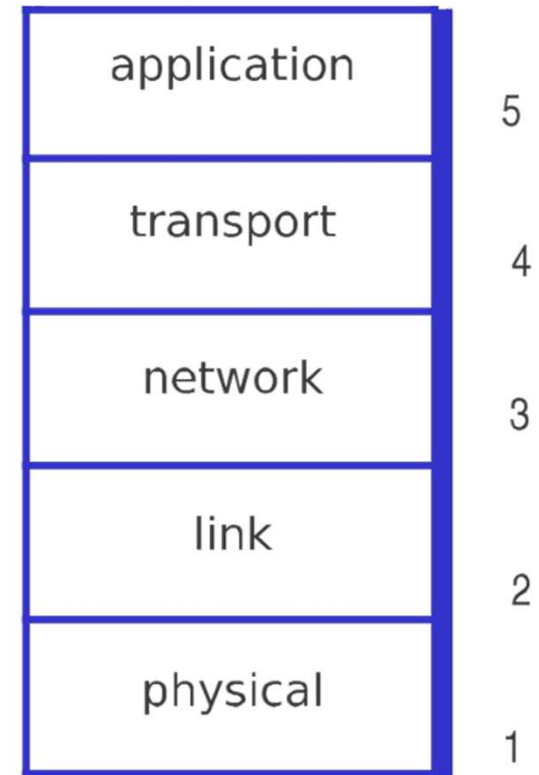


Computer Networks Lab

- Overview

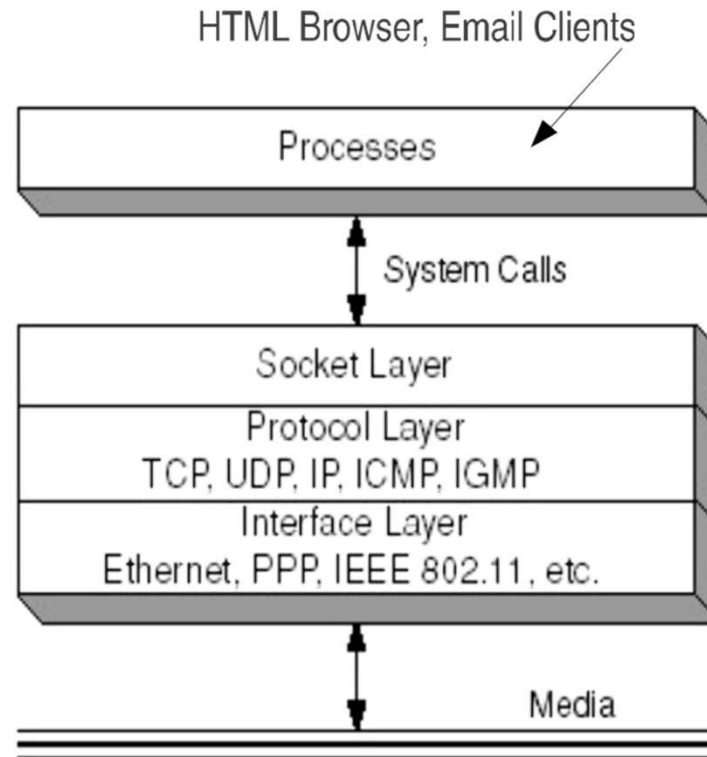
Internet protocol stack

- **Application:** supporting network applications
- **Transport:** process-process data transfer
 - TCP, UDP
- **Network:** routing of datagrams from source to destination
 - IP, routing protocols
- **Link:** data transfer between neighboring network elements
 - PPP, Ethernet
- **Physical:** bits “on the wire”



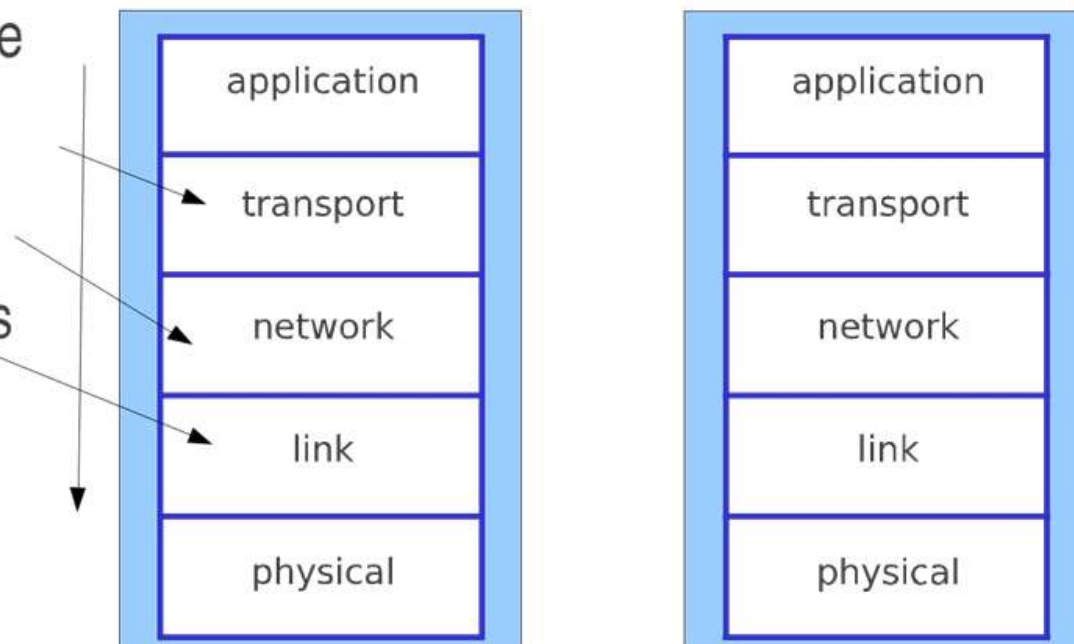
Networking Code Organization

- Most applications are implemented as *user space* processes.
- Protocols are implemented in the system kernel
 - Socket layer
 - Protocol layer
 - Interface layer



Naming and Addressing

- Uniquely identify processes in different computers for communications.
- Domain name
- Port number
- IP address
- MAC address



How to figure out the addresses of the corresponding host?

Domain Name

A user friendly name to identify a host

- Domain Name System (DNS): resolves a domain name to the
- Example:
 - www.cse.iitb.ac.in → 59.162.23.130 (outside world)
 - www.cse.iitb.ac.in → 10.105.1.3 (inside IITB)

A host first contacts its local DNS server to get the mapping

- host needs to know the local DNS server address
(specified in configuration file)

IP Address

- Each interface in a host is assigned an IP address.

IPv4, 32 bits, dotted-decimal notation

128.238.42.112 means

10000000	in 1 st Byte
11101110	in 2 nd Byte
00101010	in 3 rd Byte
01110000	in 4 th Byte

- IPv6, 128-bit address

Media Access Control Address

- Apart from IP address, each interface in a host also has a hardware address (MAC address)
- Ethernet MAC address is 48 bits long
E.g 00:18:F3:96:C2:A7

ARP protocol is used to translate an IP address to MAC address

Port Numbers

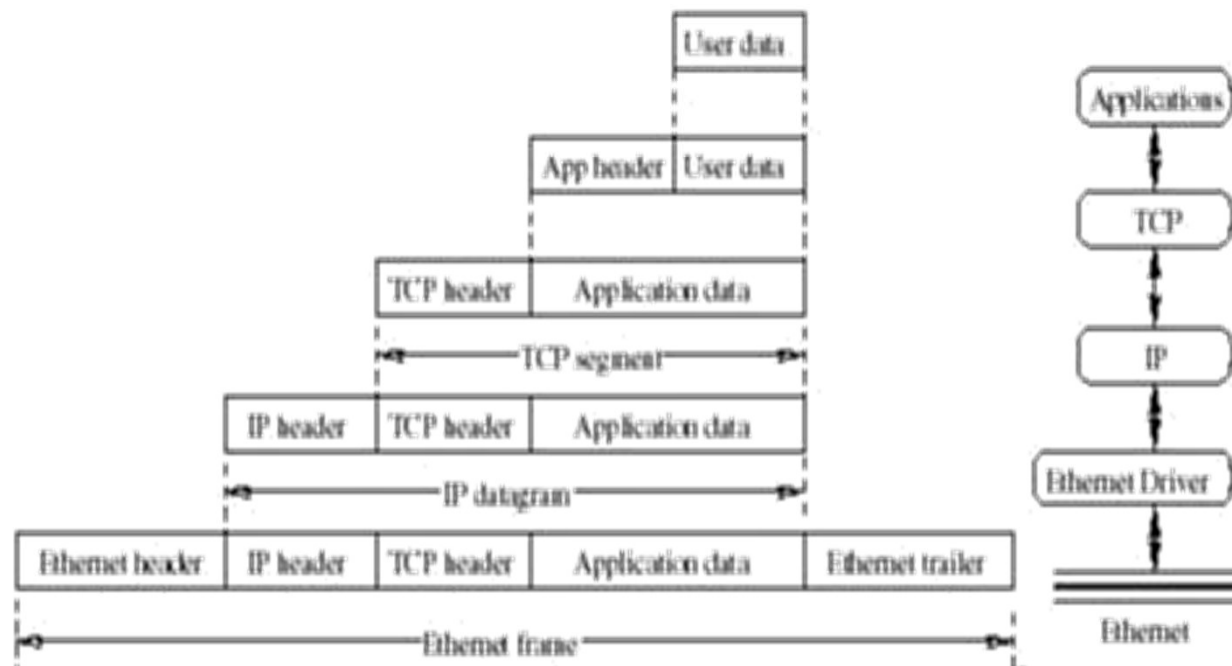
- Address for the application layer user process.

Port Number field specified in TCP or UDP header.

- Well-known port numbers
 - 1 to 255: Internet wide services
 - 256 to 1023: preserved for Unix specific services
 - 1024 and up: ephemeral port numbers
 - Port 80 is associated with http (web server)
 - Port 25 is associated with email

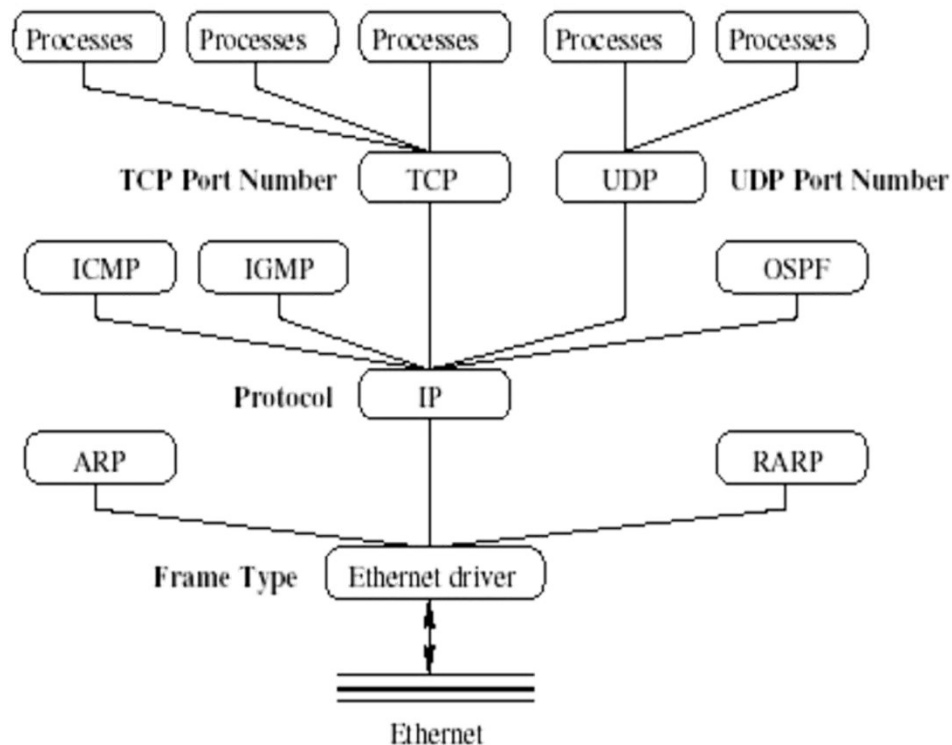
Encapsulation

- The application data is sent down
- Each layer adds a header to the data (PDU) from its higher layer.



Multiplexing and Demultiplexing

- Different higher layer protocols can use the service by the same lower layer protocol.



UDP Header Format

0	16	32
Source Port Number		Destination Port Number
Length		Checksum

TCP Header Format

0		16		32	
Source Port Number			Destination Port Number		
Sequence Number					
Acknowledgement Number					
Hdr Len.	Reserved	Flags	Window Size		
TCP Checksum			Urgent Pointer		
Options (if any)					
Data (optional)					

TCP Header Format

0	16	32
Source Port Number		Destination Port Number
Sequence Number		
Acknowledgement Number		
Hdr Len.	Reserved	Flags
TCP Checksum		Urgent Pointer
Options (if any)		
Data (optional)		

IP Header Format

- Size: 20 bytes without options.

0	16		32	
Version	Hdr Len	Differentiated Services	Total Length	
Identification		Flags	Fragment Offset	
Time to Live	Protocol	Header Checksum		
Source IP Address				
Destination IP Address				
Options (if any, <= 40 bytes)				
Data				

Ethernet Frame Format

- Source Ethernet (MAC) Address
- Destination Ethernet Address
- Frame Type: used to identify the payload
- CRC: used for error control

Destination Address	Source Address	Frame Type	Data	CRC
6 bytes	6 bytes	2 bytes	46–1500 bytes	4 bytes