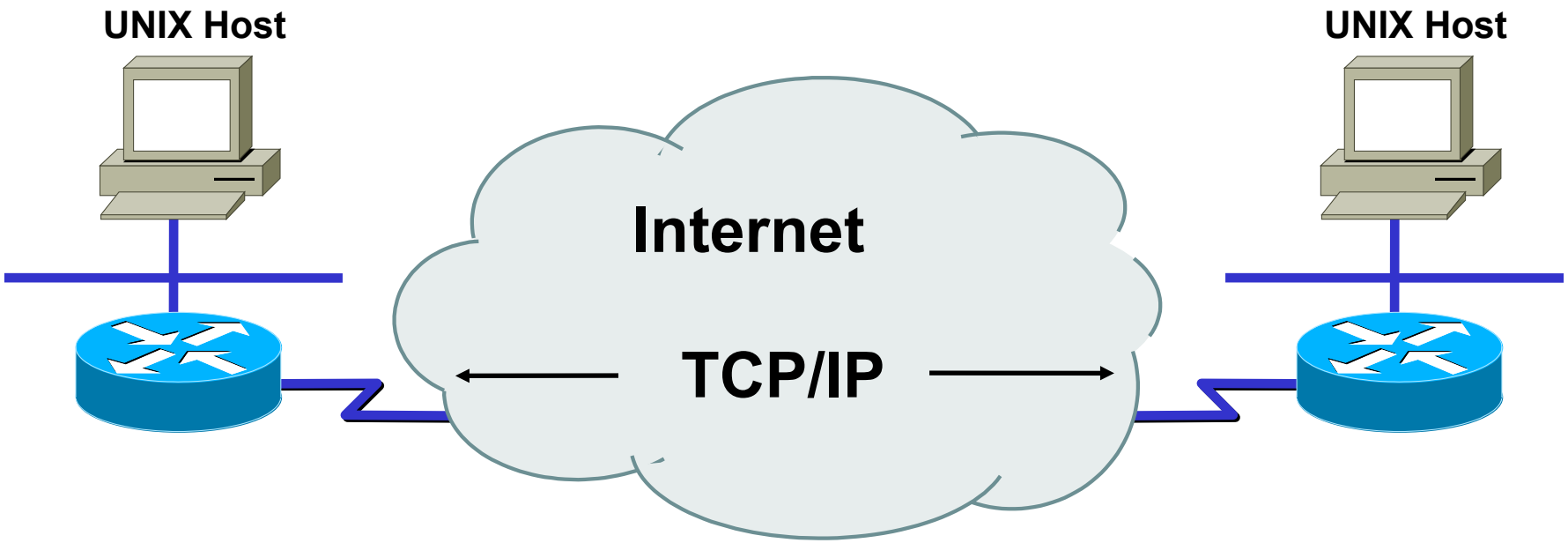
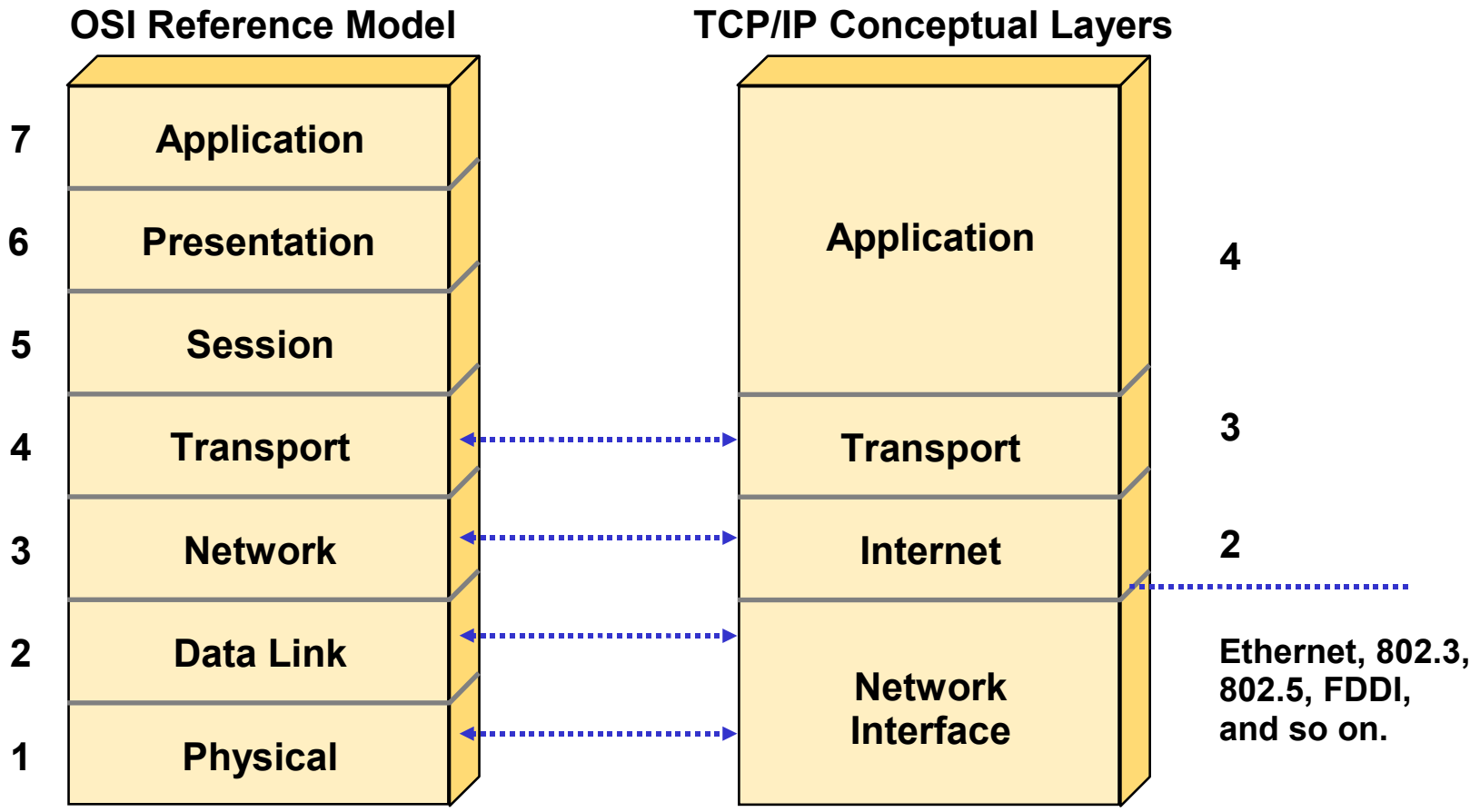
IPv4 Overview



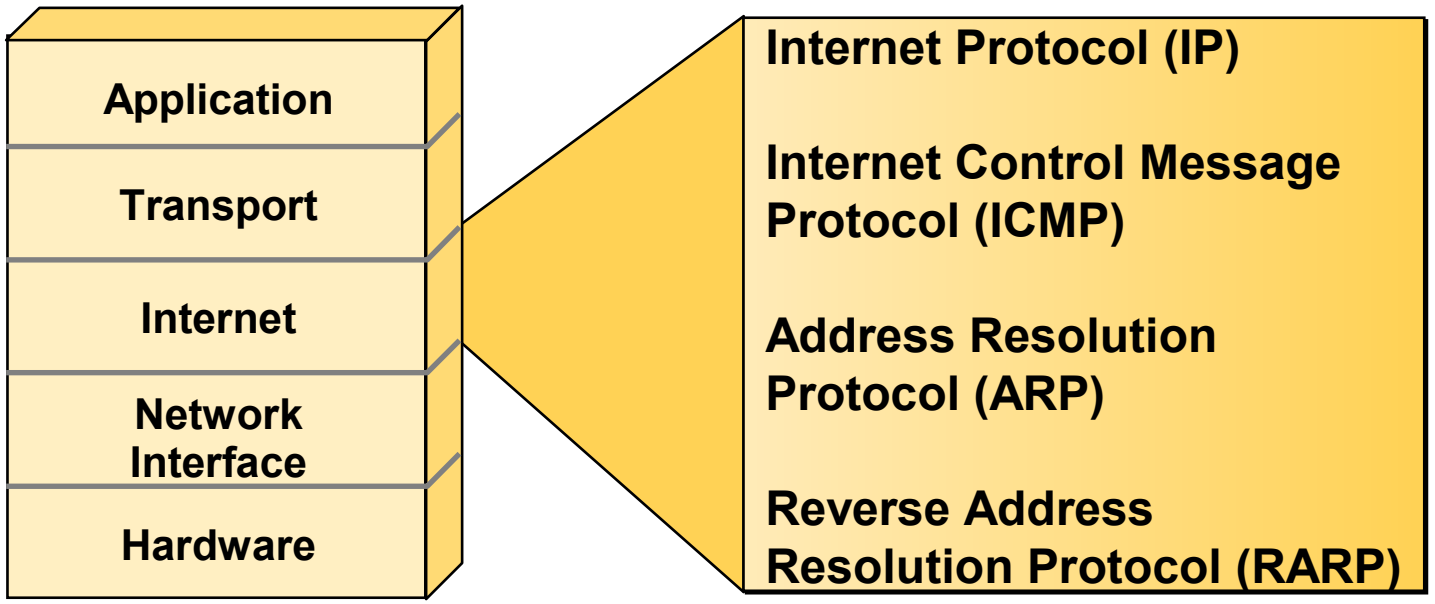
- Early protocol suite
- Universal

TCP/IP Protocol Stack



Internet Layer

Network Layer Overview



IPv4

- Workhorse of TCP/IP protocol suite
- RFC 791
  - Can be downloaded from www.ietf.org
- Proposed in 1981
- Designed with inter-networking in mind

IPv4

- Unreliable
  - No guarantee of packet delivery
  - Best effort service
  - Sends an ICMP message in case of certain errors, before dropping packets
  - Reliability to be provided by higher layers

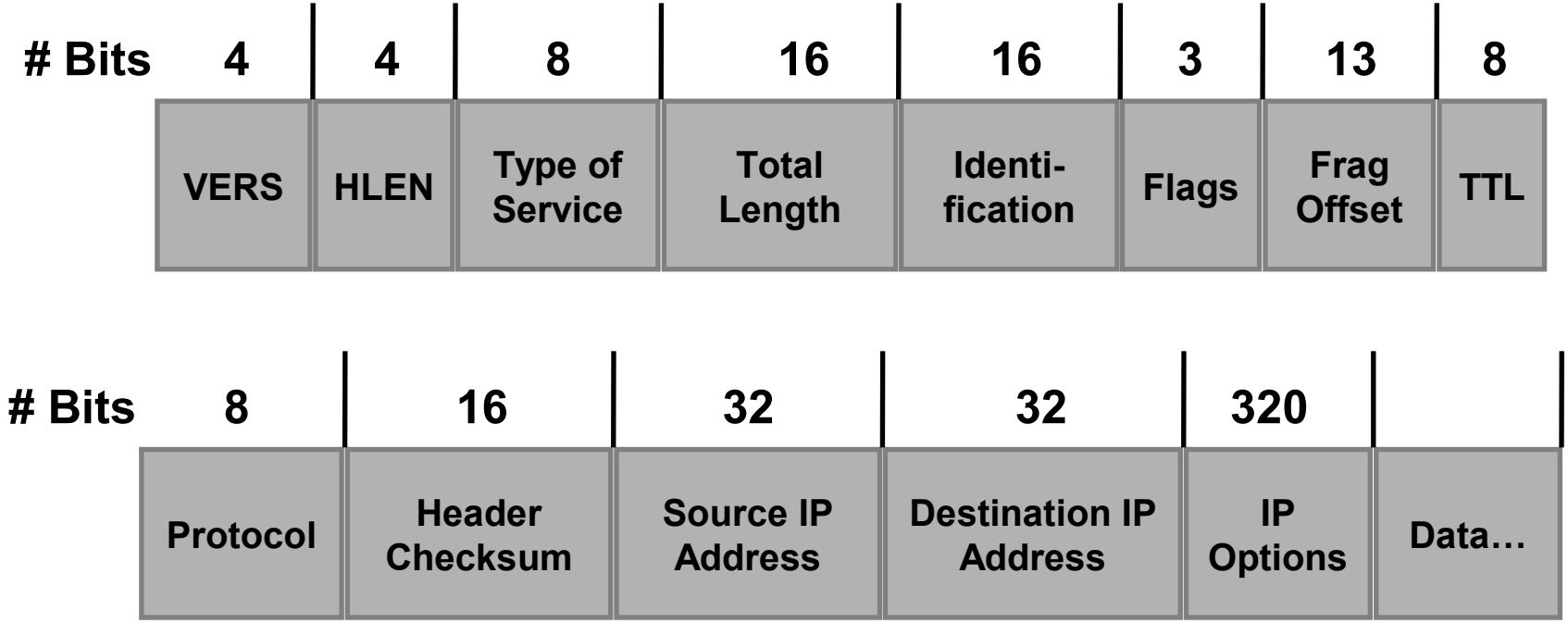
IPv4

- Connectionless
  - Does not maintain state information of datagrams
  - Each datagram is independent and can take different routes
  - Datagrams can be delivered out of order

IPv4

- Maximum datagram size = 64Kbytes
- Practical size (default size) = 1500 bytes
- Datagram may be fragmented as it passes through different network segments
  - Depends on DLL's max frame length

IPv4 Datagram Format



IP Header Fields

- *Version* field
  - 4 bits
  - Indicates the version of protocol
  - Currently version 4 is in use
  - Version 5 was an experimental real time stream protocol, not in use
  - Version 6 is being implemented now

IP Header Fields

- *IHL*
  - 4 bits
  - Indicates length of the header
  - Multiples of 32 bit words
  - Minimum value = 5 when no options present
  - Maximum header length = 60 bytes
    - ❖ Why not 64 bytes?

IP Header Fields

- *TOS:* 8 bits
  - 3-bit precedence field (priority 0 to 7)
  - 4 TOS bits (only one bit can be set)
    - Minimize delay
    - Maximize throughput
    - Maximize reliability
    - Minimize monetary cost
  - Unused last bit (always = 0)
  - Most of routers ignore TOS

IP Header Fields

- *Total length*
  - 16 bits field
  - Total length of the IP packet in bytes, including header length
  - Limits the size of IP packet (**MTU**) to 64Kbytes
  - This field changes when packet is fragmented

IP Header Fields

- *Identification*
  - 16 bits
  - Uniquely identifies each packet
  - Helps in fragmentation and reassembly of the packets
  - All the fragments of a packet contain same *Identification* value

IP Header Fields

- *Flags*
  - 3 bits
    - ❖ Unused bit
    - ❖ DF – don't fragment
    - ❖ MF – more fragments
      - All the segments except the last fragment will have this bit enabled

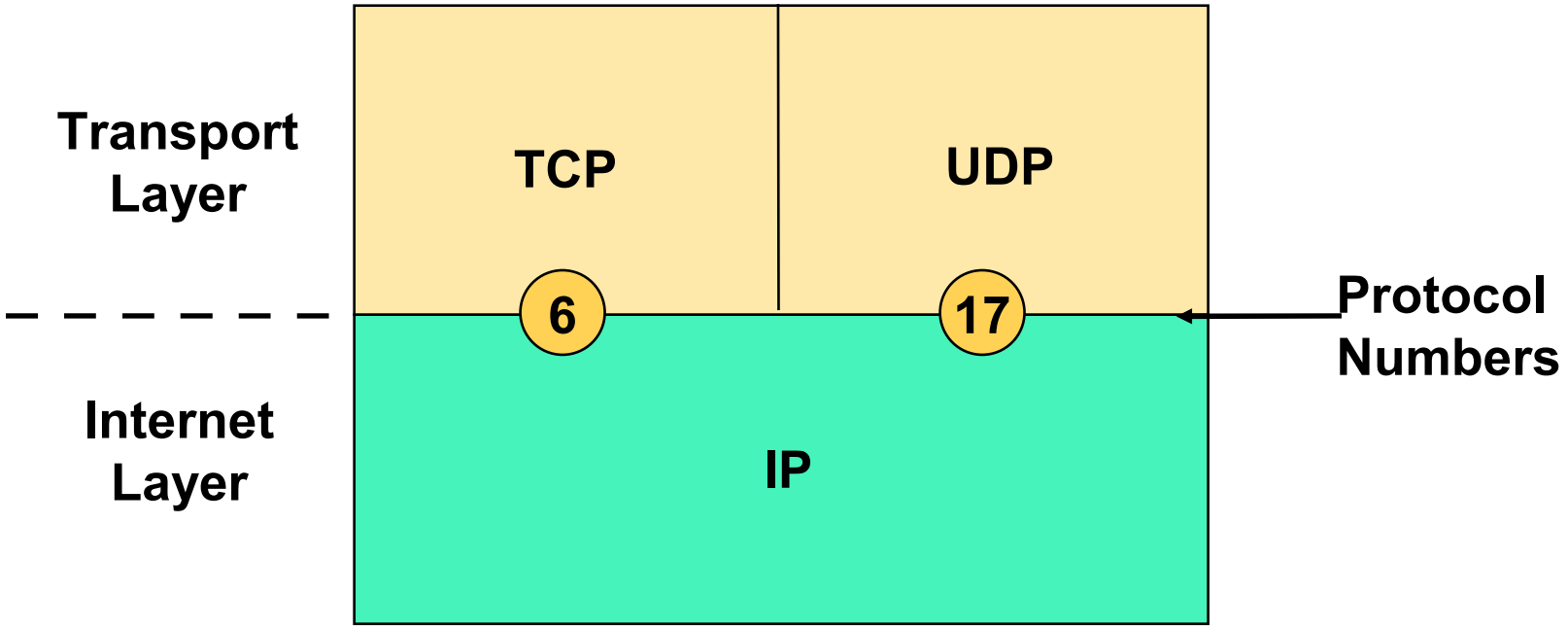
IP Header Fields

- *Fragment Offset*
  - 13 bits
  - Indicates the position of fragment in the datagram
  - Maximum of 8K (8192) fragments per IP datagram

IP Header Fields

- *TTL: 8 bits*
  - Time-to-live
  - Limits the lifetime of the datagram in the network
  - Used to eliminate routing loops
  - Value set by the sender (normally 32 or 64)
  - Decremented by each en-route router
  - ICMP message sent to sender when value = 0

Protocol Field



- 8 bits
- Determines destination upper-layer protocol

IP Header Fields

- *Header Checksum:* 16 bits
  - Calculated for header only, does not cover data
  - ICMP, IGMP, UDP, TCP checksum covers data and header in their respective headers
  - 16 bit 1's complement sum after setting checksum field to 0
  - Re-calculated at each router
  - Datagram discarded if checksum is incorrect, no error message generated

IP Header Fields

- *Source address:* 32 bits
- *Destination address:* 32 bits
- *Options*
  - Security and handling restrictions
  - Record route, record timestamp
  - Loose source routing
  - Strict source routing

Internet Addresses

- Every node in the Internet should have a unique address
- 32 bit address in *dotted decimal* notation
  - W.X.Y.Z
  - Each decimal number = 8 bits
- Total of 2^{32} addresses

IP Address

- Address divided in two components
  - Network address
  - Host address
- Routing is done using network address
- Network-Host address boundary is determined by *subnet mask*

Types of IP Addresses

- Unicast address
- Multicast address
- Broadcast address
- Private address/Local address
- Public address/Global address

IP Address Classes

- Addresses are divided into various classes
  - Class A
  - Class B
  - Class C
  - Class D
  - Class E
  - CIDR (Classless InterDomain Routing)

Class A IP address

- First bit = 0
- Next 7 (8–1)bits for network address
- Last 24 bits for host address
- Address range
  - 0.0.0.0 to 127.255.255.255

Class B IP address

- First two bits = 10
- Next 14 (16-2) bits as network address
- Last 16 bits for host address
- Address range
  - 128.0.0.0 to 191.255.255.255

Class C IP address

- First three bits = 110
- Next 21 (24-3) bits as network address
- Last 8 bits for host address
- Address range
  - 192.0.0.0 to 223.255.255.255

Class D IP address

- First four bits = 1110
- Next 28 (32-4) bits as group address
- No network and host address
- Used as multicast address
- Common IP address for the group and not bound to an individual
- Address range
  - 224.0.0.0 to 239.255.255.255

Class E IP address

- First five bits = 11110
- Next 27 (32-5) bits reserved for future use
- Address range
  - 240.0.0.0 to 247.255.255.255

Special IP Address

- All 0's
  - 0.0.0.0
  - Used during initial booting by BOOTP, DHCP
- All 1's
  - 255.255.255.255
  - Indicates local broadcast

Special IP Address

- Netid.all 1's
  - Broadcast to a specific network
- 127.anything
  - Loopback
  - Does not go to the network

IP Address Allocation

- Address allocation is done by ***InterNIC/ICANN***
  - Internet Network Information Centre
  - Internet Corporation for Assigned Names and Numbers
- Network address allocated by InterNIC
- Host address allocated by local network administrator

Subnets

- Host address can be further divided into ***subnet address*** and host address with the help of ***subnet mask***
- Why?
  - When number of hosts are less
  - To structure the network
  - To reduce routing
  - To reduce/restrict broadcasts

Subnet Mask

- 32 Bit value
- Contains ‘one’ bits for network ID and subnet ID
- Contains ‘zero’ bits for host ID
- May not be contiguous 1s

Key Concepts

- Fragmentation
- Subnet Mask
- Classful and Classless IP addressing

Reading Assignment

- Download and read RFC 791
- Find out – how does ***traceroute*** work?
- Find out type of address used in IIIT-H
- How does an IP address get allocated to a Network? Find out the process.
- Deadline - before next class