3-01-2018

Module - 1

Computer Networks - A computer network or data network, is a digital telecommunication network which allows nodes to share resources. In computer networks, networked computing devices exchange data with each other using datalink. The connection b/w nodes are established using either cable media or wireless media.

Objectives :-

* Transfer data from one machine to another.
* Facilitate sharing of data.
* Facilitate access of remote information.

Applications :-

* world wide web
* Online social networks
* Email

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Internet is a network of networks. But web is a distributed system that runs on top of the internet.

In distributed s/m, a collection of independent Computers appears to its users as a single coherent s/m. It has a single model or paradigm that it presents to the users. A layer of software on top of the OS, called middleware, is responsible for implementing this model. An example of distributed s/m is world wide web.

In a computer network, this coherence, model

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and software are absent. Users are exposed to actual machines, If the machines have different hardware and different operating sys, that is fully visible to users. If a user wants to run a program on a remote machine, he has to log onto that machine and run it there.
Thus distributed sys is a s/w system built on top of a network.

Uses

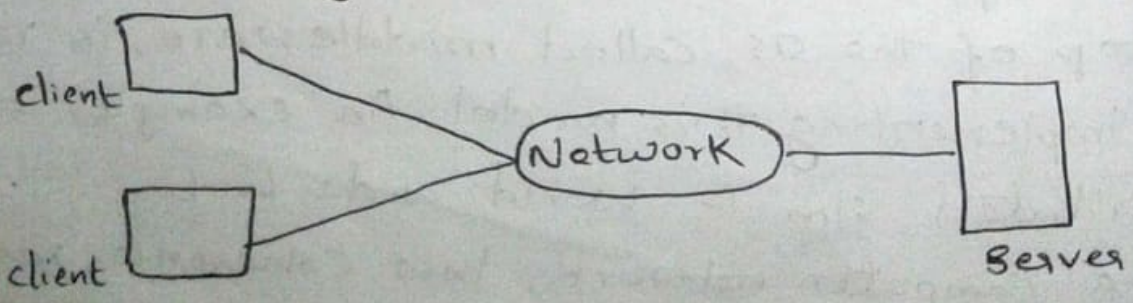
1. Business Applications

* Resource and Information sharing

Goal is to make all programs, equipment and especially data available to anyone on the network without regard to physical location of the resource and the user.

Client Server model ⇒

Data are stored on powerful computers called servers. These are centrally housed & maintained by a sys administrator. Employees have simple machines, called clients with which they access remote data. client & server machines are connected by a network



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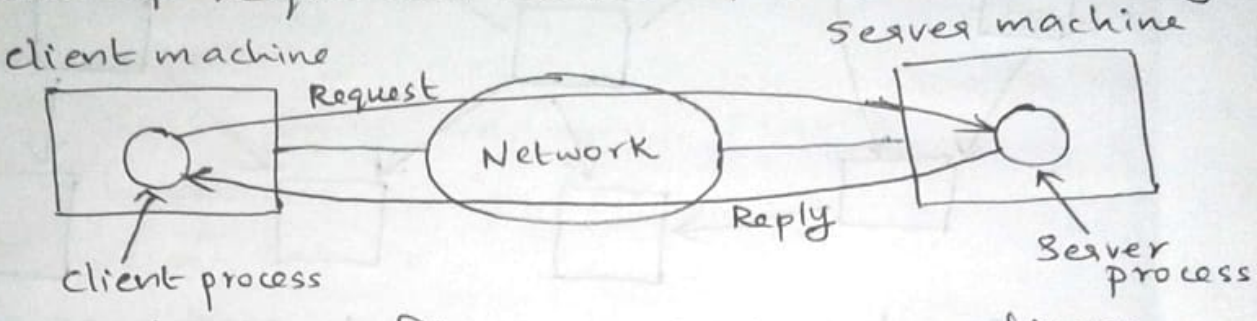
Communication takes the form of the client process sending a message over the network to the server process. Client process then waits for reply message. When the server process gets the request, it performs the requested work or looks up requested data & send back reply.



* provide powerful communication medium among employees (e-mail, videoconferencing, ...)
* Doing business electronically with other companies, especially suppliers & customers. Manufacturers can place orders electronically as needed.
* Doing business with consumers over Internet (e-commerce).

2. Home Applications.

* Access to remote information
  - Surfing the World Wide Web for information
  - Online newspapers
  - Online digital library
* Person to person Communication
  - E-mail
  - Instant messaging
  - World wide news groups

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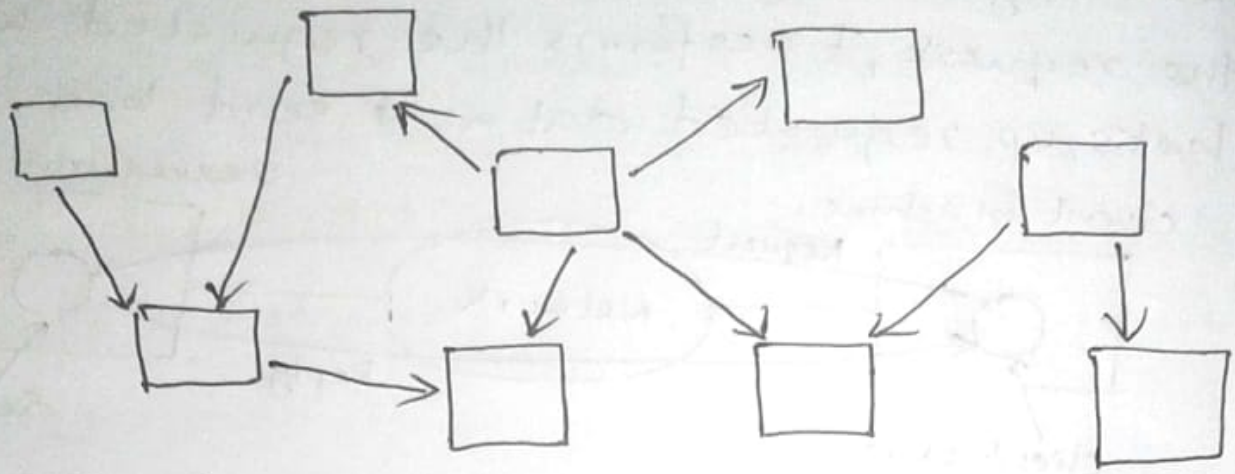
- peer to peer communication

Individuals form loose groups & communicate with others in the group. There is no fixed division into clients and servers.



e-mail is inherently peer-to-peer.

- Using internet to carry telephone calls, video phone and internet radio
- telelearning

* Interactive entertainment
  - game playing

* electronic commerce. (Selling & buying goods over net)
  - access to financial institutions
  - electronic flea markets (e-flea) - Online auction of second hand goods.

Ubiquitous computing - wired with security s/m that include door & window sensors.

B2C	Business-to-consumer	Ordering books online
B2B	Business-to-Business	Car manufacturer ordering tires from supplier
G2C	Government-to-Consumer	Government distributing tax forms electronically.
P2P	peer-to-peer	file sharing.

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C2C	Consumer-to-Consumer	E-flea

3. Mobile Users
- portable office
- wireless hotspots
- military
- mobile commerce
- GPS
- sms (short messaging service)
- Wearable Computers

4. Social issues
- people's privacy

Small files called cookies that web browsers store on user's Computers allow Companies to track users' activities in Cyberspace.

- Identity theft

Thieves collect enough information about victim to obtain get credit cards & other documents in victim's name.

Captcha, end-to-end encryption and authentication of messages can be used to solve these problems to an extend.

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Network hardware

Two types of transmission technology ⇒

1. Broadcast links.
2. Point-to-point links.

Broadcast networks have single communication channel that is shared by all machines on network. Packets (short messages) sent by any machine

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are received by all the others. Address field within the packet specifies intended recipient. Upon receiving machine checks address field. If the packet is intended for receiving machine it process the packet else ignore it.

Broadcasting – Possibility of addressing packet to all destinations by using special code in address field. It is received & processed by every machine on n/w.

Multicasting – Source node wants to send message to some subset of other nodes, but not all of them.

An example of broadcast link is wireless n/w WIFI

Point-to-point n/w consist of many connections b/w individual pairs of machines. To go from source to destination, packet have to visit one or more intermediate machines.

Smaller, geographically localized networks tend to use broadcasting whereas larger networks usually are point to point.

Unicasting - point-to-point transmission with one sender and one receiver.

Classification of n/w based on their scale ⇒

Distance	located in same	Example
1m	Square meter	PAN

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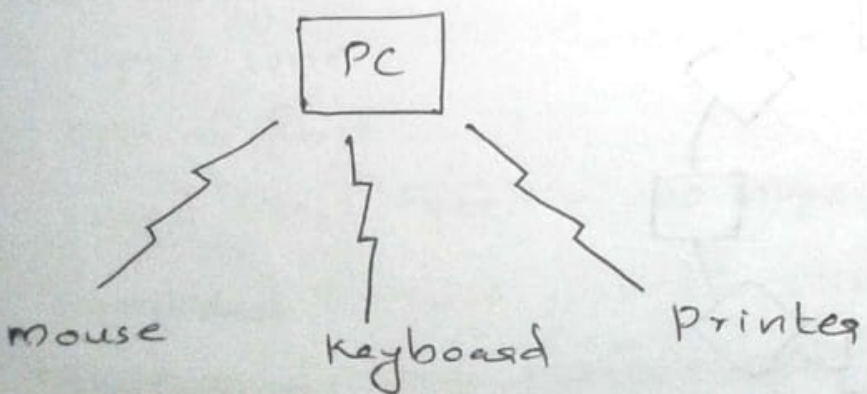
10m	Room	LAN
100m	Building	
1Km	Campus	
10Km	City	MAN
100 Km	Country	WAN
1000 Km	Continent	
10,000 Km	Planet	Internet

Personal Area Network (PAN)

* Networks that are meant for one person.
* e.g: Wireless network Connecting Computer with it's peripherals, like Bluetooth.
* Use master slave paradigm.
* PC is the master, talking to mouse, keyboard etc. as slaves. Master tells slaves what address to use, when they can broadcast, how long they can transmit, what frequencies they can use and so on.



Local Area Network (LAN)

* privately-owned networks within single building. They are widely used to connect PC & workstations

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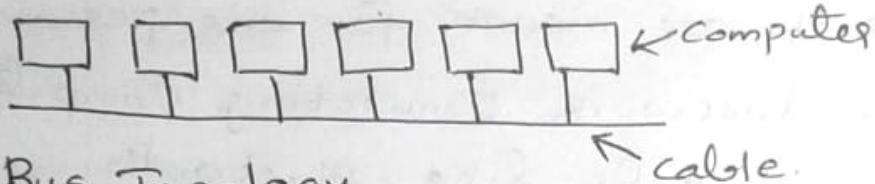
in Company offices & factories to share resources and exchange information

LANs are distinguished from other kinds of networks by three characteristics

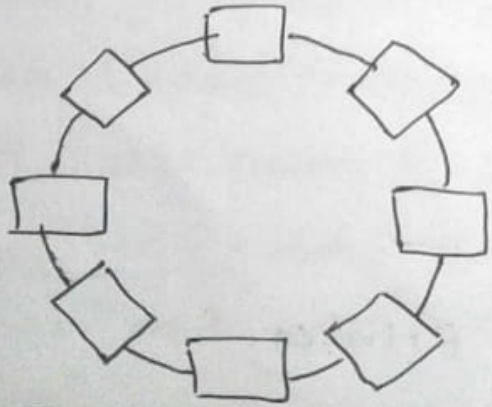
1. Size 2. Transmission technology 3. topology.

* LANs are restricted in size. This simplifies network management
* Also called enterprises network
* Two broadcast networks – Bus and Ring.



Bus Topology

* atmost one machine is master & is allowed to transmit. others are required to refrain from sending. Arbitration mechanism is needed to resolve conflicts when 2 or more machines want to transmit simultaneously.
* e.g: Ethernet



Ring Topology

* each bit propogates around on its own, not waiting for the rest of packet to which it belongs

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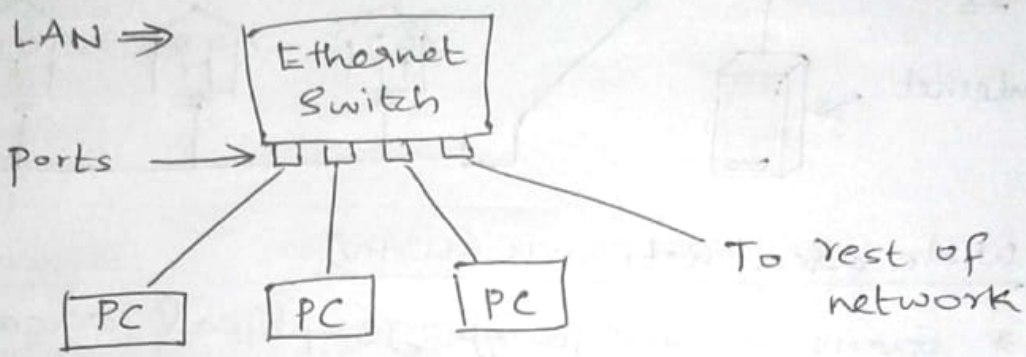
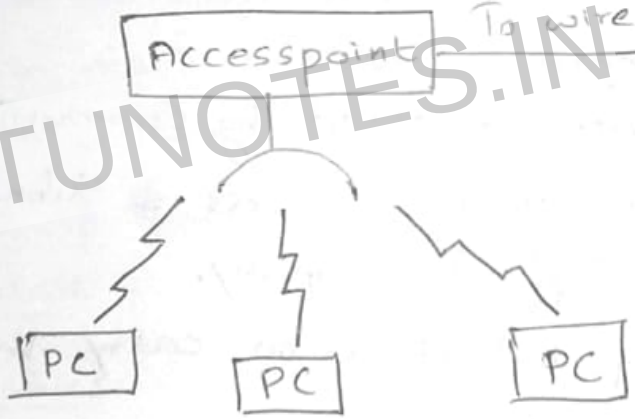
* e.g: FDDI

1. Networked device have to be easy to install
2. Network & device have to be foolproof in operation
3. low price is essential for success
4. Security & reliability

wired LAN ⇒



Wireless LAN ⇒



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Transmission Technology ⇒

- Copper wire
- optical fibre
- Wired LAN's Speed - 100 Mbps - 1 Mbps
- Compared to WIFI, Wired LAN exceed in all dimensions of performance.

Metropolitan Area Network (MAN)

* Covers a city
* e.g: cable television n/w

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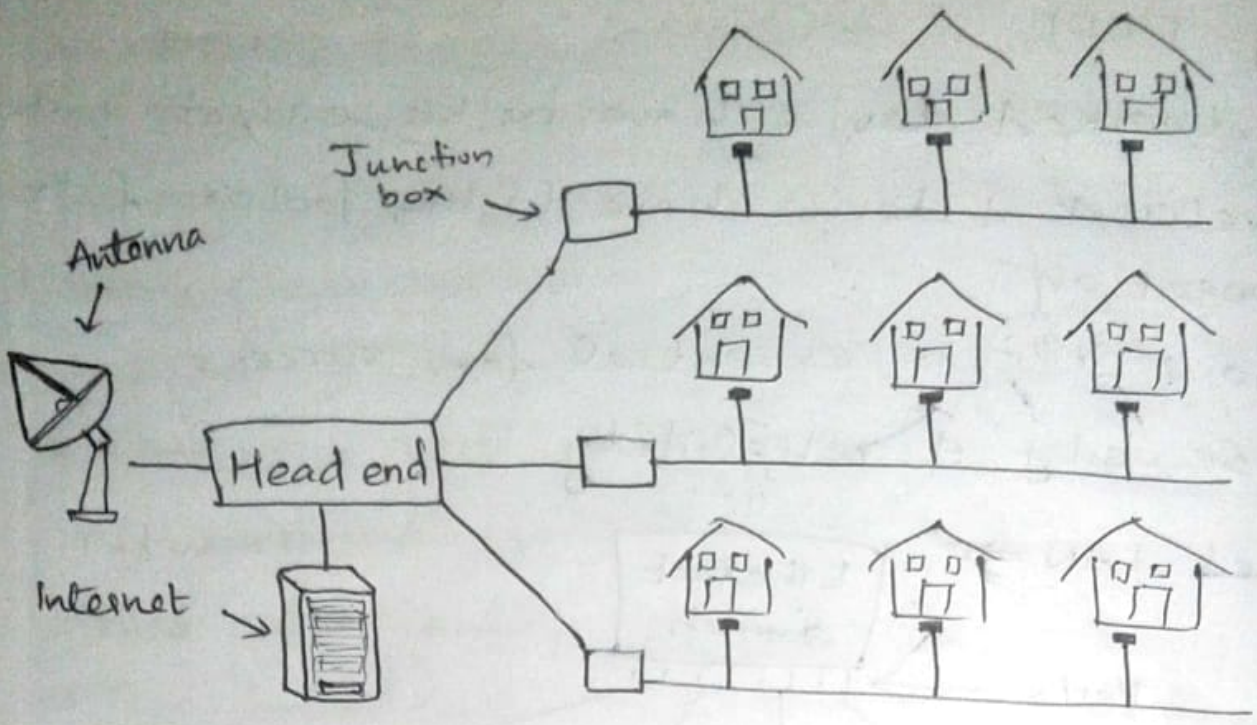

Wide area network (WAN)

* Spans a large geographical area.
* Collection of machines intended for running user programs - hosts
* hosts are connected by communication subnet.
* hosts are owned by users & subnet is owned by ISP or telephone company.
* Job of subnet is to carry messages from host to host.
* In most WAN, subnet consist of 2 componen

① transmission lines : They move bits b/w machine
② switching elements : specialized computers that connect three or more transmission lines. ie routers.

Thus subnet is the collection of routes & communication lines that moved packets from the source host to destination host.

* e.g: offices with different branches

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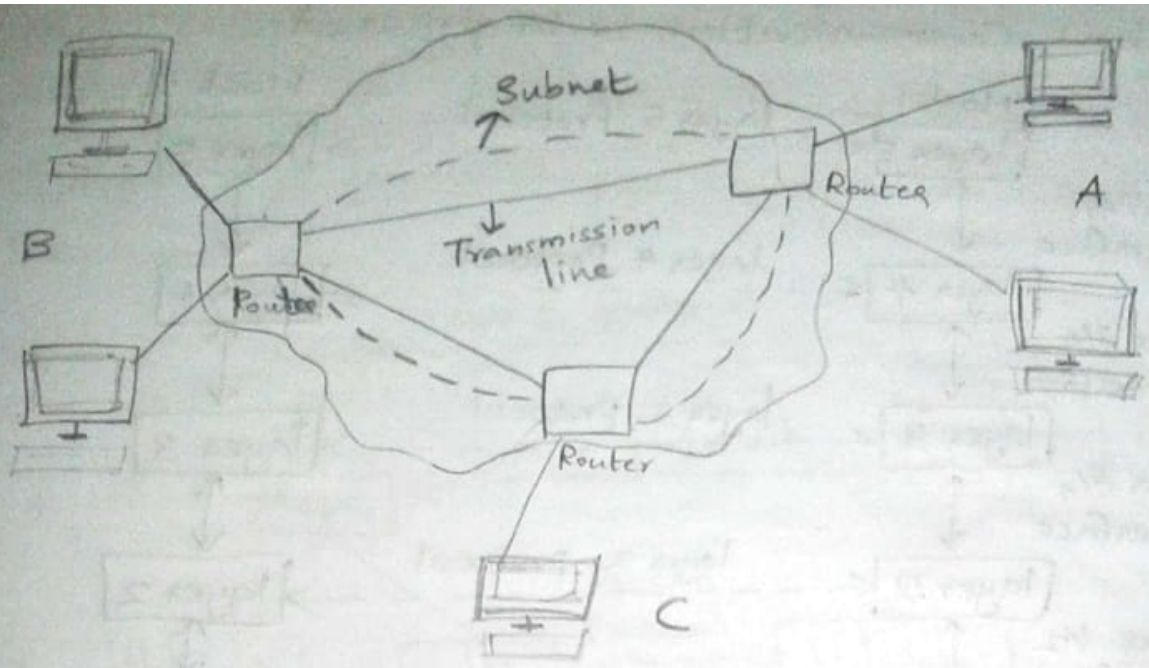

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Internetworks

* Collection of interconnected networks is called an internetwork or internet.
* Gateways are machines that make connection b/w two or more n/w and provide necessary translation both in terms of hardware & Software.

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Network Software

Protocol Hierarchies

To reduce design Complexity, most networks are designed as stack of layers or levels. The purpose of each layer is to offer Certain services to the higher layers while shielding those layers from the details of how the offered services are actually implemented. This concept is known as information hiding.

Protocol is an agreement b/w communicating parties

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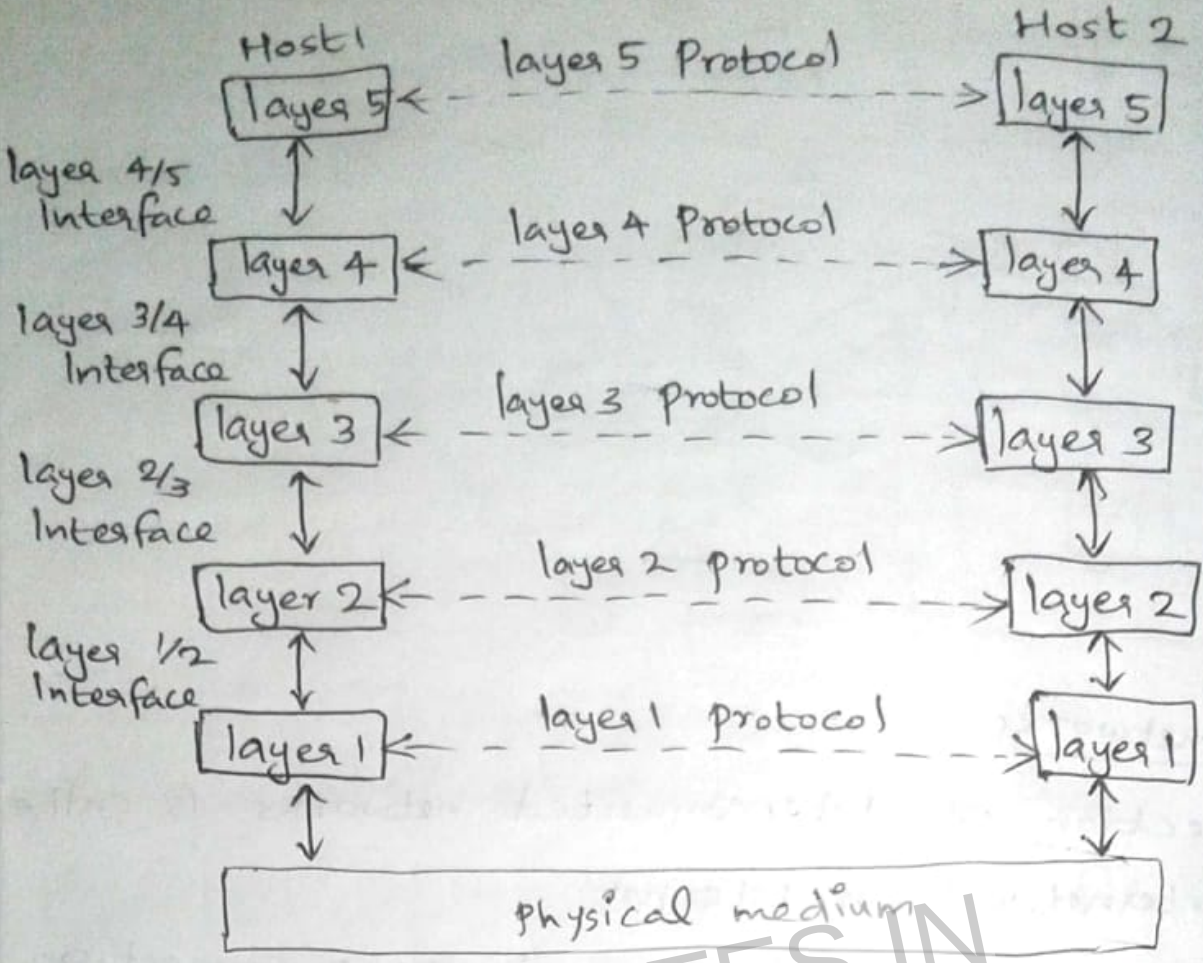
on how Communication is to proceed.



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Peers ⇒

* Entities Comprising the corresponding layers on different machines
* peers may be processes, hardware devices or human beings.
* peers communicate by using the protocol.
* No data are directly transferred from layer n on host 1 to layer n on host 2. Instead actual communication occurs through physical medium.

Between each pair of adjacent layers is interface. Interface defines which primitive operations & servies the lower layer makes available to upper one.

A set of layers and protocols is called network

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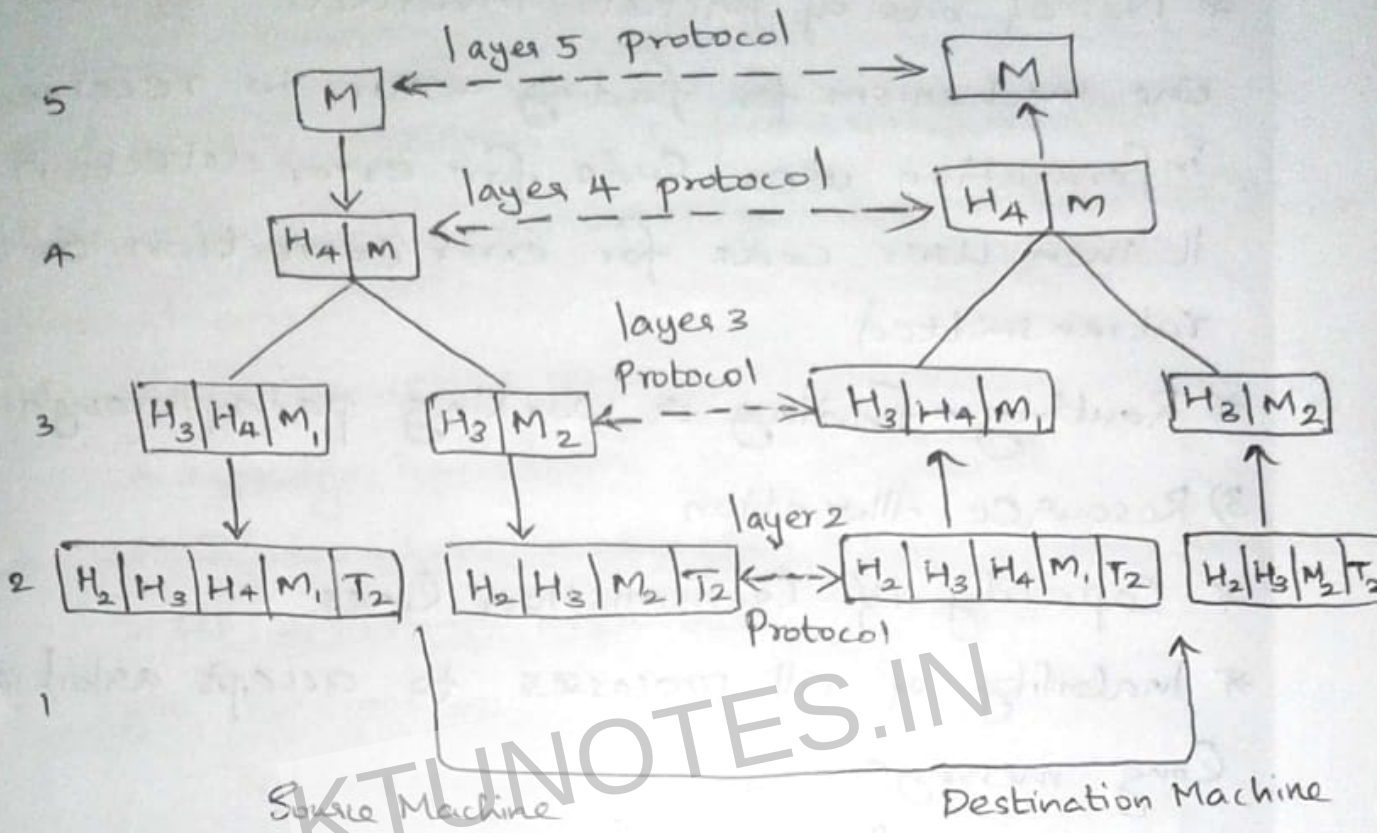
architecture.

protocol stack - list of protocols used by a certain system one protocol per layer is called protocol stack.



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Design issues for the layers

1) Evolution of network

* Each layer need a mechanism for identifying senders and receivers

* Protocol must determine how many logic channels the connection corresponds to and what their priorities are.

* Not all communication channel preserve the order of messages sent on them.

* To setup seperate connection for each pair of communicating processes

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* Mechanisms for disassembling (multiplexing, demultiplexing.

2) Reliability

* No. of bits of packets invested.

One mechanism for finding errors in received information uses code for error detection. It then uses code for error correction or is retransmitted

* Routing - finding a working path through n/w

3) Resource Allocation

* Capacity of transmission lines
* Inability of all processes to accept arbitrarily long messages.
* Statistical multiplexing - sharing based on statistics of demand.
* How to keep fast senders from swamping slow receivers with data - flow control.

Connection oriented & Connectionless Services.

Connection oriented services ⇒

* modeled after telephone s/m.
* service user first establishes connection, uses the connection and then release the connection.
* Act like a pipe.
  - Sender pushes bits at one end
  - Receiver takes them out at other end.

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* In some cases when connection is established, sender, receiver & subnet conduct a negotiation about parameters to be used, such as maximum message size, quality of service required & other issues.

* A typical example is file transfer.

* Reliable Connection oriented service has 2 minor variations:

1) Message sequence ⇒
   - Message boundaries are preserved.
   - 2 1024 byte messages are sent. They arrive as 2 distinct 1024 byte messages.

2) byte streams ⇒
   - No message boundaries
   - When one 2048 byte message arrives at receiver, it could be send as one 2048 byte or 2 1024 byte messages
   - Not reliable.

Connectionless services ⇒

* modeled after postal s/m.
* Each message carries full destination address & each one is routed through s/m independent of all the others. When 2 messages are sent to same destination first one arrives first. It can also be delayed so that second one arrives first.

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* Each service can be characterized by quality service. Some services are reliable. They never lose data.
* Receiver acknowledge receipt of each message. So the sender is sure, it is arrived. But it introduces overhead & delays
* Unreliable connectionless service is often called datagram servie (does not acknowledge)

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Service primitives

Service is formally specified by set of primitives (operations) available to user process to access the Service. Primitives tell the service to perform some action or report on an action taken by peer entity

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Primitive	Meaning
LISTEN	Block waiting for incoming Connection
CONNECT	Establish connection with waiting peer.
ACCEPT	Accept incoming Connection from peer
RECEIVE	Block waiting for incoming message
SEND	Send a message to peer
DISCONNECT	Terminate a connection.

First server executes LISTEN to indicate it is prepared to accept incoming connections. Then server process is blocked until a request for Connection appears. Next Client process executes CONNECT. client process is

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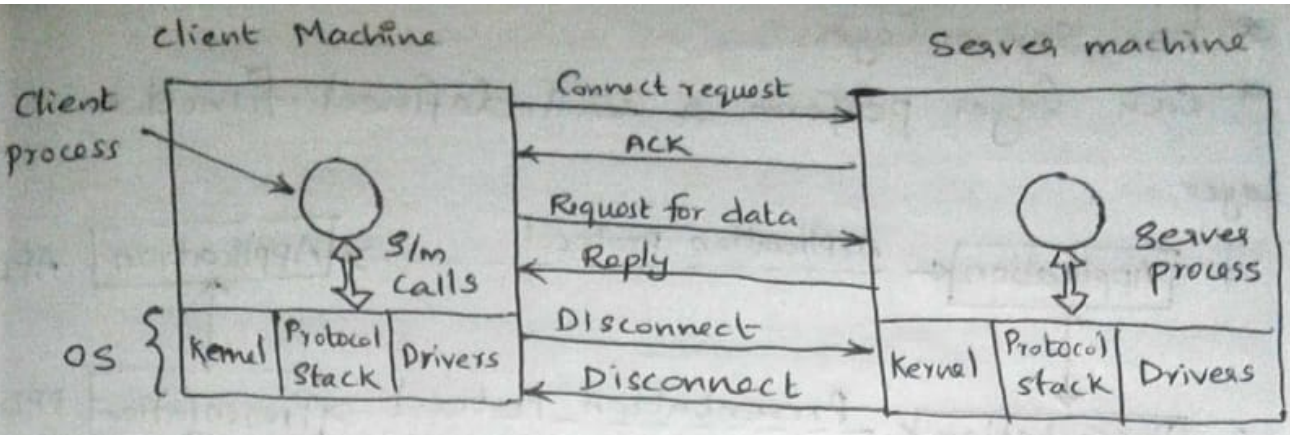

suspended until there is a response. when packet arrives at server it is processed by OS. When the s/m sees the packet is requesting a connection, it checks to see if there is a listener. If so it unblocks the listener & send back an acknowledgement. The arrival of this acknowledgement then releases the client. At this point connection is established. Server execute RECEIVE to accept first request. The RECEIVE call blocks the server. Then client executes SEND to transmit its request. followed by execution of RECEIVE to get the reply. Arrival of request packet at server unblocks the server to process the request. It then uses SEND to return answer to client which unblocks the client. After work is done it can use disconnect to terminate the connection.

Reference Models

1) OSI Reference Model
2) TCP/IP reference Model

OSI Reference Model

The model is called ISO OSI (Open Systems Interconnection) Reference model because it deals with Connecting open s/m

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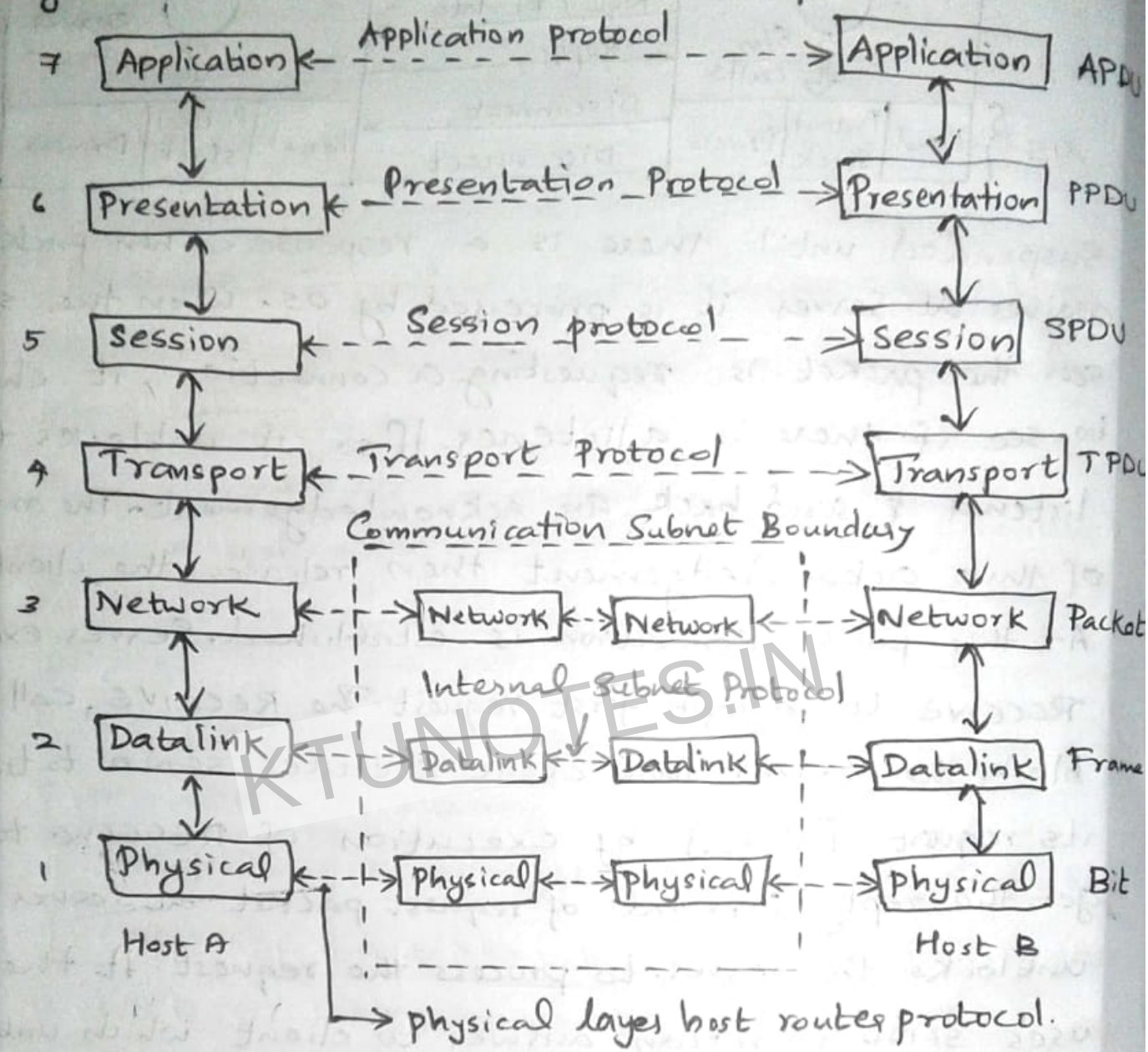
* has seven layers.
* Each layer perform a well defined function.



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Physical layer

* Concerned with transmitting raw bits over Communication Channel
* Design issues are
  - whether the bit is received in inverted form or not
  - how many volts are used to represent bit 1 and 0.
  - how many nanosecond a bit last
  - how many pins connector has & what each pin is used for

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- whether transmission proceed simultaneously in both directions.

Data link layer

* Transform raw transmission facility into a line tha appears free of undetected transmission errors to the network layer
* Sender breakup data into data frames & transmi the frames sequentially.
* If service is reliable, receiver confirms correct receipt of each frame by sending back acknowledge- ment frame.
* Design issue - how to keep a fast transmitter from drowning a slow receiver in data
Broadcast networks have an additional issue - how to control access to shared channel.

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Network layer

* Control operation of Subnet
* Design issue - how packets are routed from sourc to destination, quality of service provided, Controlling Congestion caused due to too many Packets, overcome the problems to allow hetero- geneous network to be interconnected.

Transport layer

* accept data from above, split it up into smaller units & pass these to network layer.
* Determines what type of service to provide to the session layer & to users of network

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* True end-to-end layer

Session layer

* Allow users on different machines to establish sessions between them.
* Services offered are dialog control (Keeping track of whose turn it is to transmit), token management (preventing 2 parties from attempting the same critical operation at the same time) and synchronization

Presentation layer

* Concerned with syntax and semantics of information transmitted.

Application Layer

* Contain variety of protocols that are commonly needed by users
* One widely used is HTTP (HyperText transfer Protocol) which is the basis for World Wide Web.

TCP/IP Reference Model

* Used in ARPANET, worldwide Internet.
* ARPANET - Research network sponsored by the DoD (U.S. Department of Defense)
  It eventually connected hundreds of universities & government installations, using leased telephone lines.
* This model has the ability to connect multiple n/w in a seamless way

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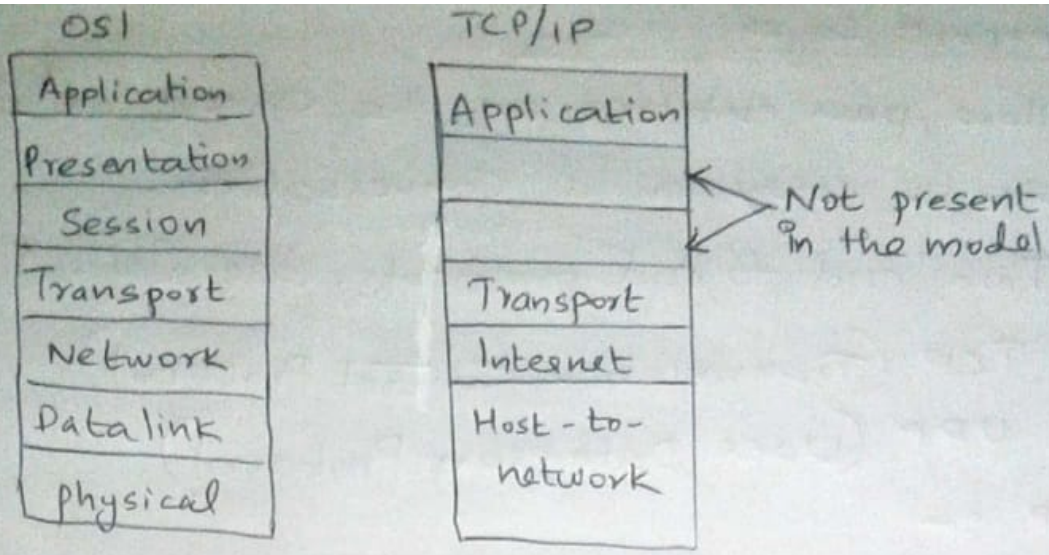

(Host-to-Network) Link Layer

* Protocol is used to connect host to n/w so that packets can be sent over it.
* Interface b/w host & transmission link
* Concerned with what links must do to meet the needs of the Connectionless Internet layer.

Internet Layer

* holds whole architecture together.
* permit hosts to inject packets into any network and have them travel independently to destination
* They may arrive in different order than they were sent. In such a case it is the job of higher layer to rearrange them, if in-order delivery is desired
* It defines an official packet format & protocol called IP (Internet Protocol).

Main functions are

- Delivering IP packets
- Performing routing
- Avoiding Congestion.

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Transport Layer

* Allow peer entities on the source and destination hosts to carry on a conversation.
* Two end to end protocols are defined here
  - TCP (Transmission Control Protocol)
  - UDP (User Datagram Protocol)

TCP :-

* Reliable connection oriented
* Allow byte stream originating on one machine to be delivered without error on any other machine in the internet.
* fragments incoming byte stream into discrete messages & passes each one on to internet layer.
* At destination receiving TCP process reassembles the received messages into o/p stream.
* handles flow control.

UDP :-

* Unreliable connectionless protocol that don't want TCP's sequencing or flow control & wish to provide their own.

Application layer

* Contains all higher level protocols.
* These include
  - Virtual terminal (TELNET)
  - File Transfer (FTP)
  - Electronic mail (SMTP)
  - Domain Name System (DNS)

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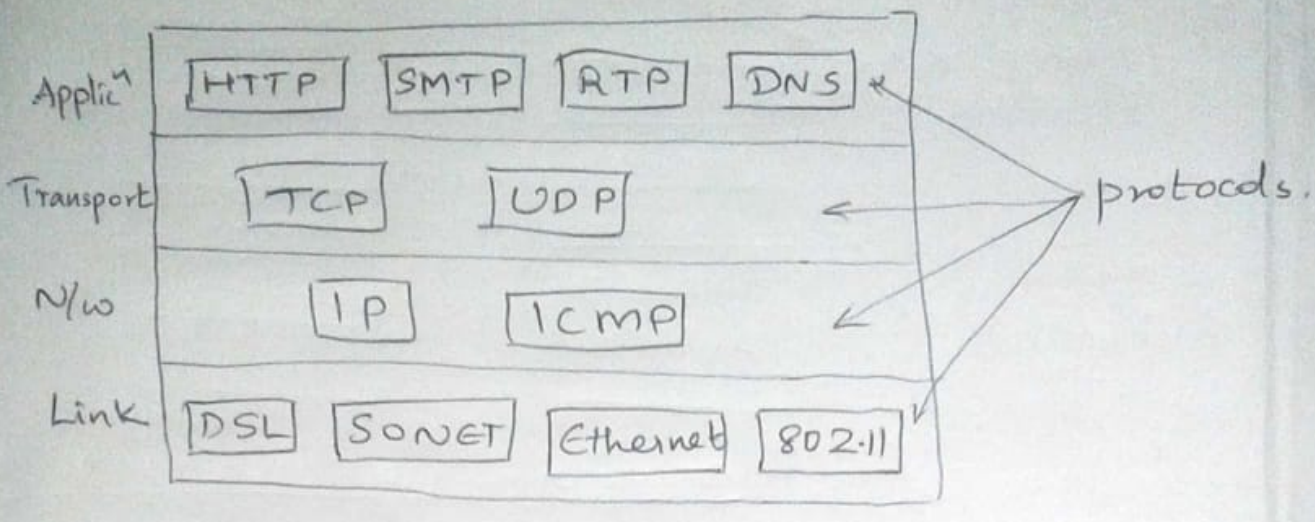
- HTTP
- RTP (Real time protocol)



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