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Department of Computer Science and Engineering
Data Science

22

Semester: V

Subject: Computer Network

Academic Year: 2023 - 2024

Main functions are

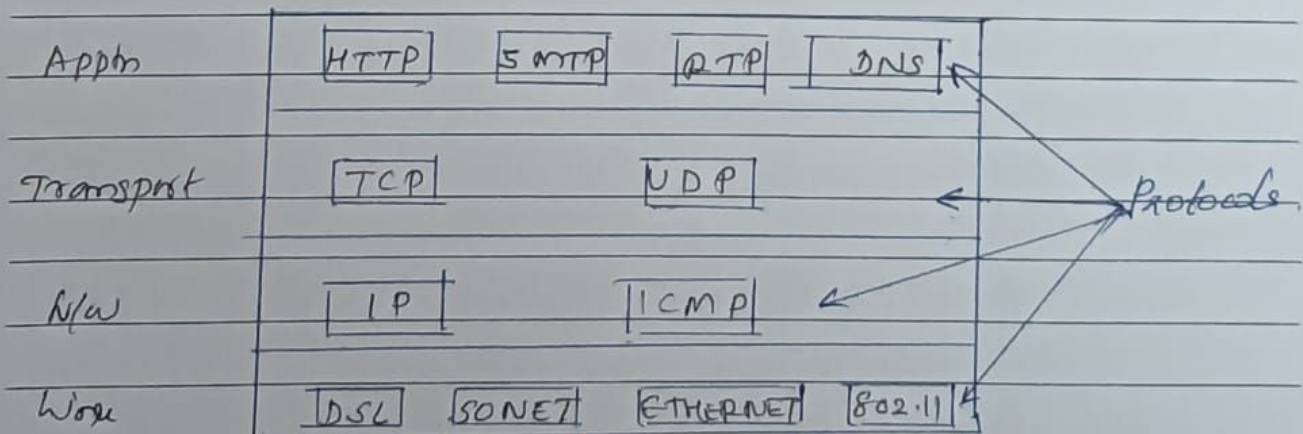
- Delivering IP packets
- Performing routing
- Avoiding congestion

Transport layer

- Allow peer entities on the source & destination host to carry on a conversation
- Two end-to-end protocols are defined here TCP and UDP.

Application Layer:

- Contains all higher level protocols.
- These include
 - + virtual terminal (TELNET)
 - + File transfer (FTP)
 - + Electronic mail (SMTP)
 - + Domain name system (DNS)
 - + HTTP
 - + RTP (Real time protocol)



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- Used in ARPANET, was wide Internet.
- ARPANET - Research network sponsored by the DoD (U.S. Dept of defence)
 - It eventually connected hundreds of universities & government installations using leased telephone line.
- This model has the ability to connect multiple n/w in a seamless way.
- (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 & 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 re-general re-arrange them, if in-order delivery is desired.
 - It defines an official packet format & protocol called IP (Internet protocols).



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Transport Layer

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

Presentation Layer

- concerned with syntax & semantics of information transmitted

Application Layer

- contains variety of protocols that are commonly needed by users
- one widely used is HTTP which is the basis for world wide web.

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- + how many nanoseconds a bit last
- x how many pin connector has & what pin is used for
- x whether transmission proceed simultaneously in both directions.

Data link layer

- Transform raw transmission facility into a line that appears free of undetected transmission errors to the network layer.
- Sender breakup data into data frames & transmitting the frames sequentially.
- If the service is reliable, receiver confirms correct receipt of each frame by sending back acknowledgement frame.
- Design issues - 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.

Network layer

- control operation of subnet
- Design issue - how packets are routed from source to destination, quality of service provided, controlling congestion caused due to too many packets, overcome the problems to allow heterogeneous n/w to be interconnected.



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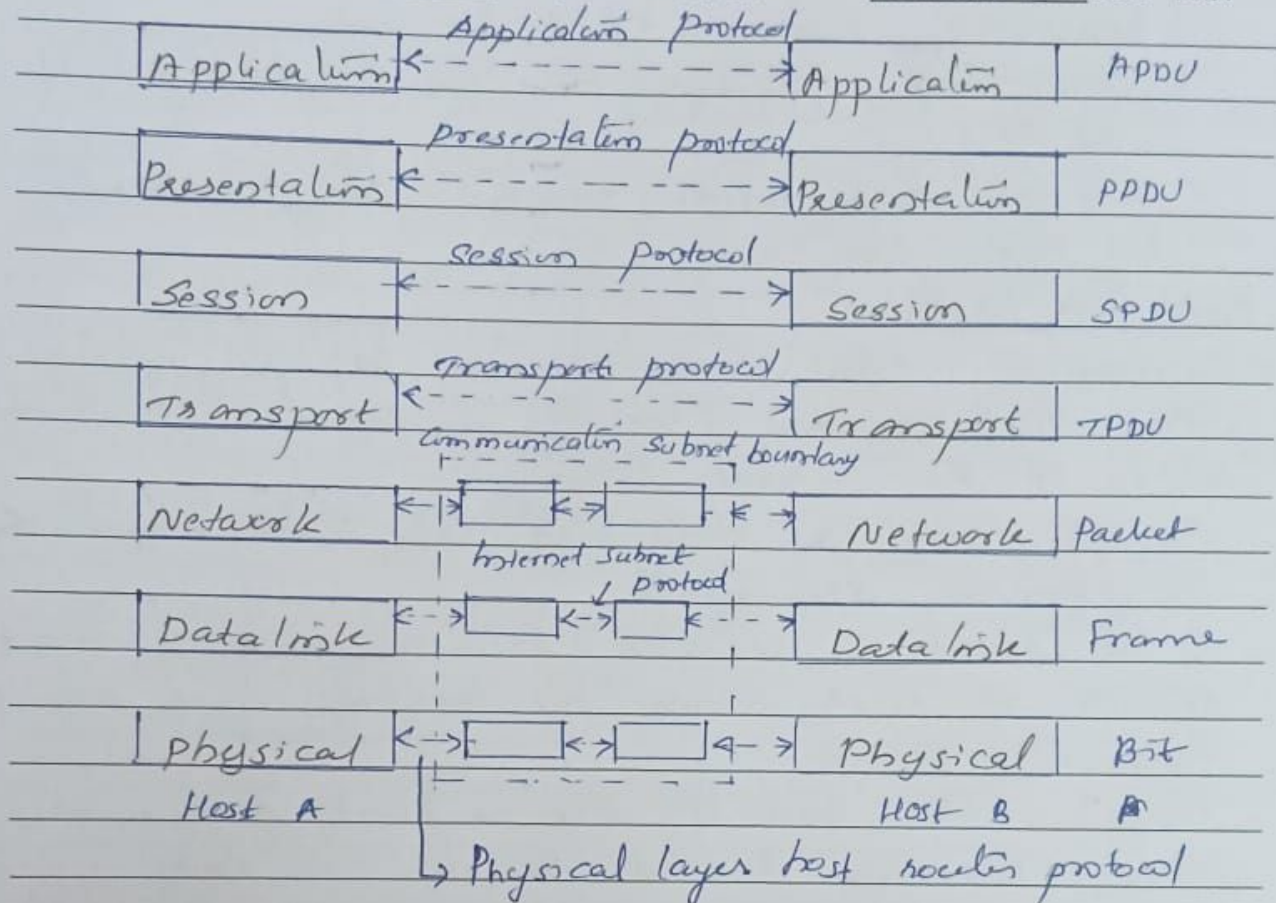
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Physical Layer

- 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.



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Service primitives

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

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 connection

Reference models:

- 1) OSI Reference model
- 2) TCP/IP Reference model

OSI Reference model

- It has 7 layers.
- Each layer performs a well function defined function.

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- when one 2048 byte message arrives at receiver, it could be sent as one 2048 byte or 2 1024 byte messages.
- not reliable.

Connectionless services

- * modeled after postal system.
- * Each message carries full destination address each one is routed through system 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.
- * Each service can be characterized by quality service. Some services are reliable. They never lose data.
- * Receiver acknowledge receipt of each message so that the sender is sure, it is arrived. But it introduces overhead & delays.
- * Unreliable connectionless services is often called datagram service (Does not acknowledge)

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long messages.

- * Statistical multiplexing - sharing based on statistics of demand.

Connection oriented & connectionless services.

- * Connection oriented services \Rightarrow

modeled after telephone sys.

- 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.

- * In some cases when connection is established, sender, receiver & subnet conduct a negotiation about parameters to be ~~ensured~~ 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 \Rightarrow

- message boundaries are preserved

- 2 1024 byte messages are sent. They arrive as 2 distinct 1024 byte messages.

2) byte streams \Rightarrow

- no message boundaries.



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Design Issues for the layers.

1) Evolution of network.

- Each layer need a mechanism for identifying senders & 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 separate connections for each pair of communicating processes
- Mechanisms for disassembling (multiplexing, demultiplexing)

2) Reliability:

- No. of bits of packets inverted.
- One mechanism for finding errors in received information uses code for error detection. It then uses code for error correction or retransmission.
- Routing - Finding a working path through n/w.

3) Resource Allocation.

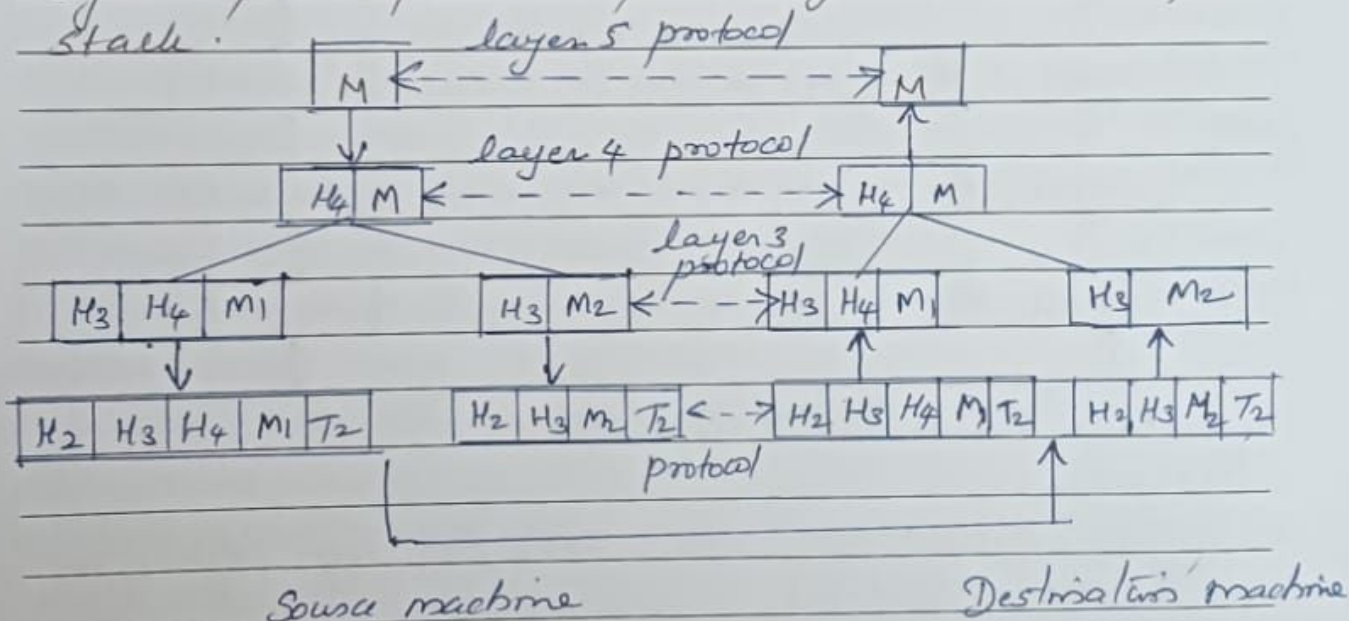
- Capacity of transmission lines
- Ability of all processes to accept arbitrarily



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- * 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 & services the lower layer makes available to upper one.
- A set of layers & protocols is called network architecture.

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





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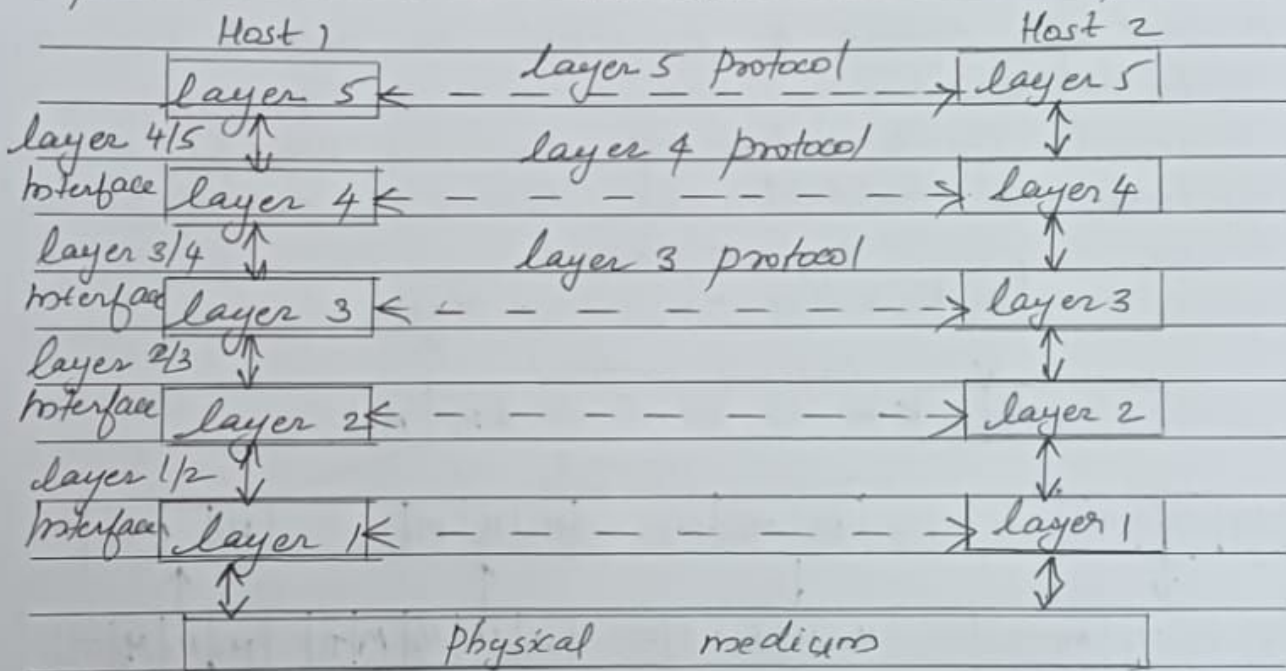
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purpose of each layer is to offer certain services to the higher layers while shielding those layers from the details of how the offered services are actually implemented. This concept is known as information hiding.

Protocol is an agreement between communicating parties on how communication is to proceed.



Peers =>

- Entities comprising the corresponding layers on different machines.
- Peers may be processes, hardware devices or human beings.



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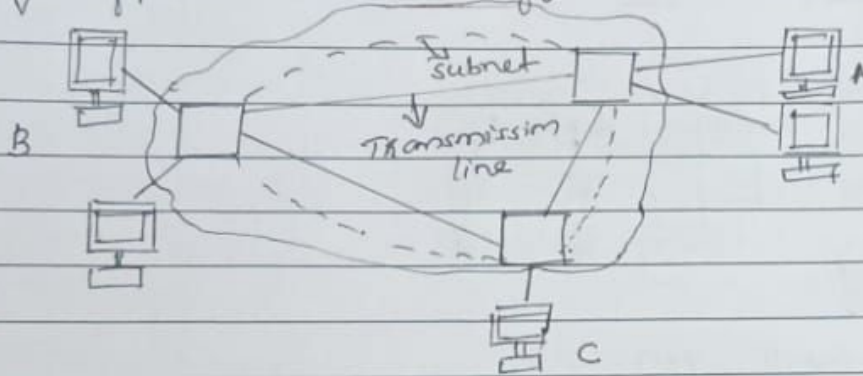
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Connect three or more transmission lines i.e., routers.

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

eg: Offices with different branches



Internetworks.

- collection of interconnected networks is called an internetwork or internet.
- Gateways are machines that make connection between two or more n/w and provided necessary translation both in terms of hardware & software.

Network software

Protocol hierarchies

To reduce design complexity, most networks are designed as stack of layers or levels. The



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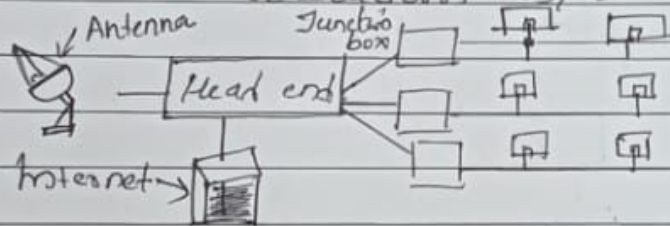
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Transmission Technology \Rightarrow

- copper wire
- Optical fibre
- wired LAN's speed - 100 mbps - 1 mbps
- compared to WIFI, wired LAN exceed in all dimensions of performs.

Metropolitan Area Network (MAN)

- covers a city
- eg: cable television or/and



Wide Area Network (WAN)

- spans a large geographical area
- collection of machines intended for running user programs - hosts.
- hosts are connected by communication subnets.
- 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 consists of 2 components.
 - 1) transmission lines: they move bits b/w machine.
 - 2) switching elements: specialized computers that



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conflicts when 2 or more machines want to transmit simultaneously.

Eg: Ethernet



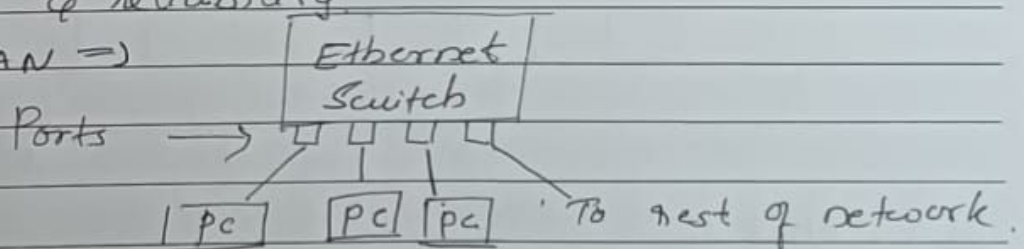
Ring Topology.

- Each bit propagates around on its own, not waiting for the rest of packet to which it belongs

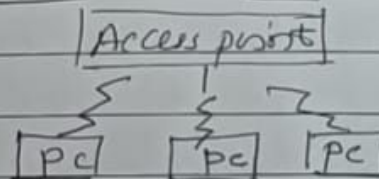
Eg: FDDI

1. Networked device have to be easy to install
2. Network Procedure have to be fool proof in operation
3. Low price is essential for success
4. security & reliability.

Wired LAN =>



Wireless LAN =>





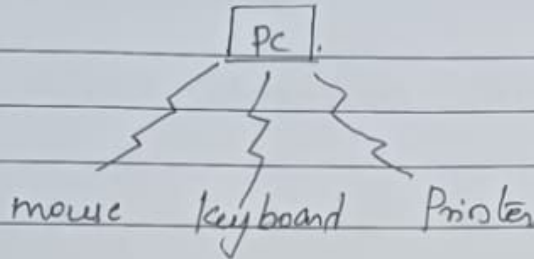
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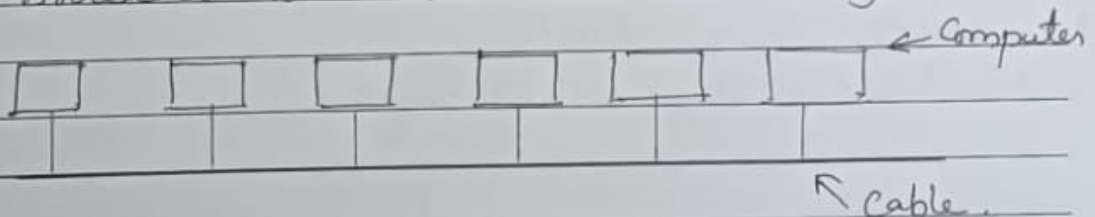
Local Area Network (LAN):

- Privately-owned networks within single building. They are widely used to connect PC & workstation in company offices & factories to share resources and exchange information.

LANs are distinguished from other kinds of net by three characteristics.

1. Size 2. Transmission technology 3. Topology.

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



Bus Topology.

- * At most one machine is master & is allowed to transmit. Others are required to refrain from sending. Arbitration mechanism is needed to resolve



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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
10m	Room	}
100m	Building	
1km	campus	
10km	city	MAN
100km	country	}
1000km	continent	
10,000km	planet	Internet

Personal area Network (PAN)

- Networks that are meant for one person
- eg: wireless network connecting computer with its peripheral 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.



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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 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 processes 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. While 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



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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
C2C	Consumer-to-consumer	E-grocery

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.



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* Person to person communication

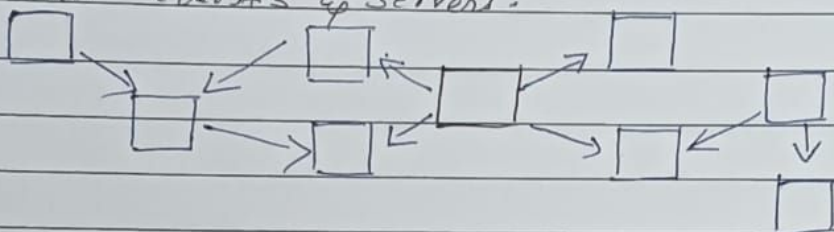
- e-mail

- instant messaging

- work wide news groups

- peer-to-peer communication

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



e-mail is inherently peer-to-peer.

- Using internet to carry telephone calls, video phone & internet radio.

- tele learning.

* 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 stars that include door & window sensors.

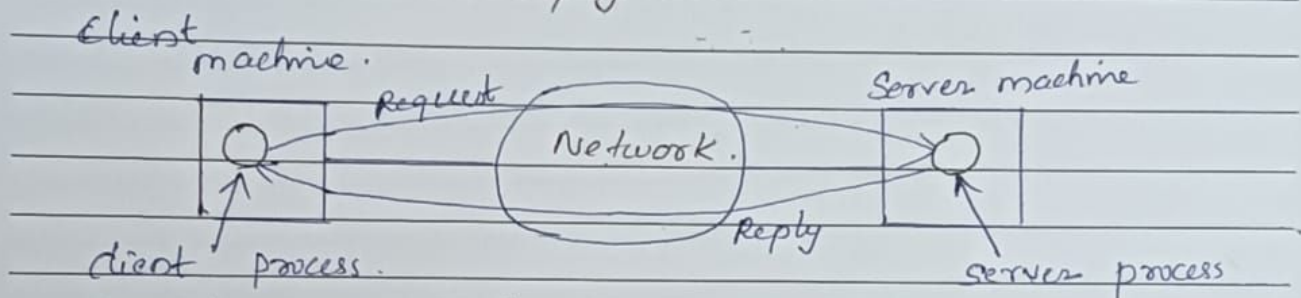


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Communication takes the form of the client process sending a message over the network to the server process. Client process then waits for reply message. When the server process gets the request, it performs the requested work or looks up requested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



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

2. Home Applications :

* Access to remote information

- Browsing the world wide web for information
- online newspapers
- online digital library.



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wide web.

In a computer network, this coherence model & software are absent. Users are exposed to actual machines, if the machines have different hardware & different operating system i.e., fully visible to users. If a user wants to run a program on a remote machine, he has to log onto that machine & run it there.

Thus distributed sys is a software system built on top of a network.

Uses:

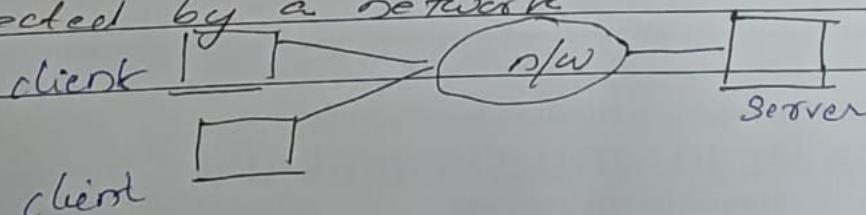
1. Business Applications

• Resource & Information sharing.

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

Client Server model \Rightarrow

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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Module-I.

Computer Networks - A computer network or data network, is a digital telecommunications network which allows nodes to share resources. In computer networks, networked computing devices exchange data with each other using data links.

The connections between 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
- E-mail.

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

In distributed, a collection of independent computers appears to its users as a single coherent system. 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 system is world