Network Architecture

A ***set of layers and protocols*** is called the network architecture.

Protocol Hierarchies

- Networks are organized as layers to ***reduce design complexity***.
- Each layer **offers services** to the **higher** layers. Between adjacent layers is an **interface**. The basic elements of a layered model are:

Services	*Interface*	*Primitives*
Connection oriented and connectionless.	Defines which **primitives and services** the lower layer will offer to the upper layer.	**Operations** such as request, indicate, response, confirm.

Design Issues for the Layers (functions)

1. Mechanism for **connection establishment**
2. Rules for **data transfer**
3. **Error** control
4. Fast sender **swamping** a slow receiver
5. **Routing** in the case of multiple paths

Network Protocols

• **Protocol**: is a **format order of messages sent and received among the network entities and action taken on messages transmission receipt**.

• **Protocol process**:

1. The **format** or structure of the message
2. The **process** by which networking devices share information about **pathways** with other networks
3. How and when **error and system messages** are passed between devices
4. The **setup and termination** of data transfer sessions

Layering in Networked Computing

• OSI Model (open system interconnection)
• TCP/IP Model

Why a layered model?

1. **Breaks down** communication into smaller, simpler parts.
2. **Easier to teach** communication process.
3. **Allows** different hardware and software to work together.
4. **Reduces** complexity

The OSI model

The Open Systems Interconnection is the model developed by the International Standards Organization. The OSI model benefits are:

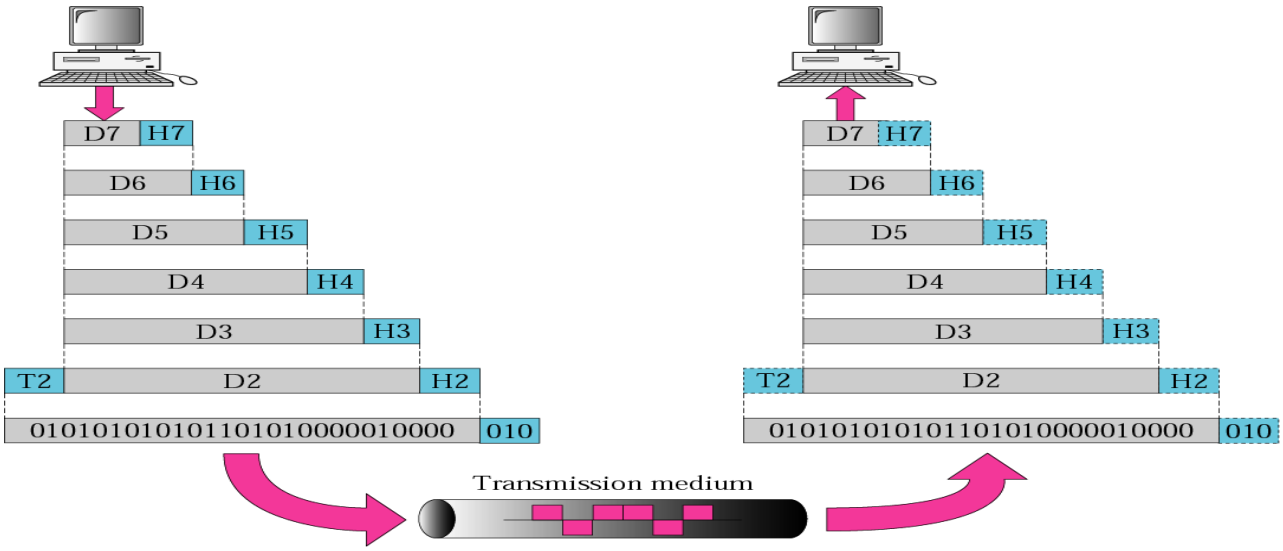
- Helps us understand ***how data gets from one user's*** computer to another.
- It aids to ***provide an organized structure for hardware and software developers to follow***.

Why use a reference model?

- **Serves** as an outline of rules for **how protocols can be used to allow communication between computers.**
- Each layer has its **own function and provides support to other layers.**

OSI model

Layer	Name	Example protocols
7	Application Layer	HTTP, FTP, DNS, SNMP, Telnet
6	Presentation Layer	SSL, TLS
5	Session Layer	NetBIOS, PPTP
4	Transport Layer	TCP, UDP
3	Network Layer	IP, ARP, ICMP, IPSec
2	Data Link Layer	PPP, ATM, Ethernet
1	Physical Layer	Ethernet, USB, Bluetooth, IEEE802.11



Benefits(Advantage)	Negative Aspect (disadvantage)
• Interconnection of different systems (open) • Not limited to a single vendor solution	• Systems might be less **secure** • Systems might be less **stable**

Layer	Main Topics
Physical Layer	• Transmission mediums (transmit bits over medium) • Encoding • Modulation • Repeaters • Hubs (multi-port repeater) • To provide mechanical and electrical specification
Data Link Layer	• Error detection and correction methods • Hop to hop delivery • Flow control • Frame format • IEEE LAN standards • Bridges & Switches (multi-port bridges) • physical addressing(MAC Address)
Network Layer	• Internetworking • Controls the operation of the subnet. • Routing algorithms(Routing packets from source to destination) • Internet Protocol (IP) addressing (Logical addressing) • Routers
Transport Layer	• Connection-oriented and connectionless services • Provide reliable process to process message delivery & error recovery • Transmission Control Protocol (TCP) • User Datagram Protocol (UDP) • Provides additional Quality of Service. • Port address • End-to-end flow control.
Session Layer	• Allows users on different machines to establish sessions (dialogue) between them. • managing dialogue control. • Token management. • Synchronization.
Presentation Layer	• Concerned with the syntax and semantics of the information. • Preserves the meaning of the information. • Data compression. • Data encryption.
Application Layer	• Provides protocols that are commonly needed. • To allow access to network resource • (FTP), (HTTP), (SMTP), (SNMP),(NFS),(Telnet)

SERVICES

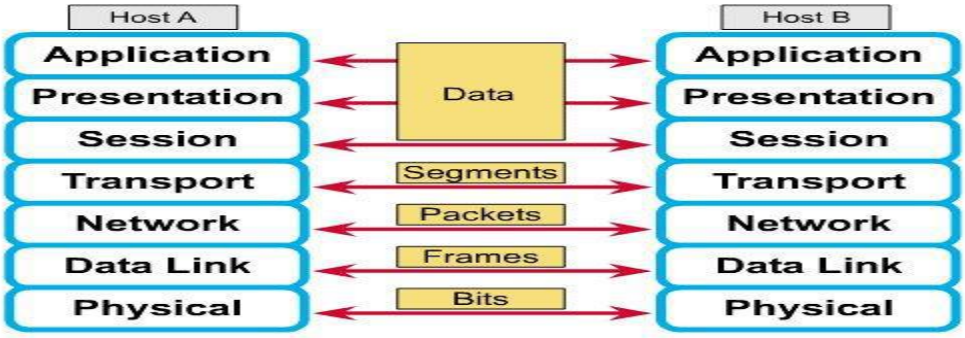
Connection-Oriented	Connectionless
Before data is sent, the service from the sending computer must **establish** a connection with the receiving computer.	Data can be sent at any time by the service from the sending computer.

Data Encapsulation

Each layer contains a **Protocol Data Unit (PDU)**

1. PDU's are used for **peer-to-peer** contact between corresponding layers.
2. Data is handled by the top three layers, then **Segmented by the Transport layer**.
3. The **Network layer places segment into packets** and the **Data Link frames the packets** for transmission.
4. Physical layer **converts frame to bits** and sends it out over the media.
5. The **receiving computer reverses the process** using the information contained in the PDU (headers of each layer).

The Layer	Shape of data (PDU)
top three layers	Data
Transport layer	Segment
Network layer	packets
Data Link layer	frames
Physical layer	bits



4 Layers of the TCP/IP Model

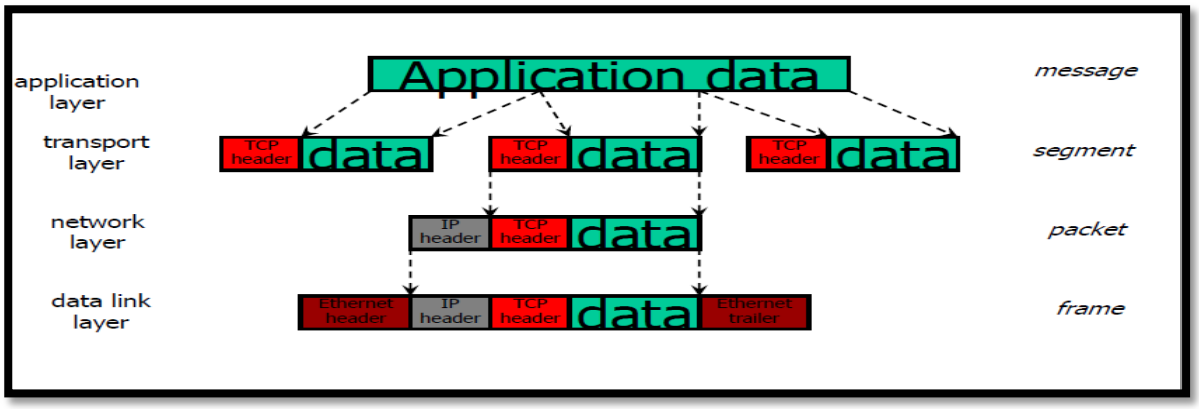
- Layer 4: Application
- Layer 3: Transport
- Layer 2: Internet
- Layer 1: Network access

It is important to note that some of the layers in the TCP/IP model have the same name as layers in the OSI model. Do not confuse the layers of the two models.

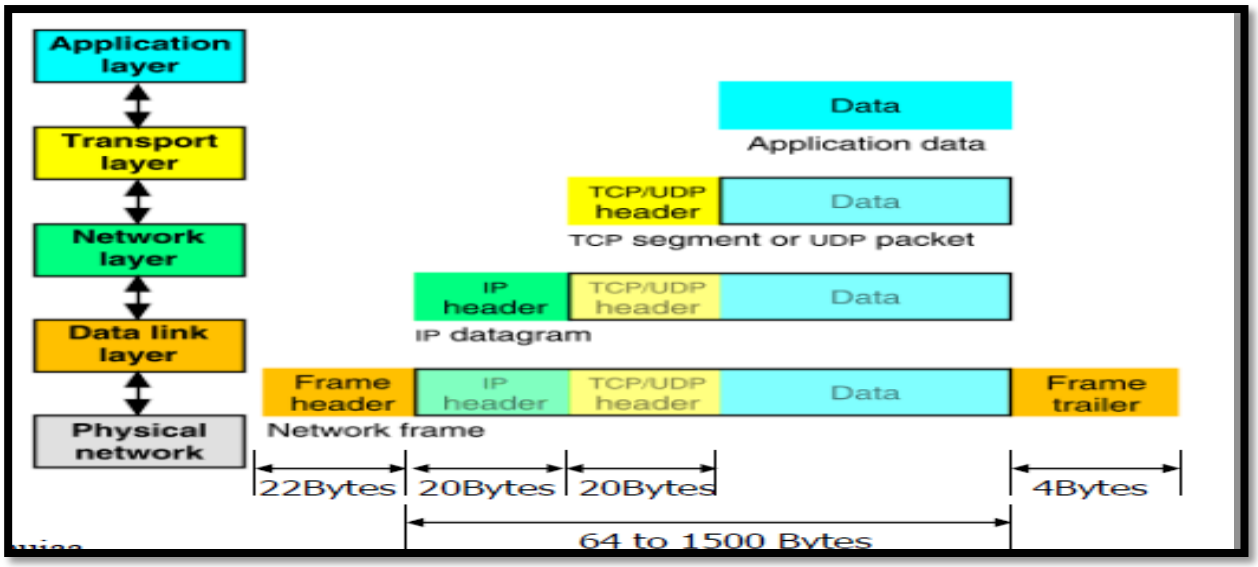
Data Encapsulation In TCP/IP

- Outgoing data is packaged and identified for **delivery** to the layer underneath
- PDU – Packet Data Unit – the "envelop" information attached to a packet at a particular TCP/IP protocol e.g. header and trailer
- Header (Identifies the protocol in use, the sender and intended recipient)
- Trailer (or packet trailer) (Provides data integrity checks for the payload)

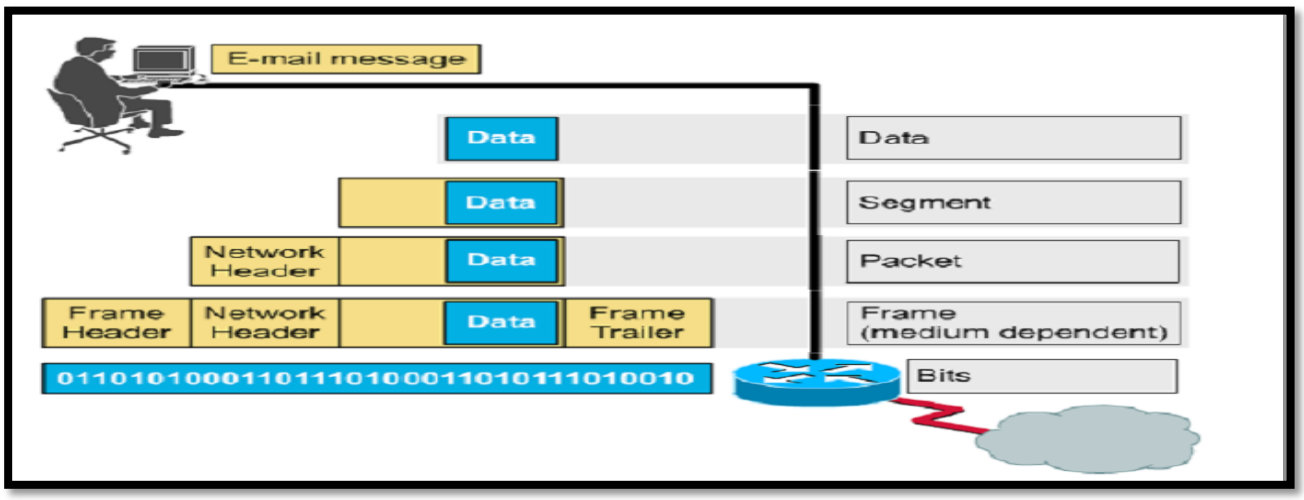
Data Formats



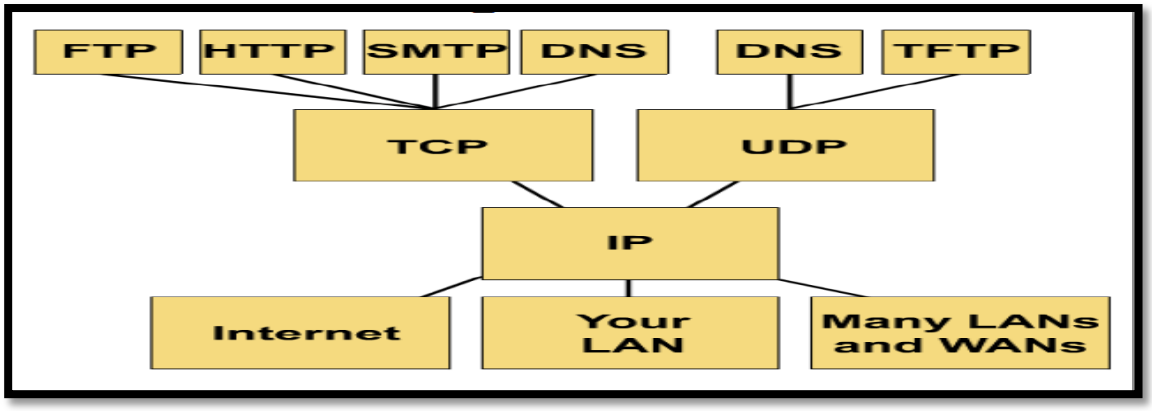
Encapsulation (TCP/IP)



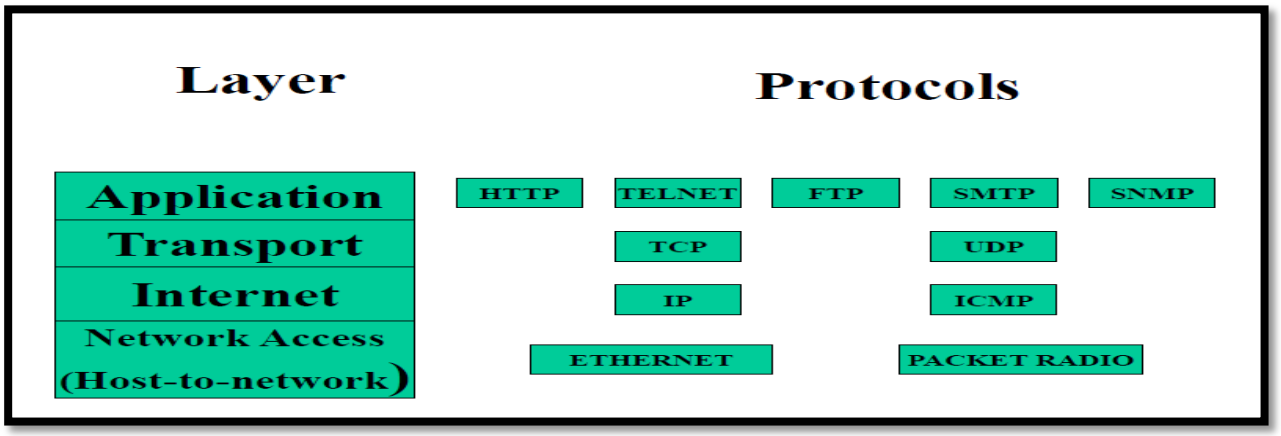
Encapsulation example: E-mail



TCP/IP protocol stack



TCP/IP Reference Model



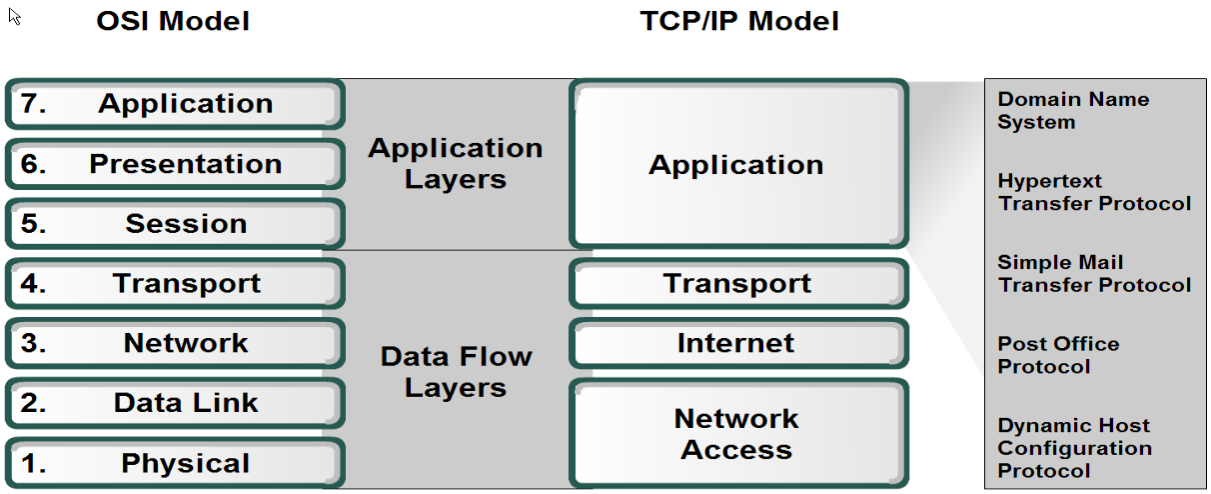
What is a socket?

- An interface between application and network(each application create socket)
- Socket(Protocol family, type-of-communication, specific- protocol);

- The socket *type* dictates the style of communication
  - ❖ reliable vs. best effort
  - ❖ connection-oriented vs. connectionless

Q /Explain the delivery of data in Layered model?

Type of delivery	Layer	Shape of data	Type of addressing
End to End	Transport	Segment	Port (socket)
Source To Destination	Network	Packet	Logical (IP)
Node to Node	Data Link	Frame	Physical(MAC)



OSI (Open System Interconnection)	TCP/IP (Transmission Control Protocol / Internet Protocol)
1. OSI provides layer functioning and also defines functions of all the layers.	1. TCP/IP model is more based on protocols and protocols are not flexible with other layers.
2. OSI model has a separate presentation layer	2. TCP/IP does not have a separate presentation layer
3. OSI is a general model.	3. TCP/IP model cannot be used in any other application.
4. Network layer of OSI model provide both connection oriented and connectionless service.	4. The Network layer in TCP/IP model provides connectionless service.
5. OSI model has a problem of fitting the protocols in the model	5. TCP/IP model does not fit any protocol
6. Protocols are hidden in OSI model and are easily replaced as the technology changes.	6. In TCP/IP replacing protocol is not easy.
7. OSI model defines services, interfaces and protocols very clearly and makes clear distinction between them.	7. In TCP/IP it is not clearly separated its services, interfaces and protocols.
8. It has 7 layers	8. It has 4 layers