

Unit 2: The Network Infrastructure for E-Commerce

Introduction:

- E-commerce needs a standard network infrastructure to transport the content. • Internet and intranet are the basic tools to implement e-commerce. The network infrastructure is provided by the I-way or business super highway.
- The information superhighway may be defined as a high-capacity electronic pipeline that is capable of simultaneously supporting a large number of e-commerce applications and provide interactive phone like connectivity between users and services and among users.
- The ability to translate the content (media) into digital form is fundamental to all the changes associated with the I-way.
- Digitization refers to the process by which all media video, audio, text, graphics are processed by computers: manipulated, mixed, transformed and delivered in new ways.

Information SuperHighway (I-Way):

- Electronic commerce needs a network infrastructure to transport the content-text, audio, video, graphics etc.
- The network infrastructure that provides such a data transmission facility is called I-Way or information superhighway.
- Thus, information superhighways can be defined as the high capacity, electronic and interactive pipeline to the consumer or business premise that is capable of supporting large number of e commerce applications simultaneously.
- It is called interactive because it provides two-way communication between users and service providers or between one user and another user.
- It is called a high-capacity electronic pipeline because it must provide broadband link.
- Historically, the voice and data networks have evolved separately, with voice networks relying on circuit switching and data networks using packet switching techniques.
- Thus, a business user requiring voice, data, and video conferencing services often had to use three separate networks- a voice network, a data network, and a videoconferencing network.
- I-way provides an integration solution to the shortcoming of the need to have separate network for voice, data and video services respectively.
- Nowadays information superhighway has emerged as basic network infrastructure for all e-commerce activities due to its capability of providing integrated text, graphics, audio, and video services.

Circuit Switching vs. Packet Switching

- When two nodes communicate with each other over a dedicated communication path, it is called circuit switching.
- There is a need for a pre-specified route from which data will travels and no other data is permitted.
- In circuit switching, to transfer the data, a circuit must be established so that the data transfer can take place.
- Applications which use circuit switching may have to go through three phases: Establish a circuit, Transfer the data, Disconnect the circuit.

- Circuit switching was designed for voice applications. Telephones are the best suitable example of circuit switching. Before a user can make a call, a virtual path between caller and callee is established over the network.

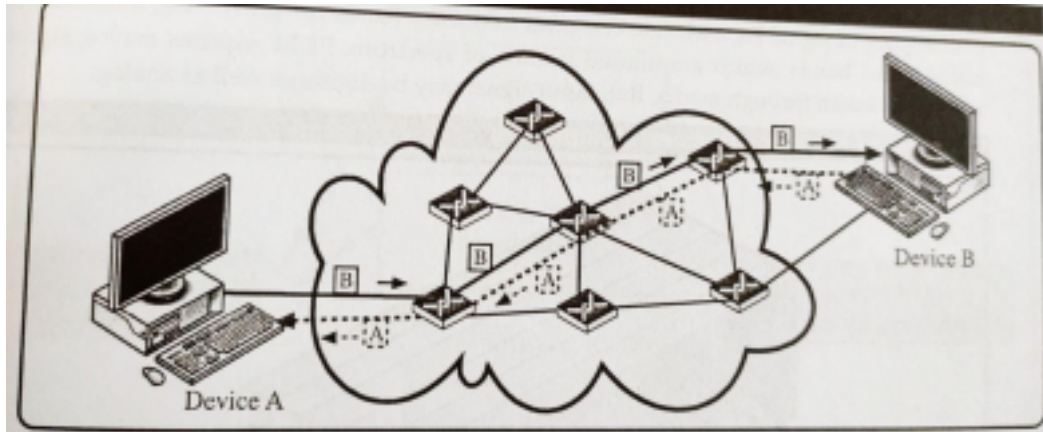


Figure: Circuit Switching

- On the other hand, in packet switching, the entire message is broken down into smaller chunks called packets.
- The switching information is added in the header of each packet and transmitted independently.
- The intermediate networking devices (switches) take the packet, store it there for a short period of time and forward it to the next node when resources are available.
- In this technique, the path between two nodes is busy only during the transmission of the packet. Once the node accepts data, the path becomes free immediately and can be used by other data packets. Thus, resource utilization is very high in packet switching networks.
- But there may be a little bit of delay in data transmission in comparison to circuit-switched networks. This is because intermediate devices need to store and forward packets.

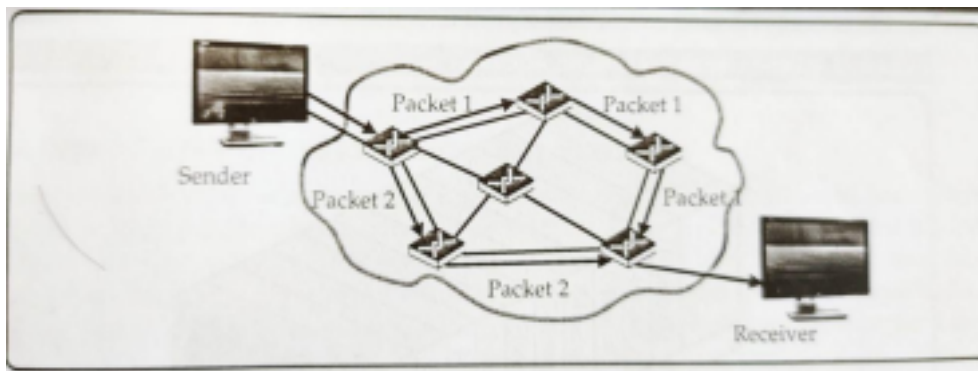


Figure: Packet Switching

Broadband Connections:

- A narrowband network is one that provides a single channel for communications across the physical medium.
- Broadband refers to the ability to stack frequencies on a single transmission medium, providing multiple channels on the same wire.
- Broadband technologies transmit multiple channels from the same carrier by multiplexing the channels.

- Most widely used multiplexing channels are frequency division multiplexing (FDM) or time division multiplexing (TDM) to transmit multiple channels from the same carrier.
- Frequency-Division Multiplexing (FDM) is a familiar and widely used form of multiplexing. It carries multiple channels on the single cable by modulating signals where each signal occupies a different carrier frequency.
- Carrier frequencies are sufficiently separated to prevent overlapping of signal bandwidths. The extra frequency bands for preventing interference are called guard bands, which are unused portions of the spectrum. FDM requires analog signaling and transmission through media. But input signals may be digital as well as analog.

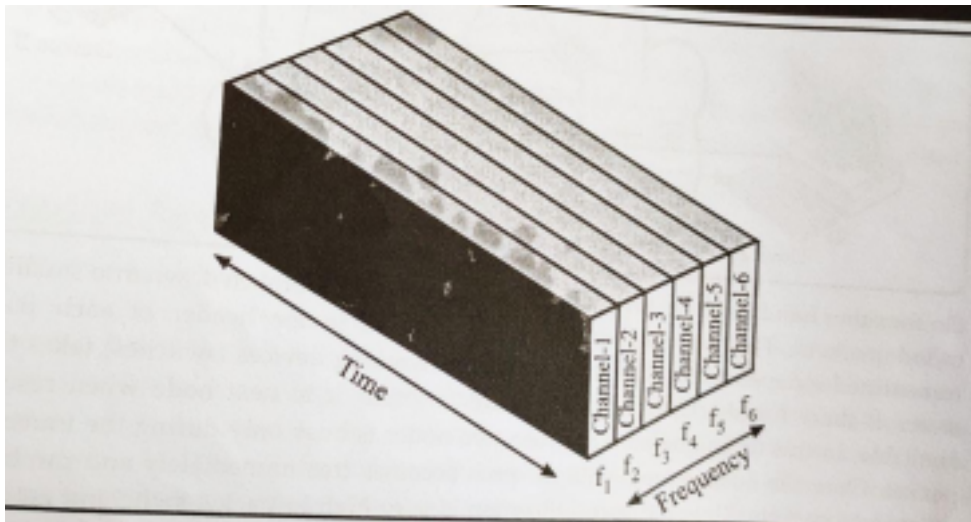


Figure: FDM

- Time-Division Multiplexing (TDM) is the division of a common transmission facility into two or more channels, one at a time. Each connection occupies a portion of time in the link.
- TDM is a method in which time slots on a shared transmission line are assigned to devices and the devices can only transmit data in the assigned time slots only.

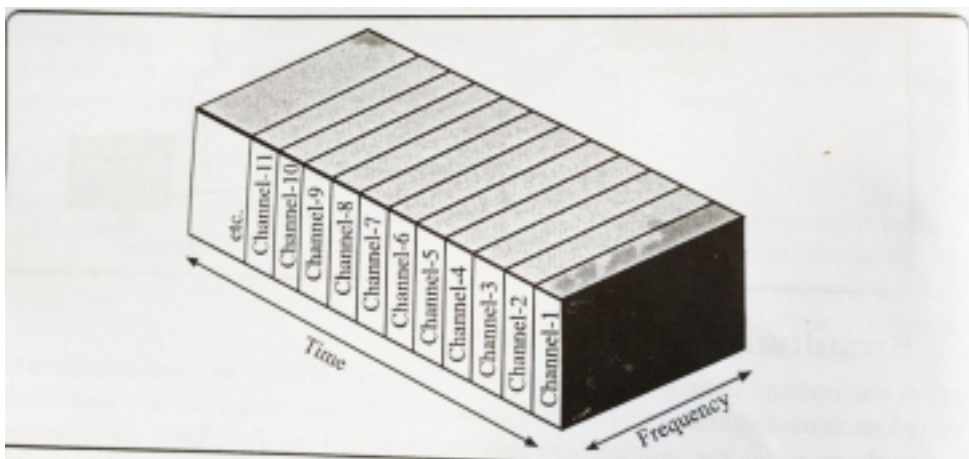


Figure: TDM

Components of the I-Way:

- Various components contained in I-way can be broadly divided into three categories: Consumer access equipment, Access Roads or Media, and Global Information distribution network.

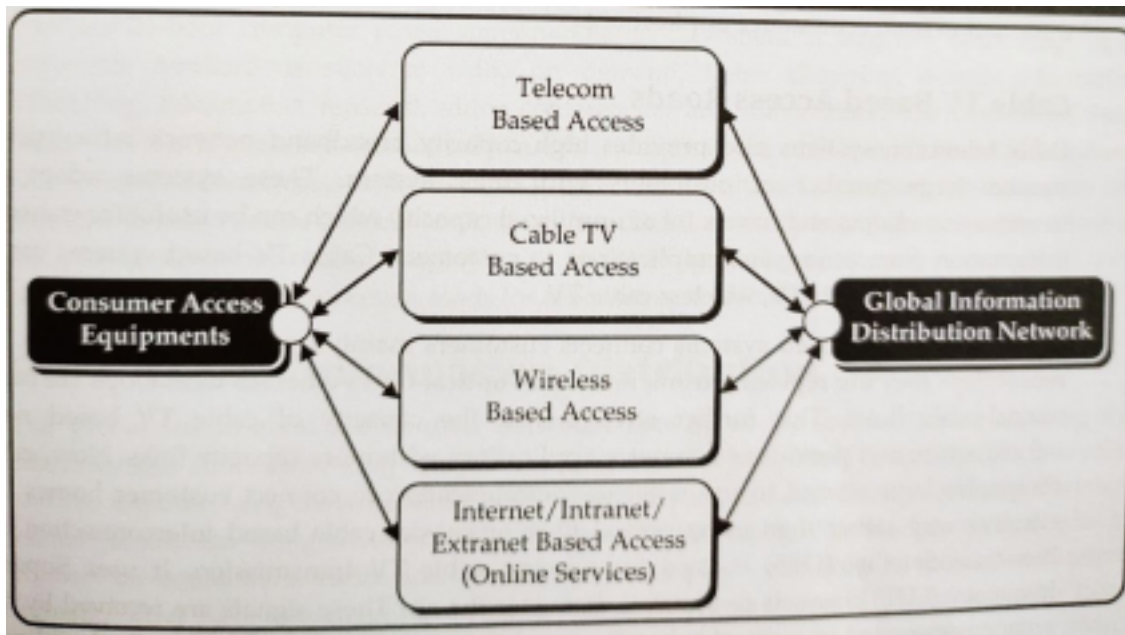


Fig:

I-Way Components

Consumer Access Equipments:

- These are the devices at the consumer end and enable consumers to access the network. It consists of hardware and software.
 - Hardware components includes devices such as computers, modems, routers, switches etc. for computer networks, set-top boxes, TV signal descramblers etc. for television networks, Cell phones etc. for cellular networks and so on.
 - And software systems installed in those hardware devices include browsers, operating systems etc.
 - The type of consumer access equipment used depends upon the communication mode used.
- These equipment are also called customer premise equipment or terminal equipment.

Access Roads/Media (Local on Ramps)

- These are the network infrastructure that provides linkage between businesses, homes, and schools to the global information distribution network. This component is often called the last mile in the telecommunication industry.
- Access road providers can be divided into four categories: Telecom based, Cable TV based, Wireless based, and Computer based online systems.
- Main function of access roads is to connect consumers with e-commerce applications.

Telecom Based Access Roads

- Telecom industries provide a high speed electronic pipeline which is capable of carrying large volumes of audio, video, and text data.
- These industries provide network infrastructure for long distance and local telephone communication.

- This network infrastructure is useful for ecommerce applications to be connected with Global Information Distribution Network.
- Main limitation of telecom-based access roads is that it continues to depend on analog transmission of data although the industry is rapidly introducing advanced digital transmission technologies.
- However, most of the trunk lines are replaced with high-capacity optical fiber in recent days, local loops are still connected by using copper wire. The customers are constrained by the limited capacity of these wires.
- Thus, the telecom industries need to replace these copper wires with high-capacity optical fiber to handle the expected flood of information from ecommerce applications.

Cable TV Based Access Roads

- Cable television systems also provide high-capacity broadband network infrastructure to connect large number of customers with their system.
- These systems adopt digital transmission of data and have a lot of unutilized capacity which can be useful for transmitting information from ecommerce applications to customers.
- Cable TV based systems can be of two types: wired cable TV, wireless cable TV.
- In wired cable TV based systems connect customers mainly by using coaxial-cables. But in recent days they are replacing trunk lines from optical fibers whereas local loops are based on coaxial cable links.
- This further strengthened the capacity of cable TV based network infrastructure and provides ecommerce applications with more capacity links.
- Now, cable TV companies have started to use wireless communication to connect customer homes in a cost effective way rather than using optical fiber or coaxial cable-based interconnection.
- Direct Broadcast Satellite (DBS) is used for wireless cable TV transmission. It uses Super high frequency (SHF) channels to transmit data over the air.
- These signals are received by special antennas mounted in roofs of subscribers and then it is distributed within the building with the help of coaxial cable.
- With the help of DBS, it is easy to make cable TV in rural areas at affordable cost.
- Thus, the emergence of wireless cable TV infrastructure makes it easy to provide ecommerce services in rural areas also.
- Although there are lots of benefits of wireless cable TV network infrastructure, it also suffers from limitations. For example, heavy rainfall may cause picture quality degradation or interruption.

Wireless Based Access Roads

- Wireless operators provide network infrastructure by using radio frequencies which are Omnidirectional waves and have high penetration power.
- The wireless-based systems have revolutionized the ways of thinking about information delivery. Technology is the most important factor.
- The rapid growth in technology has impacted the wireless industry in a number of ways:
 - Apart from the voice calls, cellular technology today has also facilitated short messaging services (SMS) using alphanumeric display and multimedia services.
 - Internet connectivity using the cellular networks has been made possible.
 - The cellular networks using the analog technology are now upgrading to digital networks to provide greater capacity at lower costs as well as increase the quality and functionality of the cellular network.

- Applications have been developed to facilitate mobile workers to exchange messages and data from their offices while on the road.
- Thus, wireless based access enables customers to access ecommerce applications from anywhere at any time and ecommerce service providers can provide content and services to customers on the basis of location.

Computer Based Online Systems

- The Internet is the global system of interconnected mainframe, personal and wireless computer networks that use the protocol suite TCP/IP to link billions of devices worldwide. • It is a network of networks that consists of millions of private, public, academic, business, and government networks of local to global scope, linked by a broad array of electronic, wireless, and optical networking technologies.
- Internet, intranets and extranets are providing online services which provide 24-hour computer based supermarkets to customers.
- It targets a wide range of ecommerce applications such as video on demand, home shopping, e-mail, information publishing, information retrieval, video conferencing and many more. • The demand of these online services has increased dramatically due to widespread use of PCs in homes and businesses.
- Due to low hardware costs and enhanced graphics and multimedia support, customers are fast attracted towards online services entertainment, education, shopping, and information services. • ISP provides Internet access, employing a range of technologies to connect users to their network and thus provides access roads for ecommerce applications,

GIDN (Global Information Distribution Network)

- The global information distribution networks consist of the infrastructure crossing the countries and continents.
- They include the long-distance telephone lines, satellite networks, and the internet. Long distance telephone connectivity is provided through cable by the interexchange carriers. • Long distance cellular networks are using the wireless technologies to connect consumers worldwide.
- Satellite networks play a vital role in the communication industry. They have advantages over the terrestrial networks in that:
 - They are accessible from any point of the globe.
 - They can provide broadband digital services to many points without the cost of acquiring wire/cable installation.
 - They can add receiving and sending sites without significant additional costs.

Requirement of I-Way

- The success of e-commerce-based business depends on the information flow and to make information flow smooth and capable I-way is required.
- The success or failure of any creativity, product or services is a key driver of market forces. • The underlying market drives of I-way is important because e-commerce applications are dependent on the underlying I-way.

Functions of I-Way

- It develops business relationships among all sorts of business and with people all around the world by the help of global information distribution network.
- It is used for communication between the business partners at any locations through the network communications.
- It acts as an information system for any organization.
- I-Way controls unwanted information distributed over the complex network.
- It allows multiple forms of messages, sent and received over the same network.

Internet as a Network Infrastructure

- The Internet is a meta-network, that is, a network of networks that spans the globe. It is impossible to give an exact count of the number of networks or users that comprise the Internet, but it is easily in the thousands and millions respectively.
- The Internet employ one of standardized protocols which allow for the sharing of resources among different kinds computers that communicate with each other on the network.
- These standards are sometimes referred to as the Internet Protocol Suite.
- Packet switching technique is employed by the Internet to transmit messages from one location to another location which makes high utilization network resources.
- This is the reason behind the low cost of the internet. The Internet is a distributed system. There is no central store.
- Technically, no one runs the Internet. Rather, the Internet is made up of thousands of smaller networks.
- However, our connection to the Internet is probably controlled by an Internet Service Provider (ISP).
- People and organizations connect into the Internet so they can access its massive store of shared information. The Internet is an inherently participative medium. Anybody can publish information or create new services.
- A computer connected to the Internet is commonly referred to as a host. Connections are made using telephone lines, cable data lines, fiber optic, or even wireless signals.
- The data passed back and forth between host computers using packets and protocols.
- Internet use client/server model of communication. We (client) make requests on the internet by using a web browser. Some computers on the internet (server) makes resources requested by us and responds to our request by using software called web servers.
- Every computer on the internet is identified by a unique IP address. IP Address is a unique set of numbers (such as 110.22.33.114) which identifies a computer location.
- A special computer DNS (Domain Name Server) is used to give a name to the IP Address so that the user can locate a computer by a name. For example, a DNS server will resolve a name http://www_fomecd.edu.np to a particular IP address to uniquely identify the computer on which this website is hosted.

History of Internet

- The Internet began as ARPANET back in 1969. ARPANET was a large wide-area network created by

the United States Department of Defense Advanced Research Project Agency (ARPA). It served as a test bed for new networking technologies. It linked many universities and research centers.

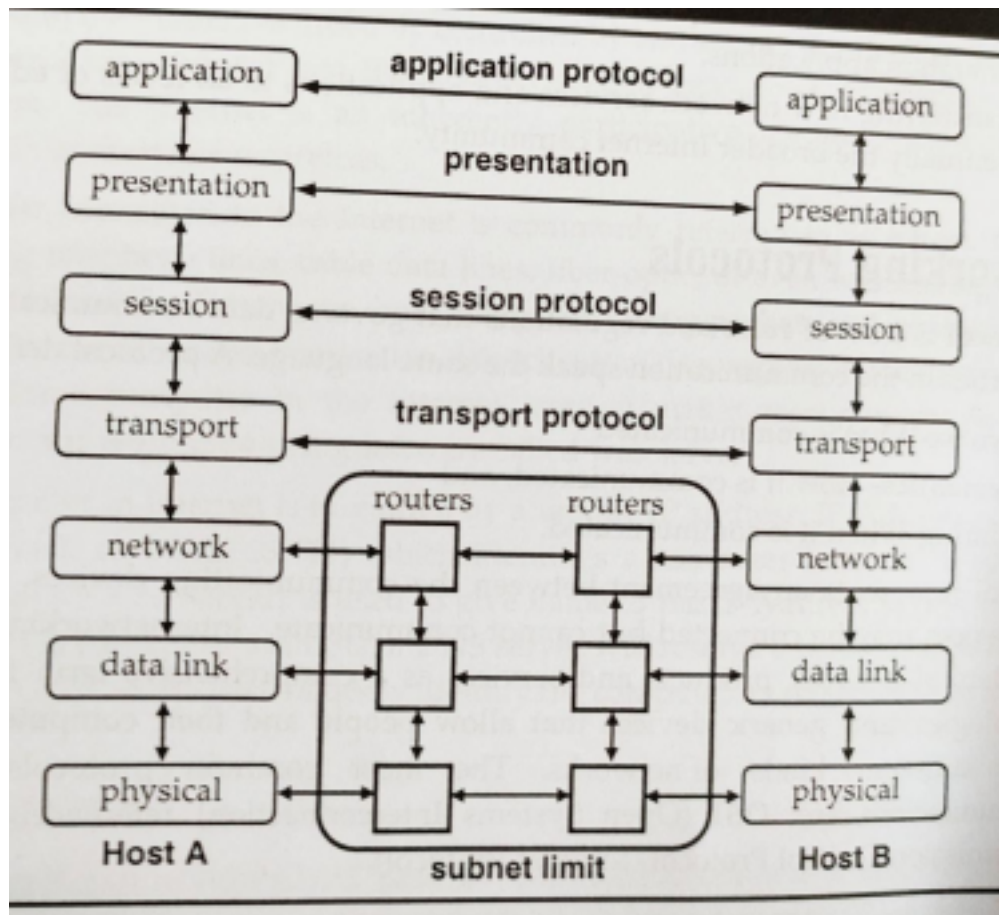
- The intention here was to ensure that the transfer of information between servers was possible if there was a nuclear attack.
- The network employed a set of standard protocols to create an effective way for people to communicate and share data with each other.
- ARPAnet's popularity continued to spread among researchers and in the 1980 the National Science Foundation (NSF), linked several high-speed computers, and took charge of what had come to be known as the Internet.
- By the late 1980's, thousands of cooperating networks were participating in the Internet.
- In 1991, the U.S. The High Performance Computing Act established the NREN (National Research & Education Network). NREN's goal was to develop and maintain high-speed networks for research and education, and to investigate commercial uses for the Internet.
- The Internet has been improved through the developments of services such as the World Wide Web.
- Even though the Internet is predominantly thought of as a research-oriented network, it continues to grow as an informational, creative, and commercial resource every day and all over the world.
- The research and education community founded Internet2 to serve its networking needs. The Internet2 Project was originally established by 31 university researchers in 1996 under the auspices of EDUCOM, and was formally organized as the not-for-profit University Corporation for Advanced Internet Development (UCAID) in 1997.
- It later changed its name to Internet2. It provides the U.S. research and education community with a network that satisfies their bandwidth-intensive requirements.
- The objectives of the Internet2 consortium are:
 - Developing and maintaining a leading-edge network,
 - Fully exploring the capabilities of broadband connections through the use of new generation applications,
 - Transferring new network services and applications to all levels of educational use, and eventually the broader Internet community.

Internetworking Protocols:

- A protocol is a set of rules and regulations that governs data communication. It ensures that two parties in the communication speak the same language.
- A protocol defines:
 - Syntax-What is communicated
 - Semantics- How it is communicated, and
 - Timing-When it is communicated,
- Protocol represents an agreement between the communicating devices. Without a protocol two devices may be connected but cannot communicate.
- Internetworking is a term used by providers of network products and services as a comprehensive term for all the concepts, technologies, and generic devices that allow people and their computers to communicate across different kinds of networks.
- The most common protocols for internetwork communications are: **OSI (Open Systems Interconnection)** reference model and **TCP/IP (Transmission Control Protocol/Internet Protocol)**.

OSI Reference Model

- OSI is an acronym for Open System Interface. This model is developed by the International Organization of Standardization (ISO) and therefore also referred to as ISO-OSI Model. • It uses the modular concept by providing different functionalities in different layers required to communicate with another system.
- With layered approach protocol development can be divided into different independent groups and also the modification to the protocol will be easy in the future.
- It consists of seven layers. This is not a method but widely used as a reference model. All practically used protocols are based on the idea of OSI reference model.



Physical Layer

- This is the lowest layer of OSI reference model and is connected with transmission media. • It is responsible for the following activities:

- Activating, maintaining and deactivating the physical connection
- Defining voltages and data rates needed for transmission
- Converting digital bits into electrical signal
- Deciding whether the connection is simplex, half duplex or full duplex

Data Link Layer

- Data link layer provides services for reliable transfer of information across the physical link. •

This layer performs the following functions:

- Performs synchronization, flow control and error control for the information which is to be transmitted over the physical link.
- Enables error detection, and adds error detection codes to the data which are to be transmitted.

Network Layer

- Network layer provides upper layers with independence from the data transmission and switching technologies used to connect systems.
- Following are the functions of Network Layer:
 - To act as the network controller by deciding which route data should take.
 - To switch the signals through the selected route to another end.
 - To divide the outgoing messages into packets and to assemble incoming packets into messages for higher levels.

Transport Layer

- This is the layer that guarantees transmission of data from one end to another end. •

The Transport layer performs the following functions:

- It decides if the data transmission should take place on parallel paths or single paths.
- It breaks the data groups into smaller units so that they are handled more efficiently by the network layer.
- It provides reliable end-to-end message delivery with acknowledgments.

Session Layer

- Session is the logical connection established between applications in sending and receiving machines.
- The Session layer performs the following functions:
 - It establishes, manages and terminates the connection (Session) between co-operating applications.
 - It controls logging on and off and user identification.

Presentation Layer

- This layer makes it sure that the information is delivered in such a form that the receiving system will understand and use it.
- The Presentation layer performs the following functions:
 - Data translation
 - Data conversion: bit order, CR-CR/LF, integer-floating point, and so on.
 - Data compression: reduces the number of bits that need to be transmitted on the network.
 - Data encryption: encrypt data for security purposes. For example, password encryption. *Application*

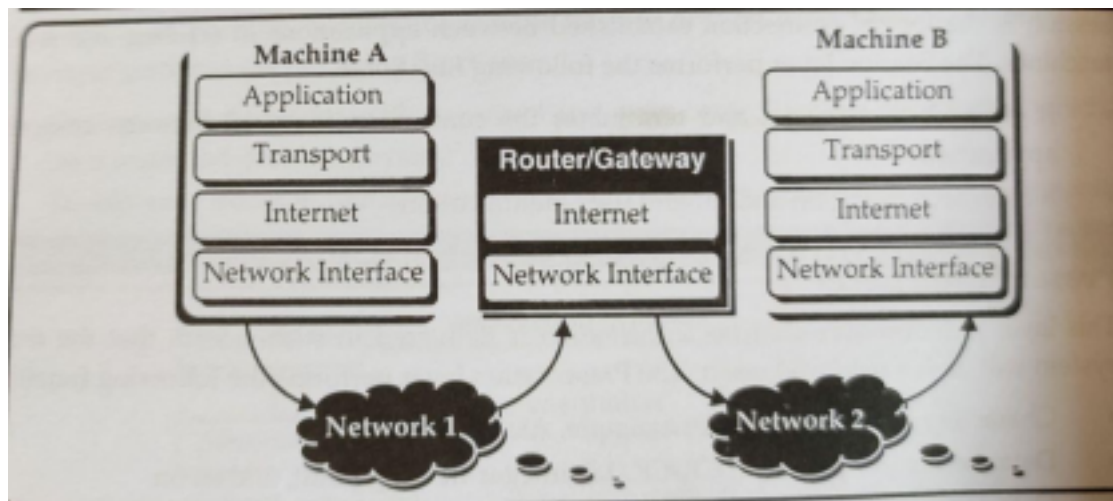
Layer

- This is the layer with which end users interact. Users create things to be sent or open the things received by using this layer.
- This layer contains a variety of commonly needed functions:
 - Resource sharing and remote file access

- Remote printer access and network management
- Directory services and electronic messaging etc.

TCP/IP Protocol

- TCP/IP model is a practical model and is used on the Internet. TCP/IP is an acronym of Transmission Control Protocol and Internet Protocol.
- Even though this protocol was originally created for what we now call the Internet, it is easily transferred to networks of all sizes.
- It provides the easiest methodology for communicating between computers through standardized protocols that ignore the hardware and software platforms of the individual pieces of equipment.
- Layers of TCP/IP protocols are shown in the figure below:



Network Interface Layer

- The Network Interface layer (also called the Network Access layer) is responsible for placing TCP/IP packets on the network medium and receiving TCP/IP packets off the network medium.
- TCP/IP was designed to be independent of the network access method, frame format, and medium.
- In this way, TCP/IP can be used to connect different network types.
- Independence from any specific network technology gives TCP/IP the ability to be adapted to new technologies.
- The Network Interface layer encompasses the Data Link and Physical layers of the OSI model.

Internet Layer

- The Internet layer is analogous to the Network layer of the OSI model.
- The Internet Layer protocols provide three specific services:
 - A connectionless delivery service: A mechanism to break the data up into individual packets or frames on the transmitting side and to put them back together on the receiving side (fragmentation and reassembly).
 - The routing functions necessary to interoperate with other networks.
- The core protocols of the Internet layer are IP (Internet Protocol), ARP (address resolution protocol), RARP (reverse address resolution protocol), ICMP (Internet control management protocol), and IGMP (Internet group management protocol).

Transport Layer

- The Transport layer (also known as the Host-to-Host Transport layer) is responsible for providing the Application layer with sessions, performing flow control, error control etc.
- The Transport layer encompasses the responsibilities of the OSI Transport layer and some of the responsibilities of the OSI Session layer.
- The core protocols of the Transport layer are Transmission Control Protocol (TCP) and the User Datagram Protocol (UDP).
- TCP provides a one-to-one, connection-oriented, reliable communications service. TCP is responsible for the establishment of a TCP connection, the sequencing and acknowledgment of packets sent, and the recovery of packets lost during transmission.
- On the other hand, UDP provides a one-to-one or one-to-many, connectionless, unreliable communications service.

Application Layer

- The Application layer provides applications the ability to access the services of the other layers and defines the protocols that applications use to exchange data.
- There are many application layer protocols and new protocols are always being developed. •

The most widely-known application layer protocols are:

- The Hypertext Transfer Protocol (HTTP) is used to transfer files that are web pages of the World Wide Web.
- The File Transfer Protocol (FTP) is used for downloading and uploading the files.
- The Simple Mail Transfer Protocol (SMTP) is used for the transfer of mail messages and attachments.
- Telnet is used for logging on remotely to network hosts.
- ARP and RARP protocols are responsible for mapping IP addresses into MAC (Media Access Control) addresses and vice versa.

TCP vs. UDP

- Most TCP/IP applications use TCP (transmission control protocol) in the transport layer. UDP (user datagram protocol) is also common as part of the TCP/IP protocol suite.
- The table given below differentiates these two protocols.

TCP	UDP
1. It is connection oriented protocol.	1. It is connectionless protocol.
2. It is reliable, guarantees delivery of the data	2. It is less reliable, does not guarantees delivery of data
3. Preservers data sequence	3. Does not preserve data sequence
4. TCP is slower than UDP	4. UDP is faster than TCP
5. Commutation using PSTN (Landline) telephone is an example where TCP is used	5. PING command is the example where UDP protocol is used

The Internet Architecture:

The architecture of the internet is hierarchical in nature. A brief description of internet architecture is:

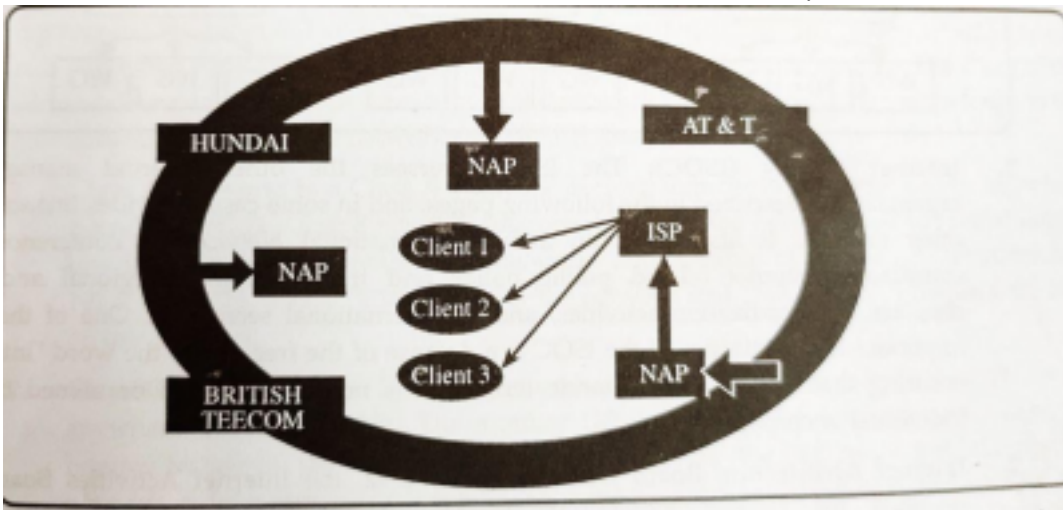


Figure:

Internet Structure

Backbone:

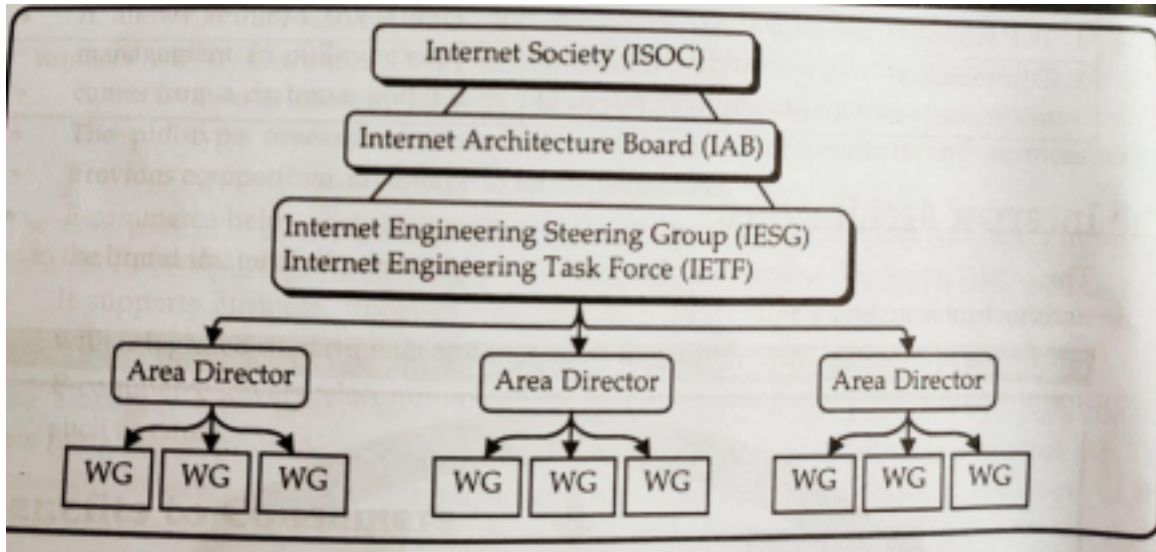
- Backbones are formed by large corporations like AT&T. These corporations have their own server farms connected to the backbone.
- Backbone is a giant pipeline capable of transporting data around the world in milliseconds.
- There are many backbones in the world that are connected by Network access points so that data can travel from one backbone to another backbone.

Internet Service Providers (ISPs):

- Internet service providers can be of two types: Regional ISPs and Local ISPs.
- Regional ISPs are also referred to as Network service providers. These are business organizations that sell bandwidth or by accessing internet backbone directly.
- On the other hand, Regional ISPs connect various local ISPs in the city sent through its routers. Local ISP's purchase bandwidth from regional ISP's, divide it into smaller bandwidth and sell to its clients.
- Clients: Clients lie at the lowest level of internet hierarchy. These are the computers at home or offices that are connected to local ISP's.

Managing Internet

- It is often said that there is no central control, administration, or management of the Internet.
- While this is generally true, there are several well-known organizations that work together in a relatively well structured and roughly democratic environment to collectively participate in the research, development, and management of the Internet.
- Inter-relationships between these organizations are shown in the chart given below:



Internet Society (ISOC):

- The ISOC oversees the other Internet management organizations and, in some cases, provides financial and other support.
- It also holds an annual International Networking conference, and coordinates Internet related public policy and trade activities, regional and local chapters, standardization activities, and an international secretariat.
- One of the most important legal activities of the ISOC is a defense of the free use of the word "Internet", ensuring that it remains a generic term that is not trademarked or owned by any Individual or corporation.

Internet Architecture Board (IAB):

- In June, 1992, the Internet Activities Board was termed the Internet Architecture Board by the Internet Society.
- The roles and responsibilities of the IAB are: Provide oversight of the Internet architecture, protocols, procedures, and standards, RFC (Request for Comment) management, IESG (Internet Engineering Steering Group) selection, IETF oversight etc.

Internet Engineering Task Force (IETF):

- The IETF studies operational and technical problems with the Internet, specifies protocols and architectural solutions, and values recommendations to its steering committee.
- Each area has one or two directors. Area director considers a problem important enough to merit concern, the IETF sets up a working group for further investigation.

Addresses in the Internet

- Every device attached to the internet must be identifiable uniquely. For this, we need to provide addresses to the devices attached to the internet.
- There are two types of addresses on the internet: IP Address and Domain Names.

IP Address

- An IP address is a numbered address provided to computers and other devices attached to the internet to identify them uniquely.

- Two versions of the Internet Protocol (IP) are in use IP Version 4 and IP Version 6. Each version defines an IP address differently.
- Because of its prevalence, the generic term IP address typically still refers to the addresses defined by IPV4.
- IP addresses can also be classified as private IP address or Public IP address.
- An IP address that can be accessed over the Internet is called a public IP address. We need to pay for public IP addresses.
- On the other hand, a private IP address is any number or address assigned to a device on a private TCP/IP Local Area Network that is accessible only within the Local Area Network. It is available free of cost.

Internet Protocol Version 4(IPV4)

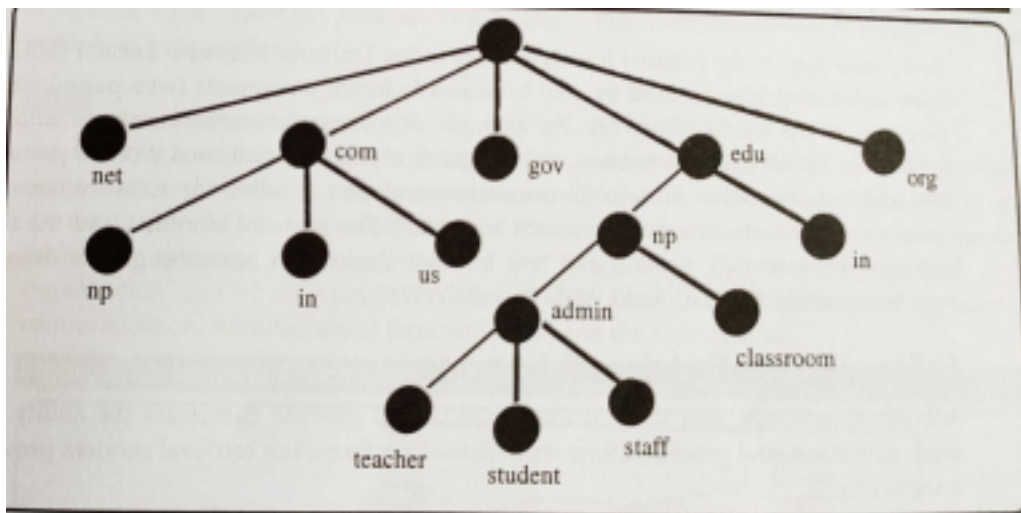
- IPV4 address consists of 32 bits and often shown as 4 octets of numbers from 0-255 represented in decimal. For example, the IP address: 168.212.226.204
- Every IP address has two parts, one identifying the network and one identifying the node, or host.
- The Class of the address determines which part belongs to the network address and which part belongs to the host address.
- We can divide networks into five classes:
 - Class A Network: In a Class A Network decimal number in first octet can be anywhere from 1 to 126. The first 8 bits (the first octet) identify the network and the remaining 24 bits indicate the host within the network. An example of a Class A IP address 102.168.212.226, where "102" identifies the network and "168.212.226" identifies the host on that network.
 - Class B Network: In a Class B Network the decimal number in first octet can be anywhere from 128 to 191. The number 127 is reserved for loopback and is used for internal testing on the local machine. The first 16 bits (the first two octets) identify the network and the remaining 16 bits indicate the host within the network. An example of a Class B IP address is 168.212.226.204 where "168.212" identifies the network and "226.204" identifies the host on that network.
 - Class C Network: In a Class C Network decimal number in first octet can be anywhere from 192 to 223. The first 24 bits (the first three octets) identify the network and the remaining 8 bits indicate the host within the network. An example of a Class C IP address is 200.168.212.226 where "200.168.212" identifies the network and "226" identifies the host on that network.
 - Class D Network: In a Class D Network, the decimal number in first octet can be anywhere from 224 to 239. Class D networks are used to support multicasting.
 - Class E Network. In a Class E Network, the decimal number in the first octet can be anywhere from 240 to 255. Class E networks are reserved for future use.
 - IPv4 is the most widely deployed Internet protocol used to connect devices to the Internet.
 - IPv4s uses a 32-bit address scheme allowing for a total of 2^{32} addresses (just over 4 billion addresses).
 - With the growth of the Internet, it is expected that the number of unused IPv4 addresses will eventually run out because every device -- including computers, smartphones and game consoles - that connects to the Internet requires an address.

Internet Protocol Version 6 (IPv6)

- A new Internet addressing system Internet Protocol version 6 (IPv6) is being deployed to fulfill the need for more Internet addresses.
- IPv6 addresses are 128-bit IP addresses written in hexadecimal and separated by colons. An example IPv6 address could be written like this 3ff8:1900:4543:0200:f8ff:fe21:67cf:ab45 • With IPV6 we can have up to 2^{128} addresses. This is deemed sufficient for the foreseeable future.
- It is the successor to Internet Protocol Version 4 (IPv4). It was designed as an evolutionary upgrade to the Internet Protocol and will, in fact, coexist with the older IPv4 for some time. • IPv6 is designed to allow the Internet to grow steadily, both in terms of the number of hosts connected and the total amount of data traffic transmitted.

Domain Names

- IP addresses are difficult to remember. Domain Names are named addresses provided to the devices attached to the network. For example, www.google.com is an example of a domain name.
- Domain Name Server (DNS) helps to resolve the host name to an address. It uses a hierarchical naming scheme and distributed database of IP addresses and associated names. • The Domain name system comprises Domain Names, Domain Name Space, and Name Servers, Domain Name is a symbolic string associated with an IP address.
- There are several domain names available; some of them are generic such as com, edu, gov, net etc, while some country level domain names such as np, au, in, us etc.
- The domain name space refers to a hierarchy in the internet naming structure.



- Name server contains the DNS database. This database comprises various names and their corresponding IP addresses.
- Since it is not possible for a single server to maintain an entire DNS database, therefore, the information is distributed among many DNS servers. Hierarchy of the server is the same as the hierarchy of names.

Working of DNS

- User program requests IP address for a domain name Resolver module in local computer or ISP

formulates query for local name server.

- Local name server checks DNS database and cache, if found returns IP address to the requestor. If not found, queries name servers at next hop.
- When a response is received, the local name server stores the name/address mapping in the local cache. User program receives IP address or error message

Internet Services

- Internet Services allows us to access huge amounts of information such as text, graphics, sound and software over the internet.
- Some of the services provided by the internet are: World Wide Web (WWW), Information Retrieval Services, Communication Services, and Web Services.

World Wide Web (WWW)

- It is commonly known as The Web. It is the most popular Internet service.
- It is a system of interlinked hypertext documents (called web pages contained on the Internet).
- A web page can contain text, graphics, animations, sound and video. All of the web pages maintained by an organization or individual are called a web site.
- WWW uses Hypertext Transfer Protocol (HTTP) for fetching files (web pages) on the Internet.
- It is set of rules and standards that transmit requests and information between web browsers and web servers.
- A web browser is a software application used to locate and display web pages.
- Some popular browsers are Microsoft Internet Explorer, Microsoft Edge, Mozilla Firefox, Google Chrome etc.
- Web server is a computer that delivers web pages.
- Every web page in the Internet has an address called Uniform Resource Locator (URL). URL is an addressing scheme used by web browsers to locate documents (web pages) and other resources on the World Wide Web.
- For example, <http://tuservicecommission.edu.np/notice.html> in the URL of TU Service Commission.
 - In the URL, the first part of the address is called protocol like http and indicates what protocol to use and the second part is called the resource name and it specifies the address where the resource is located.
 - The protocol identifier and the resource name are separated by a colon and two forward slashes.
- A search engine is designed to search information on the World Wide Web (WWW).

Information Retrieval Service

- It Involves browsing and information retrieval, and provides customers the ability to find, view, download, and process information. Some of information retrieval services provided by internet are:
 - File Transfer Protocol (FTP): FTP is an acronym for File Transfer Protocol. It is used to transfer files between computers over the network or Internet. It is commonly used to download a file from a server or to upload a file to a server by using the internet.
 - Archie: It's updated database of public FTP sites and their content. It helps to search a file by its name.

- Gophers: Gophers are tools that are used to search, retrieve, and display documents on remote sites.
- Wide Area Information Servers (WAIS): WAIS is a client server text searching system. It is used to search indexed databases or remote servers.

Communication Services

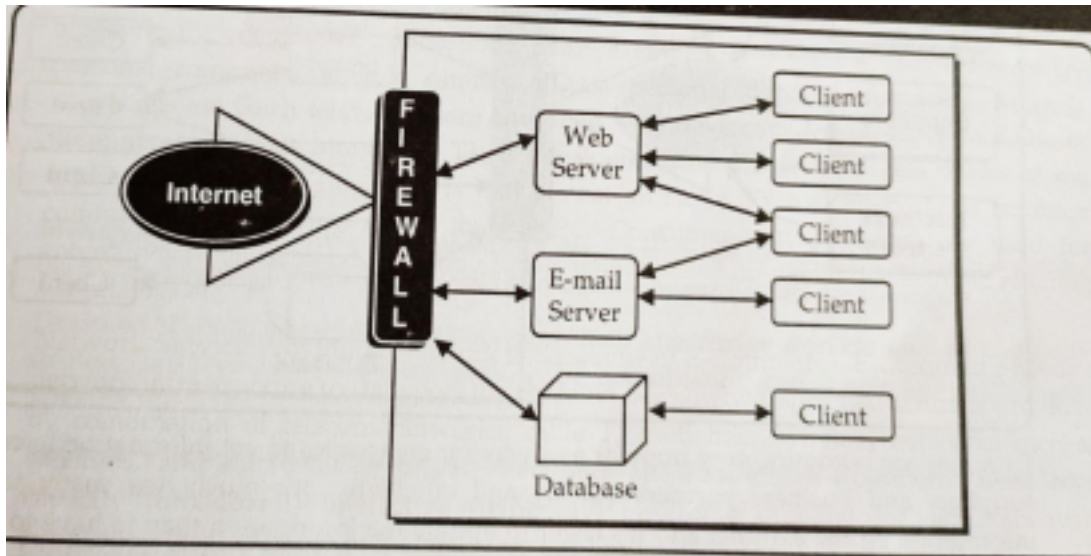
- There are various Communication Services available that offer exchange of information with individuals or groups.
- Some of these services are:
 - Electronic Mail: Email is used to send electronic message over the internet
 - Telnet: It is used to log on to a remote computer that is attached to internet
 - Newsgroup: Offers a forum for people to discuss topics of common interests
 - Internet Telephony (VoIP): It allows the internet users to talk across internet to any PC equipped to receive the call
 - Instant Messaging: It offers real time chat between individuals and groups of people. For example, Yahoo messenger, MSN messenger.
 - Internet Relay Chat (IRC): It allows people from all over the world to communicate in real time.

Web Services

- Web services allow exchange of information between applications on the web. Using web services, applications can easily interact with each other.
- Web services allow different applications from different sources to communicate with each other without time-consuming custom coding.
- Web services are not tied to any one operating system or programming language. For example, Java can talk with Perl, Windows applications can talk with UNIX applications,

Intranet

- An intranet is an internal private network based on internet and World Wide Web (WWW) technology and standards.
- Intranets are restricted to the internal members of an organization.
- Access to intranets is controlled through the use of usernames, passwords and firewalls, which are security software programs that keep users that are members of the organization out of the network.
- Intranet also uses TCP/IP protocol as internet for communication.
- Architecture of intranet is shown in the figure below:



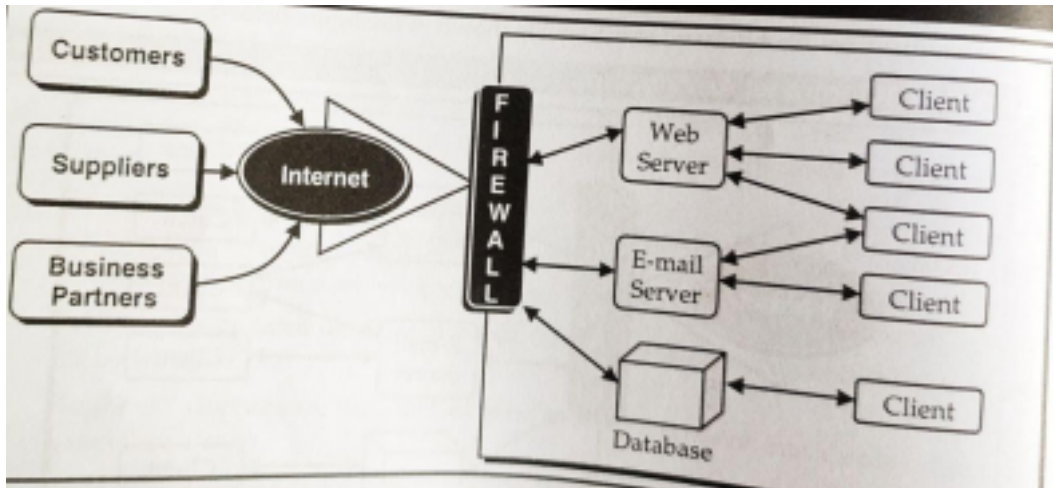
- Intranet provides network infrastructure for intra-business activities and plays vital role to strengthen the organizational work which are listed below:

Business Values of Intranet

- Cross-functional Integration: Intranet can be used to connect many business processes in the organization which helps to improve efficiency and effectiveness of business processes.
- Enterprise Ecommerce Application: Centralized sales and purchase can be done online.
- Enhanced Knowledge Sharing: Knowledge and information can be shared through web pages.
- Enhanced Group Decision: Web based groupware tools can be used to collaborate with each other which enhances group decision.
- Document Management: Employees can access and exchange documents, pictures, charts, maps etc. over the intranet.
- Resource Distribution: An intranet server can be used as an application warehouse and hence avoids many maintenance and support problems.

Extranet

- An extranet is the internal private network where limited numbers of outsiders are given access to the intranet.
- Like intranet, extranet is also based on internet and World Wide Web (WWW) technology and standards and uses TCP/IP protocol for communication.
- Access to intranets is controlled through the use of usernames, passwords and firewalls, which are security software programs that keep users that are not members of the organization out of the network.
- The beauty of intranets and extranets is that they don't require any special software or hardware other than what we would use for the Internet.



Extranets are becoming very popular as a way for companies to get information to customers, suppliers and business partners quickly and efficiently.

- It's much less costly to put the information on the extranet and it's faster to update the information than to have to print and send out paper updates.
- Some companies are using extranets to replace EDI systems. Smaller companies that couldn't afford the cost of EDI are using extranets as a way to allow product ordering and shipment tracking.

Business Values of Extranet

- Enhanced Communication: Extranets provides an easy way of communication between geographically dispersed organizational branches, customers, supplies and business partners.
- Productivity Enhancement: Extranets supports the concepts of just-in-time delivery which is helpful to increase productivity of business processes.
- Business Enhancement: Extranets helps to collaborate with geographically dispersed branches and it also helps to enhance relationships to customers and other stakeholders which have positive implications on business enhancement.
- Cost Reduction: Extranets help reduce errors, paper work, travel costs etc. by automating business activities. Besides this, it helps to reduce administrative and operational costs as well.
- Information Delivery: With the help of extranet it is easy to provide information to customers, suppliers, and other business partners quickly and efficiently. It is also easy and less costly to update information on the extranet.

Software Agents

- A software agent is a persistent, goal-oriented, and intelligent computer program that reacts to its environment and runs without continuous direct supervision to perform some function for an end user or another program.
- Some, but not all, software agents have UIs (user interfaces). Here the term persistent refers to the fact that the program can outlive its creator process.
- Typical tasks that are performed by software agent include locating and retrieving information, filtering electronic mails, scheduling appointments etc.
- Individuals are capable of handling these routine tasks and have been doing so far for years, but intelligent agent technology holds the promise of easing the burdens on users by automating

such tasks.

• Software agents are different from conventional programs in the sense that software agents work with goals in mind while conventional programs execute directives stored in memory. • Typical application scenarios where software agents show superiority over conventional software systems are as follows:

- Managing the Information Overload: Software agents are useful for filtering and sorting the input data such that it is easy to find and analyze required data for managers.
- Decision Making Support: Software agents help knowledge workers such as managers, doctors, lawyers etc. in decision making by coordinating and interacting with expert systems.
- Repetitive office Activity: Using software agents to do such type of works reduces labor cost hence increases business productivity.
- Doing Mundane Personal Activities: Agents are useful for performing routine personal activities such as booking and purchasing tickets.
- Domain Experts: Software agents are suitable to model costly expertise and make it widely available. Examples of expert software agents could be models of real-world agents such as translators, lawyers, diplomats etc.

Features of Intelligent Agents

As already stated, software agents are intelligent programs. Following are the factors that make software agents intelligent:

- Autonomous: Once launched, it must be able to work independently without guidance of its creator or owner.
- Learning: Agents must have capacity to learn from the environment in which it is running.
- Reasoning: Agents must have capacity of making rule-based reasoning in changing environment and needs to learn from that reasoning.
- Cooperation: Agents must be able to interact with other agents that are working with the same or similar problems.

Components of Software Agents

While writing a program to develop software agents, a programmer needs to include certain essential components. Every agent must have following components:

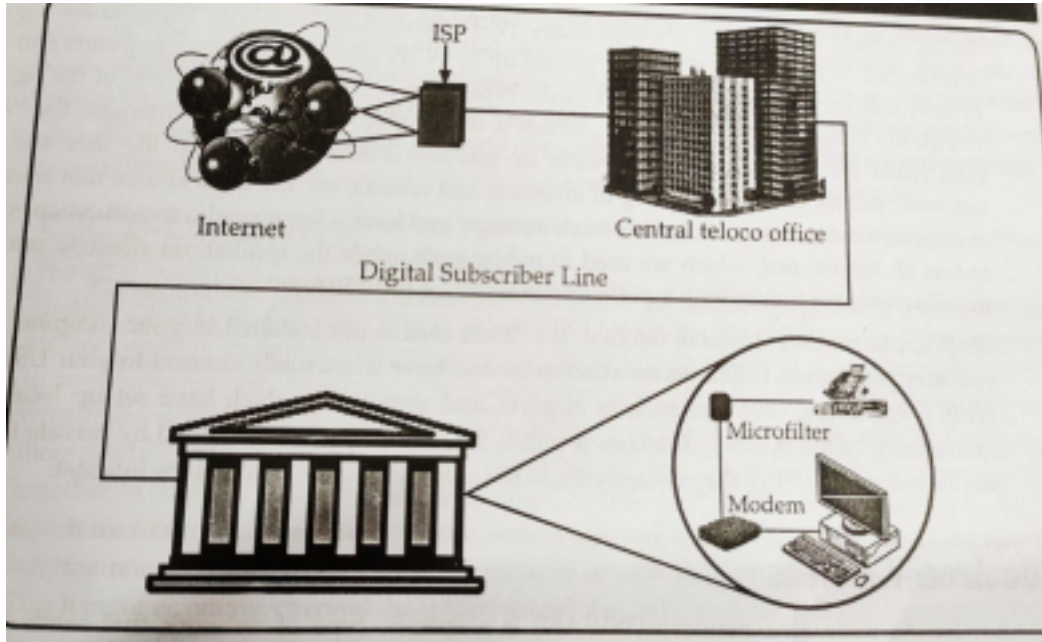
- Owner: Agent can have owners. By having this information, one knows to whom to refer if there is any problem.
- Author: It is the name that has developed the agent. By having this information, one knows to whom to refer if upgrade is required.
- Lifetime: It defines time to live for the agent. If lifetime is known the agent can be killed after it has finished its mission so no more bandwidth is consumed.
- Account: It is linked to the owner's account. With this information, it is easy to bill owners and pay for the service.
- Goal: It represents the measure for success. Measures for success may include completion of transactions within the boundaries of stated goal.
- Background: It includes all supporting information. The information should be in the form that the agent understands.

Static and Dynamic Agents

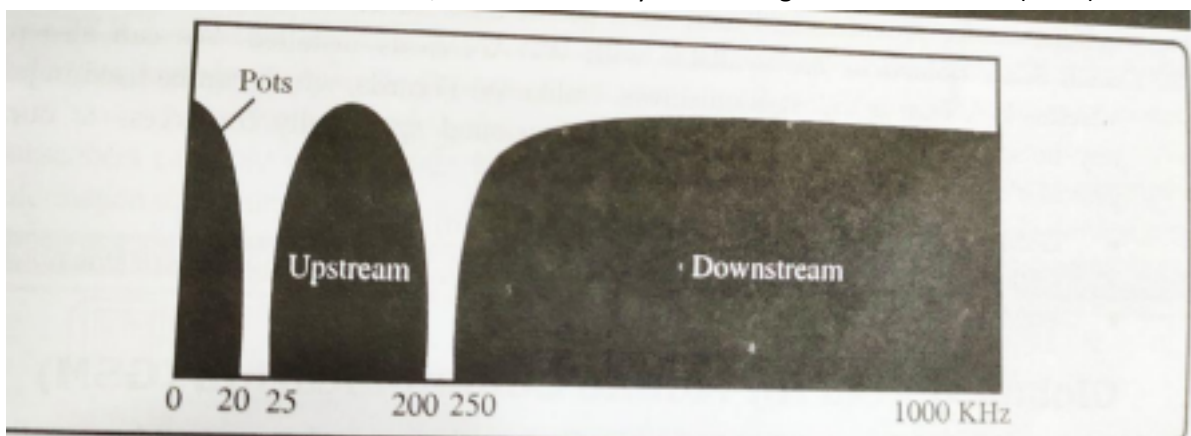
- Software agents can be static or dynamic.
- Static agents reside on PC or server and provide expert advice or services locally. It uses embedded knowledge to process the incoming information.
- Dynamic agents execute on remote computers and then return results to computers. • Mail agent and Filtering agents are typical examples of static agents where mail agents are responsible for replying email automatically and filtering agents are responsible for processing large volumes of information and extracting summary information from it.
- Dynamic agents are also called mobile or roaming agents. Software agent that searches over the internet and returns the cheapest T-shirt of some particular brand is an example of a dynamic agent.
- An agent that searches for new jobs and then posts these jobs in say social networking sites is another example of dynamic agent.
- Static and dynamic agents need to collaborate with each other to perform complex tasks.

Asymmetric Digital Subscriber Line (ADSL)

- DSL refers collectively to all types of digital subscriber lines. The two main categories of DSL are ADSL and SDSL.
- DSL technologies use sophisticated modulation schemes to pack data onto copper wires. • They are sometimes referred to as last-mile technologies because they are used only for connections from a telephone switching station to a home or office, not between switching stations.
- ADSL is a broadband data transmission technology that supports high speed digital transmission over ordinary telephone lines. Telephone office provides this facility where data and voice signal are combined and sent.
- This combination uses Frequency division multiplexing (FDM). It reserves the lowest 25 KHz for voice and the rest of the capacity is used for data. Out of 25 KHz, the voice is carried only in the 0 to 4 KHz band. The additional bandwidth is used to prevent interference between voice and data channels.
- A subscriber twisted pair is routed to both PC and telephone. At PC, ADSL modem demodulates the data for PC and at telephone micro-filter passes the 4 kHz voice signal.



- It is called asymmetric because the frequency band allocated for upstream and downstream is not equal. Normally frequency band from 25 KHz to 200 KHz is reserved for upstream and frequency band above 250 KHz is reserved for downstream.
- The frequency band between 200 KHz to 250 KHz acts as a guard band so that two frequencies do not interfere with each other.
- On the other hand, SDSL is called symmetric because it supports the same data rates for upstream and downstream traffic. Otherwise, it is similar to asymmetric digital subscriber line (ADSL).



Wireless Fidelity (Wi-Fi)

- Wi-Fi is designed for communication between devices such as computers, printers and scanners. • It is typically used to set up private wireless networks in home or office, allowing us to move our PC or laptop while still having access to the internet and our printer and other devices. • Wi-Fi is based on IEEE 802.11x standard and uses radio waves for communication. Therefore, it does not request line of sight (LOS) communication.
- It transmits unlicensed spectrum of 2.4 GHz and operates in the low frequency area of UHF (Ultra high frequency) in a point to multipoint fashion.
- Radio Signals are the keys, which make Wi-Fi networking possible. These radio signals transmitted from Wi-Fi antennas are picked up by Wi-Fi receivers, such as computers and cell phones that

are equipped with Wi-Fi cards.

- Whenever a computer receives any of the signals within the range of a Wi-Fi network, which is usually 300 - 500 feet for antennas, the Wi-Fi card reads the signals and thus creates an internet connection between the user and the network.
- Access points, consisting of antennas and routers, are the main source that transmit and receive radio waves.
- Antennas work stronger and have a longer radio transmission with a radius of 300-500 feet, which are used in public areas while the weaker yet effective router is more suitable for homes with a radio transmission of 100-150 feet.
- Wi-Fi cards can be external or internal. If a Wi-Fi card is not installed in your computer, then you may purchase a USB antenna attachment and have it externally connected to your USB port.
- Wi-Fi hotspots are premises such as airports, and restaurants which have set up local Wi-Fi connectivity to the internet.
- The largest public Wi-Fi networks are provided by private internet service providers (ISPs); they charge a fee to the users who want to access the internet.

Wide Area Wireless

- A wireless wide area network (WWAN) is a specific type of network that sends wireless signals beyond a single building or property.
- Wireless wide area networks and wireless local area networks also differ in the types of signal processing technologies they use.
- A wireless wide area network (WWAN) is also called wireless broadband or broadband wireless and uses cell towers to transmit a radio signal within a range of several miles to a moving or stationary device.
- Contrast this with wireless Wi-Fi LANs (WLANs), which span only a few hundred feet to stationary or very slow-moving devices.
- WWAN services are typically delivered to smart phones and other handheld devices sold by cellular service providers and their retail partners but other mobile devices can use them as well. Some notebooks are available with WWAN cards installed.
- We can also purchase wireless WAN cards to install ourselves. Unlike Wi-Fi cards, which can be used in just about any hotspot, WWAN devices must be provisioned specifically for access to our service provider's network.
- The main technologies are:
 - GSM (Global System for Mobile Communication)
 - CDMA (Code Division Multiplexing)
 - Wi-Max

Global System for Mobile Communication (GSM)

- GSM stands for Global System for Mobile Communication and is a second-generation mobile telephony system.
- It is a digital cellular technology used for transmitting mobile voice and data services. It is the most widely accepted standard in telecommunications and it is implemented globally.
- GSM is a circuit-switched system that divides each 200 kHz channel into eight 25 kHz time-slots.
- GSM operates on the mobile communication bands 900 MHz and 1800 MHz in most parts of the world. In

the US, GSM operates in the bands 850 MHz and 1900 MHz.

- GSM makes use of narrowband Time Division Multiplexing (TDM) technique for transmitting signals. It was developed using digital technology and has an ability to carry 64 kbps to 120 Mbps of data rates.
- Presently GSM supports more than one billion mobile subscribers in more than 210 countries throughout the world.
- GSM provides basic to advanced voice and data services including roaming service. Roaming is the ability to use our GSM phone number in another GSM network.
- GSM phones use a Subscriber Identity Module (SIM) smart card that contains user account information. Any GSM phone becomes immediately programmed after plugging in the SIM card.
- GSM includes the short messaging service (SMS) that enables users to send 160-character text messages to each other.
- GSM contains four basic elements: Mobile Station, Base Transceiver Station, Base Station Controller, and mobile switching Center.

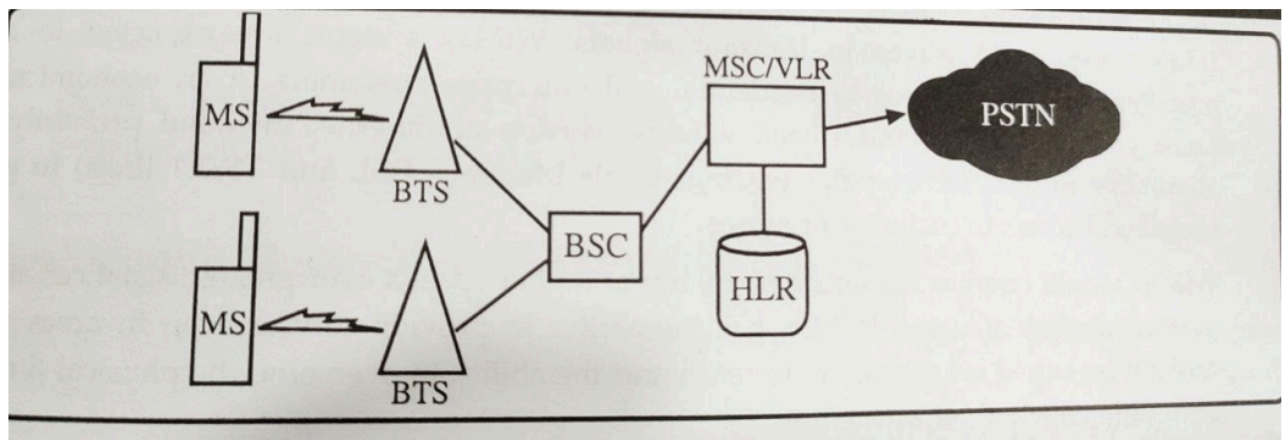


Figure: Global System for Mobile Communication (GSM)

- Mobile Station: The mobile station (MS) consists of the mobile equipment (the terminal) and a smart card called the Subscriber Identity Module (SIM). The SIM provides personal mobility, so that the user can have access to subscribed services irrespective of a specific terminal.
- Base Transceivers Station: The Base Transceiver Station (BTS) houses the radio transceivers that provide radio-link to the Mobile Stations. In a large urban area, there will potentially be a large number of BTSs deployed.
- Base Station Controller. The Base Station Controller (BSC) manages the radio resources for one or more BTS. A group of BTSs are controlled by a BSC.
- Mobile Switching Center: The Mobile Switching Center (MSC) performs the telephony switching functions for the mobile network. It controls calls to and from other telephony and data systems, such as the Public Switched Telephone Network (PSTN), Integrated Services Digital Network (ISDN), public data networks, private networks and other mobile networks. A number of BSCs may be controlled by each MSC. MSC maintains different databases such as HLR (Home Location Register) database, VLR (Visitor Location Register) database, AuC (Authentication Center) database etc.
- The HLR is a centralized network database that stores and manages all mobile subscriptions belonging to a specific operator. It acts as a permanent store for a person's subscription information until that subscription is canceled.
- The VLR database contains information about all the mobile subscribers currently located in an

MSC service area. The VLR temporarily stores subscription information so that the MSC can service all the subscribers currently visiting that MSC service area.

General Packet Radio (GPRS) is a third-generation step toward Internet access. GPRS is also known as GSM-IP, which is a Global-System Mobile Communications Internet Protocol as it keeps the users of this system online, allows them to make voice calls, and access the internet on-the-go.

Code Division Multiple Access (CDMA)

- Code Division Multiple Access (CDMA) is a digital cellular technology used for mobile communication CDMA cellular systems are deemed superior to frequency division multiple access (FDMA) and time division multiple access (TDMA), which is why CDMA plays a critical role in building efficient, robust, and secure radio communication systems.
- Although it is used in various radio communications systems, the most widely known application of CDMA is for cell phones.
- CDMA provides up to 10 times the calling capacity of earlier analog networks and up to five times the capacity of GSM systems.
- Unlike GSM and earlier digital systems which use TDMA to divide the channel into time slots, CDMA's spread spectrum overlaps every transmission on the same carrier frequency by assigning a unique code to each conversation.
- Let's take a simple analogy to understand the concept of CDMA. Assume we have a few students gathered in a classroom who would like to talk to each other simultaneously. Nothing would be audible if everyone starts speaking at the same time. Either they must take turns to speak or use different languages to communicate. The second option is quite similar to CDMA - students speaking the same language can understand each other, while other languages are perceived as noise and rejected.
- Similarly, in radio CDMA, each group of users is given a shared code. Many codes occupy the same channel, but only those users associated with a particular code can communicate, CDMA, which is based on the spread spectrum technique, has the following salient features.
 - In CDMA, every channel uses the full available spectrum.
 - Individual conversations are encoded with a pseudo-random digital sequence and then transmitted using a wide frequency range. CDMA consistently provides better capacity for voice and data communications, allowing more subscribers to connect at any given time.
- CDMA is the common platform on which 3G technologies are built.

Wi-Max

- Wi-Max is an acronym for Worldwide Interoperability for Microwave Access and is based on Wireless MAN technology.
- It is a wireless technology optimized for the delivery of IP centric services over a wide area. Wi-Max is one of the hottest broadband wireless technologies around today. It also uses radio waves to transmit signals.
- Wi-Max systems are expected to deliver broadband access services to residential and enterprise customers in an economical way.

- Loosely, Wi-Max is a standardized wireless version of Ethernet intended primarily as an alternative to wire technologies (such as Cable Modems, DSL) to provide broadband access to customer premises.
- Wi-Max would operate similar to Wi-Fi, but at higher speeds over greater distances and for a greater number of users.
- Wi-Max has the ability to provide service even in areas that are difficult for wired infrastructure to reach and the ability to overcome the physical limitations of traditional wired infrastructure.
- Wi-Max can offer up to about 40 Mbps capacity per wireless channel for both fixed and portable applications which is enough to support hundreds of businesses and thousands of Residences.
 - Wi-Max can support voice and video as well as Internet data. Wi-Max developed to provide wireless broadband access to buildings, either in competition to existing wired networks or alone in currently unserved rural or thinly populated areas. It can also be used to Connect WLAN hotspots to the Internet.
- Wi-Max is also intended to provide broadband connectivity to mobile devices.
- A Wi-Max system consists of two major parts. These are: A Wi-Max Base Station and a Wi-Max Wi-Max Base Station:
- A Wi-Max base station consists of indoor electronics and a Wi-Max tower similar in concept to a cell-phone tower.
- A Wi-Max base station can provide coverage to a very large area up to a radius of 6 miles. Any wireless device within the coverage area would be able to access the Internet.
- Each base station provides wireless coverage over an area called a cell. Theoretically, the maximum radius of a cell is 50 km or 30 miles however, practical considerations limit it to about 10 km or 6 miles.
- Wi-Max Receiver A Wi-Max receiver may have a separate antenna or could be a stand- alone box or a PCMCIA card sitting in our laptop or computer or any other device. This is also referred to as customer premise equipment (CPE).

Wi-Fi vs. Wi-Max

- Wi-Max is similar to the wireless standard known as Wi-Fi, but on a much larger scale and at faster speeds.
- Wi-Max-enabled devices connected over large areas, much like today's cell phones.
- We can compare it with Wi-Fi based on the following factors.
 - IEEE Standards: Wi-Fi is based on IEEE 802.11 standard whereas Wi-Max is based on IEEE 802.16.
 - Range: Wi-Fi typically provides local network access for a few hundred feet with the speed of up to 54 Mbps. A single Wi-Max antenna is expected to have a range of up to 40 miles with the speed of 70 Mbps or more.
 - Scalability: Wi-Fi is intended for LAN applications, users scale from one to tens with one subscriber for each CPE device. Wi-Max is designed to efficiently support from one to hundreds of Consumer premises equipment (CPE), with unlimited subscribers behind each CPE Flexible channel sizes from 1.5MHz to 20MHz.
 - Bit Rate: Wi-Fi works at 2.7 bps/Hz and can peak up to 54 Mbps in 20 MHz channel whereas Wi-Max works at 5 bps/Hz and can peak up to 100 Mbps in a 20 MHz channel.
 - Quality of Service: Wi-Fi does not guarantee any QoS but Wi-Max will provide several levels of QoS.

Universal Mobile Telecommunication System (UMTS)

- UMTS is an umbrella term that encompasses the third generation (3G) radio technologies developed by the SGPP (3rd Generation Partnership Project).
- These 3G Systems are intended to provide a global mobility with a wide range of services including telephony, messaging, Internet and broadband data.
- It is the third-generation successor to the second-generation GSM based cellular technologies which also include GPRS.
- UMTS uses Wideband referred to by the name WCDMA. It employs a 5 MHz channel bandwidth.
- Using this bandwidth, it has the capacity to carry over 100 simultaneous voice calls, or it is able to carry data at speeds up to 2 Mbps.
- Because UMTS is built on GSM networks, it enjoys the same global roaming capabilities.
- Practically all UMTS phones are capable of switching to GSM mode. That means, if using a UMTS device and happen to wander away from a UMTS network and into a GSM network, you can still avail cellular services using the same phone.
 - Like their GSM predecessors, UMTS phones also come with an upgraded SIM (Subscriber Identity Module known as the USIM (Universal SIM). UMTS phones can work with either SIMS/USIMs.
 - Networks upgrading from GSM to the Universal Mobile Telecommunications System are able to reuse a number of network elements, including: the Home Location Register, Visitor Location Register, Mobile Switching Center, and the Authentication Center, to name some.
 - However, a new Base Station Controller and Base Transceiver Station is required. In this way, the investment required is kept to a minimum.
- Upgraded UMTS networks around the globe are able to provide fast download speeds of up to 14 Mbps via the HSDPA (High-Speed Downlink Packet Access) protocol.
- Faster uplink speeds of up to 5.7 Mbps are currently underway via the HSUPA (High-Speed Uplink Packet Access) protocol.
- Both HSDPA and HSUPA are part of a larger family of protocols known as High-Speed Packet Access (HSPA).

4G Long-term Evolution (LTE) Systems

- An acronym for Long Term Evolution, LTE is a 4G wireless communications standard developed by the 3rd Generation Partnership Project (3GPP) that's designed to provide up to 10x the speeds of 3G networks for mobile devices such as smartphones, tablets, notebooks etc.
- Long Term Evolution (LTE) refers to a standard for smooth and efficient transition toward more advanced leading-edge technologies to increase the capacity and speed of wireless data networks.
- 4G technologies are designed to provide IP-based voice, data and multimedia streaming at speeds of at least 100 MBit per second and up to as fast as 1 GBit per second.
 - LTE features include higher download rates approaching 300 mbps and upload rates of 75 mbps, expanding cell capacity to accommodate 200 active users and supporting fast moving mobiles.
- LTE is referred to as the next generation network beyond 3G, with the capacity to support a high demand for connectivity from new consumer devices tailored to new mobile applications.
- In an

LTE live air demo, Web browsing, HD video, and telecommunications are demonstrated simultaneously inside a single computer moving within a vehicle at 108 kilometers per hour.

Bluetooth

- Bluetooth is a global wireless communication standard that connects devices together over a certain distance.
- Think headset and phone, speaker and PC, basketball to Smartphone and more. It is built into billions of products on the market today.
- A Bluetooth device uses radio waves instead of wires or cables to connect to a phone or computer. A Bluetooth product, like a headset or watch, contains a tiny computer chip with a Bluetooth radio and software that makes it easy to connect.
- When two Bluetooth devices want to talk to each other, they need to pair. • Communication between Bluetooth devices happens over short-range, ad hoc networks known as piconets.
- A piconet is a network of devices connected using Bluetooth technology. • The network ranges from two to eight connected devices. When a network is established one device takes the role of the master while all the other devices act as slaves.
- In this model, a single master device can be connected to up to seven different slave devices. • Any slave device in the piconet can only be connected to a single master. • Piconets are established dynamically and automatically as Bluetooth devices enter and leave radio proximity.
- The master coordinates communication throughout the piconet. It can send data to any of its slaves and request data from them as well.
- Slaves are only allowed to transmit to and receive from their master. They can't talk to other slaves in the piconet.
- Bluetooth is particularly convenient in certain situations - for example, when transferring files from one mobile phone to another without cables. Sending music and photos between a PC and a mobile phone is another useful application.
- If we are sending sensitive information over any wireless network, we need to take precautions. • When any device tries to connect to ours through Bluetooth, we have to allow it before it can connect. Thus, we do not need to bother about security while using Bluetooth. • There are actually several different versions of the core specification of Bluetooth. The most common today is Bluetooth BR EDR (basic rate/enhanced data rate) and low Bluetooth with low energy functionality (Bluetooth smart).
- We will generally find BR/EDR in things like speakers and headsets while we will see Bluetooth Smart in the newest products on the market like fitness bands, and smart home devices. • Every single Bluetooth device has a unique 48-bit address, commonly abbreviated BD_ADDR. This will usually be presented in the form of a 12-digit hexadecimal value.
- The most-significant half (24 bits) of the address is an organization unique identifier (OUI), which identifies the manufacturer. The lower 24-bits are the more unique part of the address. • It uses very little power so it doesn't drain your phone's battery as much Wi-Fi or 3G. • Minimum standards require that Bluetooth chips have at least 10 meters (about 30 feet) of range.