Communication Technologies [10 Marks]

Evolution of Networking: ARPANET, Internet, Interspace
Different ways of sending data across the network with reference to switching techniques (Circuit and Packet switching);
Data Communication terminologies: Concept of channel, Bandwidth (Hz, KHz, MHz) and Data transfer rate (bps, kbps, Mbps, Gbps, Tbps);

Transmission media: Twisted pair cable, coaxial cable, optical fiber, infrared, radio link, microwave link and satellite link;

Network devices: Modem, RJ45 connector, ethernet card, router, switch, gateway, wifi card;
Network Topologies and types: Bus, Star, Tree, LAN, WAN, MAN, PAN;
Network Protocol: TCP/IP, File Transfer Protocol (FTP), PPP, SMTP, POP3, Remote Login - Telnet, Internet Wireless/Mobile Communication protocol such GSM, CDMA, GPRS, WLL;
Mobile Telecommunication Technologies: 1G, 2G, 3G, 4G
Electronic Mail Protocols such as SMTP, POP3
Protocols for chat and video conferencing VoIP
Wireless Technologies such as WiFi and WiMAX
Network Security Concepts: Threats and prevention from Viruses, Worms, Trojan horse, Spams Use of cookies, protection using firewall;
India IT Act, Cyber Law, Cyber Crimes, IPR issues, Hacking;
Introduction To Web services: WWW, Hyper Text Markup Language (HTML), eXtensible Markup Language (XML); Hyper Text Transfer Protocol (HTTP); Domain Names; URL; Website, Web browser, Web Servers; Web Hosting, Web Scripting - Client side (VB Script, Java Script, PHP) and Server side (ASP, JSP, PHP), Web 2.0 (for social networking)

Computer network is defined as a set of interconnected autonomous systems that permits distributed processing of information.

Need for networking:

- Resource sharing (Processing, Peripherals, Information and software)
- Personal or national or worldwide communication
- Information discovery and retrieval.

Evolution of Networking: The first computer network was jointly designed by The Advanced Research Projects Agency (ARPA) and Department of Defence (DoD) of United States in 1969 and was called ARPANET. It was an experimental project, which connected a few computers from some of the reputed universities of USA and DoD. ARPANET allowed access to computer resource sharing projects. This ARPANET was handed over to Defence Communication Agency (DCA) for further development. As a result Defence Data Network (DDN) was born in 1983.

Internet: A network of computer networks that share a common communication protocol (Transfer Control Protocol - TCP/IP) that allows computers of different types to exchange information. Since each computer often has more than a single user, it has been estimated that more than 3.17 billion people have Internet access. It is an interconnected system of networks that connects computers around the world via the Internet Protocol.

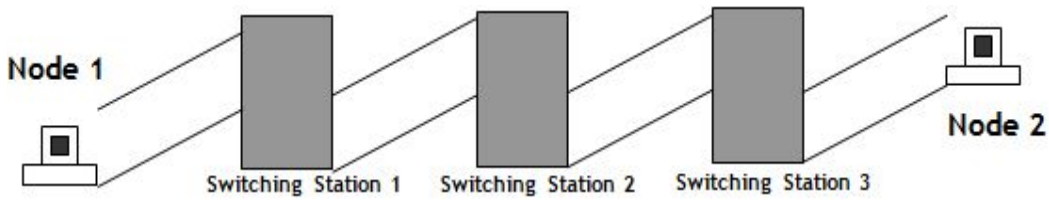
Interspace: The Interspace is a vision of what the Internet will become, where users cross-correlate information in multiple ways from multiple sources The Interspace will offer distributed services to transfer concepts across domains, just as Arpanet used

distributed services to transfer files across machines and the Internet uses distributed services to transfer objects across repositories.

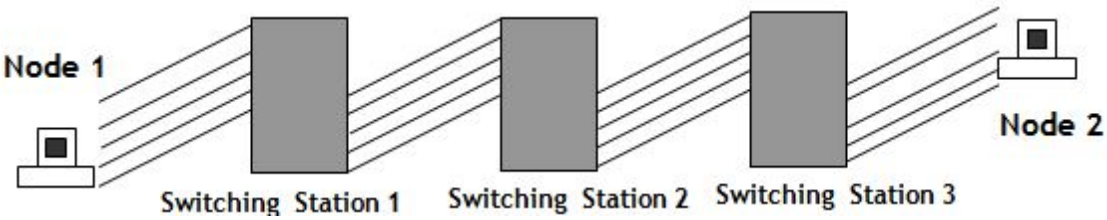
Network switching techniques: It provides communication between two computers. There are three type of network switching techniques.

1. **Circuit switching:** This provides end-to-end connection between two computers. First, physical connection between two computers is established and then data (message) is *directly transmitted* from the source computer to the destination computer.

2. **Message switching:** The source computer sends data (message as a single file) to the switching station, which stores data in a buffer. It then looks for a free link to another switching station and sends data to that station. This process continues until data is delivered to the destination computer. This type of switching technique is also known as 'store and forward' switching.



3. **Packet switching:** In packet switching, the data (file) is broken down in fixed size of small data packets and then these data packets are sent through switching stations to the final destination. All the packets are stored in the main memory instead of disk. As a result accessing time of packets is reduced.



Data Communication terminologies:

In computer networking and telecommunications, a channel or a communication channel, refers either to a physical transmission medium such as a wire/cable, or to a logical connection over a multiplexed medium such as a radio channel.

Bandwidth: The amount of data that can be passed along a communications channel in a given period of time (1 Second). The units used for it are Hz, 10^3 Hz=Kilo Hz (KHz), 10^3 KHz=Mega Hz (MHz)

Data transfer rate: The amount of data transferred in one direction over a link divided by the time taken to transfer it, usually expressed in bits per second (bps), Kilo bps (Kbps), Mega bps (Mbps), Giga bps (Gbps), Tera bps (TBps))

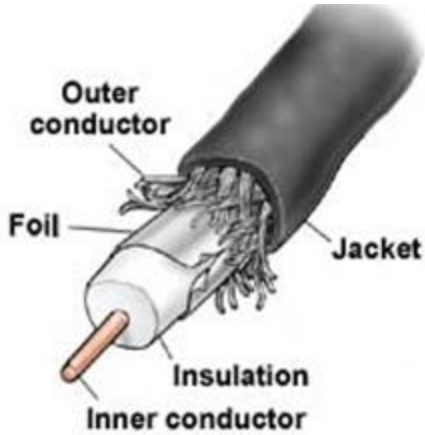
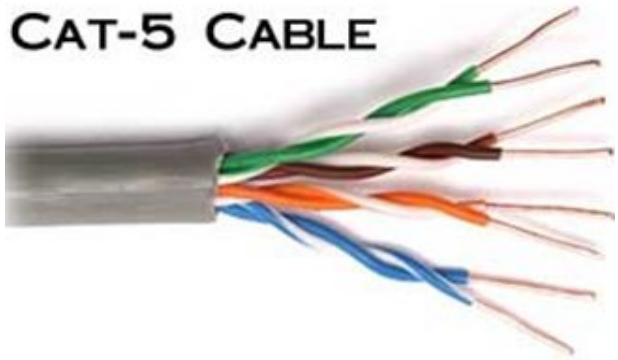
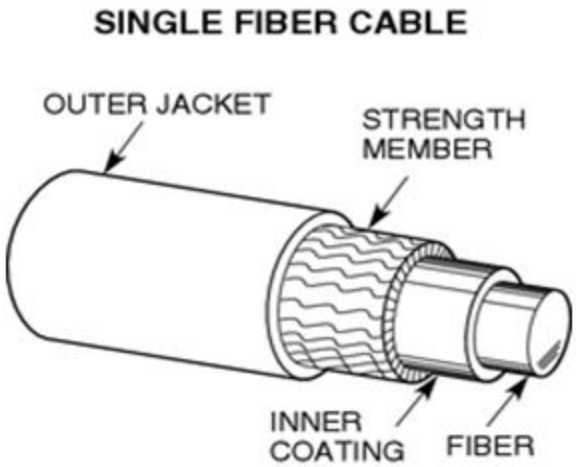
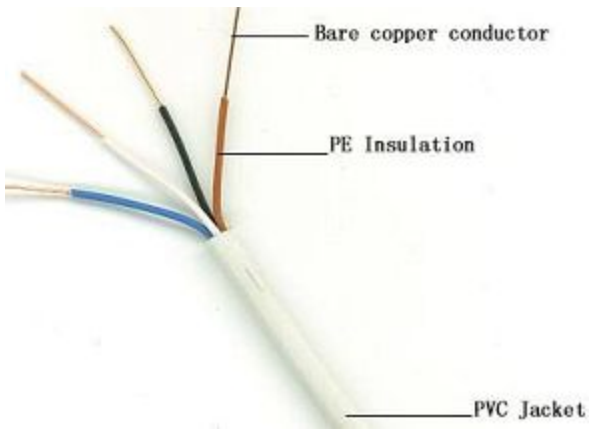
Internet speed and bandwidth are technically different. Bandwidth is referring to the maximum amount of data that can be transmitted in a fixed amount of time through the network while

speed is the time taken to deliver the data (in form of packets) from source device to destination device. So we can see bandwidth is a fixed one while network speed can vary. Network speed depends on many factors like the protocol using to send data, server efficiency, network conjunction.

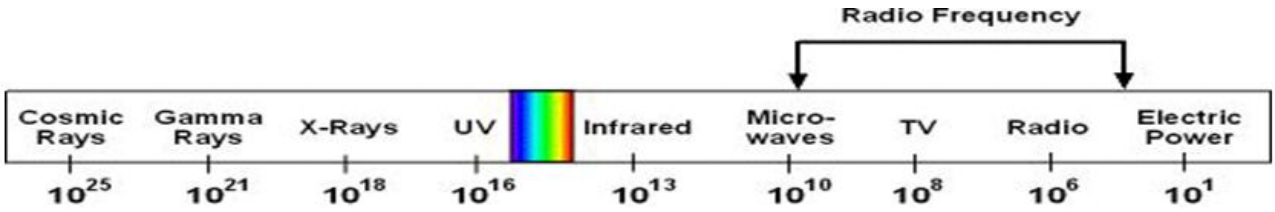
Transmission media

It is a means of communication or access (lines of communication) setup between the two devices to exchange data/information.

Wired Technologies

Coaxial Cable Comparatively Slow, Economic, Convenient to lay down using the bus topology topology of networks;	**Twisted Pair/Ethernet Cable (CAT-5/CAT-6)** Comparatively fast, prone to electromagnetic interference, used in star topology of network; Ideally an Ethernet Cable can carry the data up to a distance on 100 mtrs.
	
Optical Fibre Very fast, expensive, very reliable, minimum interference	**Telephone Wire (uses RJ-11 connector)** Most economic, widely available, slow, good for analog signals
	

Wireless Technologies



Infrared: Infrared electromagnetic waves have frequencies higher than microwaves but lower than the visible spectrum. Infrared transmission is used for wireless LANs, as well as for point-to-point communications with portable devices. Example: Mobile Phones, Remote controls, etc.

Radio Link: It is a form of wireless communications in which the output of the transmitter takes the form of dissipating electromagnetic radiation, which spreads outward from the antenna through free space. It is a Slow means of communication;

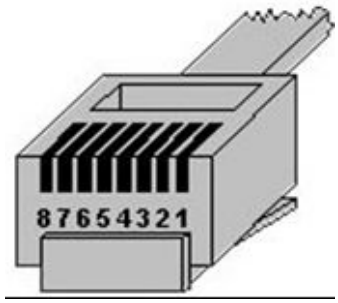
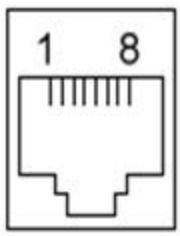
Microwave: Very expensive, works on **line of sight** principle, faster than radio communication;

The term microwave refers to electromagnetic energy having a frequency higher than 1 gigahertz (billions of cycles per second). They are not refracted or reflected by ionized regions in the upper atmosphere. Microwave beams do not readily diffract around barriers such as hills, mountains, and large human-made structures.

Satellite link: It is a link using radio frequencies relayed by satellite. It is very expensive, fast, and has wide area coverage.

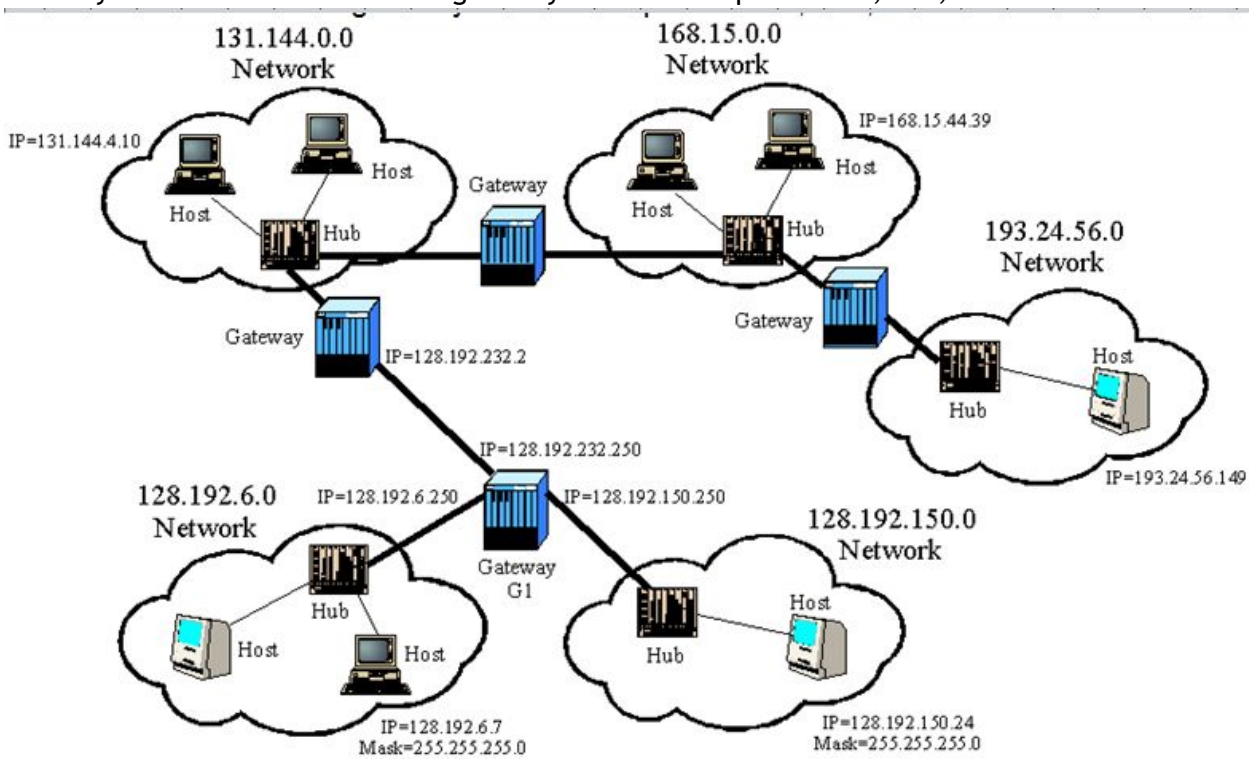
Network Devices

Modem, RJ45 connector, ethernet card, router, switch, gateway, wifi card;
MODEM (Modulator Demodulator): It is a device used to convert the digital signals into analog signals and vice versa. It is mainly used to connect a telephone to a computer terminal.

RJ45 is a standard type of connector for network cables. RJ45 connectors are most commonly seen with Ethernet cables and networks. It is an 8-pin connector usually used with Ethernet cables.	
Ethernet card: A network interface controller (also known as a network interface card, network adapter, LAN adapter and by similar terms) is a computer hardware component that connects a computer to a computer network. Most of the new computers, Ethernet port is built into the computer, whereas in the earlier computers it was available on an expansion cards that used to be plugged into the motherboards.	

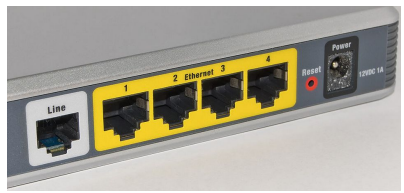
Switch: It is a multi-port (similar to a hub), but with some intelligence and so the data packets received from one part of network are refreshed and delivered to the other part of the network as if the switch is the original point (source) of delivery of data.

Gateway: It is a network point that acts as an entrance to another network, such as the server through which people on a company's local area network access the internet. Often a gateway conceals the IP address of the specific user sending out information, and outsiders can only see the IP address of the gateway itself. Examples: VSNL, MIT, etc.



Router: A router is a networking device, that forwards data packets between computer networks. This creates an overlay internetwork, as a router is connected to two or more data lines from different networks. When a data packet comes in one of the lines, the router takes the address of its ultimate destination and directs the packet to the next network on its journey.

Router performs the "traffic directing" functions on the Internet. A data packet is typically forwarded from one router to another through the networks that constitute the internetwork until it reaches its destination node.



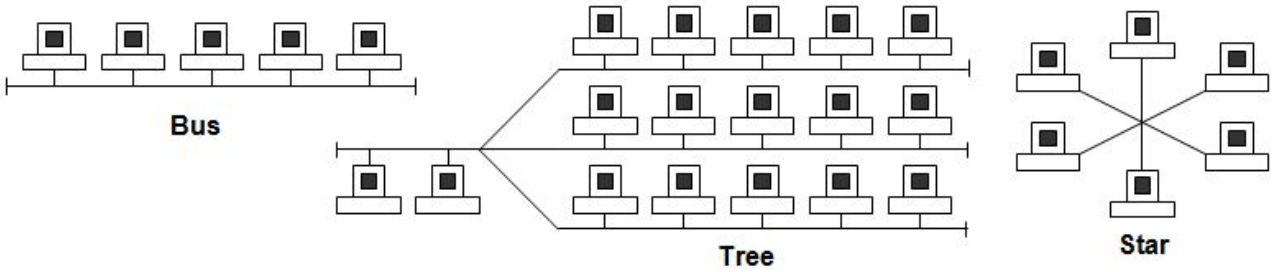
WiFi Card: A WiFi/Wireless Network Interface Controller (WNIC) is a network interface controller, which connects to a radio-based computer network. A WiFi/WNIC Card, just like other wired Network Interface Controller. A WiFi/WNIC is an essential component for wirelessly connected laptop/desktop computer. This card uses an antenna to communicate through radio signals. A WiFi/WNIC card in a desktop computer usually is connected using the PCI bus. Now, a days other WiFi connectivity options are also available using USB.

Network topologies: It is the physical makeup of a network, i.e., endpoints or user station attached to the network.

1. **Bus:** It is characterised by common transmission medium shared by all the connected hosts, managed by dedicated nodes. It offers simultaneous flow of data and control.

2. **Tree:** A tree topology may be defined as a group of bus or star topologies put together.

3. **Star:** It is characterised by central switching mode (communication controller) unique path (point to point link) for each host. It is easy to add and remove additional hosts by upgrading the centralised node.



Advantages

Bus Topology	Tree Topology	Star Topology
Economic as compared to other topologies of network Simple Architecture	Faster as compared to Bus Topology Easier to set-up for multi-floor plans of network	Faster communication as compared to Bus topology Independent line of connection allows freedom of removing or adding nodes from the network

Disadvantages

Bus Topology	Tree Topology	Star Topology
Slower as compared to tree and star topologies of network Breakage of wire at any point disturbs the entire network	Slower as compared to Star Topology Expensive as compared to Bus Topology	Expensive as compared to Bus topology Long wire length

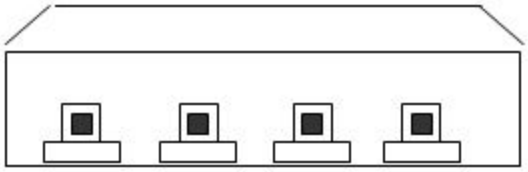
Types of Network

Networks are classified in accordance with the amount of physical territory they encompass.

PAN (Personal Area Network): A **personal area network** - **PAN** - is a computer network organized around an individual person. Personal area networks typically involve a cell phone and palm devices/handheld computing devices. You can use these networks to transfer files

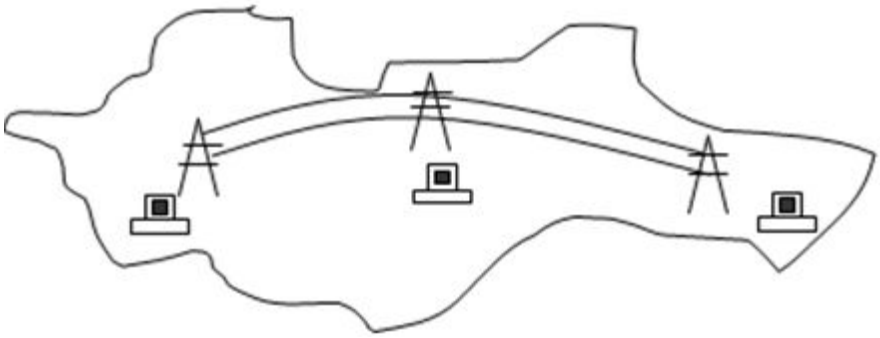
including email and calendar appointments, digital photos and music. PAN may be constructed with cables or wirelessly (usually Blue tooth).

LAN (Local Area Network): LAN interconnects a high number of access or node points or stations within a confined physical area within a kilometer. An example is the territory covered in a single office building those houses various departments/offices. All these areas are interconnected using a LAN.



Network with in a building/compound

MAN (Metropolitan Area Network): It is used to connect systems confined within a city/limited geographical area (20-30 Kilometers). Localised systems such as teller machines within a single citywide area are interconnected using a MAN. A small bank with offices restricted to a city or a single state might also be interconnected through a MAN.



Network within a City

WAN (Wide Area Network): Used to connect systems with no limitation of geographical area. It is used to serve many locations distributed over a large geographical area. A system of overnight teller machines used by a banking organisation covering the North of India is an example of a WAN. Internet is also an example of the same.

Protocols: It is the set of rules for governing communication between two communication devices. It also infers documentation, negotiations and establishment of rules.

TCP/IP (Transmission Control Protocol / Internet Protocol): A protocol for communication between computers used as a standard for transmitting data over networks and is the basis for standard Internet protocols.

FTP (File Transfer Protocol): It is a primary method to transfer files over the Internet. FTP transfers files to and from a remote network site. It is a common method of moving files between two computers.

PPP (Point-to-Point Protocol): The Point-to-Point Protocol (PPP) originally emerged as an encapsulation protocol for transporting IP traffic over point-to-point links. PPP also established a standard for assigning and managing IP addresses, network protocol multiplexing, etc. for added networking capabilities.

Simple Mail Transfer Protocol (SMTP) is an Internet standard for electronic mail (e-mail) transmission across Internet Protocol (IP) networks. While electronic mail servers use SMTP to send and receive mail messages, user-level client mail applications typically only use SMTP for sending messages to a mail server for relaying. For receiving messages, client applications usually use either the Post Office Protocol (POP) or the Internet Message Access Protocol (iMAP) or a proprietary system (such as Microsoft Exchange or Lotus Notes/Domino) to access their mail box accounts on a mail server.

Post Office Protocol (POP) is Internet standard protocol used by local e-mail clients to retrieve e-mail from a remote server over a TCP/IP connection. POP and IMAP (Internet Message Access Protocol) are the two most prevalent Internet standard protocols for e-mail retrieval. The POP protocol has been developed through several versions, with version 3 (POP3) being the current standard. POP3 is used for most webmail services such as Gmail and Yahoo! Mail.

Remote Login (Telnet) or an Application Level-Remote Login - Telnet is a program that allows user to establish a virtual terminal connection between two machines using TCP/IP (Transfer Control Protocol/Internet Protocol).

Wireless/Mobile Communication is the communication using devices, which are not physically connected with each other by cable.

GSM (Global System for Mobile Communication)

Global system for mobile communication (GSM) is a wide area wireless communications system that uses digital radio transmission to provide voice, data, and multimedia communication services. A GSM system coordinates the communication between mobile telephones (mobile stations), base stations (cell sites), and switching systems. Each GSM radio channel is 200 kHz wide that is further divided into frames each of which hold 8 time slots. GSM was originally named Group Special Mobile. The GSM system includes mobile telephones (mobile stations), radio towers (base stations), and interconnecting switching systems. In India this technology is adapted by Airtel and Vodaphone.

CDMA (Code Division Multiple Access) - It is a digital wireless telephony transmission technique, which allows multiple frequencies to be used simultaneously - Spread Spectrum. It is patented by QUALCOMM. In India this technology is used by Reliance, Tata and MTNL

General Packet Radio Service (GPRS) is a packet oriented mobile data service on the 2G and 3G mobile systems of GSM. The service is available to users in over 200 countries worldwide.

WLL (Wireless Local Loop) - Sometimes called as Radio In The Loop (RITL) or Fixed-Radio Access (FRA), WLL is a system that connects subscribers to the Public Switched Telephone Network (PSTN) using radio signals as a substitute for cable for all or part of the connection between the subscriber and the switch. This includes cordless access systems; proprietary fixed radio access, and fixed cellular systems.

Mobile telecommunication technologies: 1G, 2G, 3G, 4G

			
1G	**2G**	**3G**	**4G**
Features			
Basic Voice Services Analog-based protocol	Better Voice Services Basic Data Services First digital standards (GSM,CDMA)	Improved Data Services with Multimedia Mobile Broadband	IP based Protocols (LTE) True Mobile Broadband
Approximate Speed			
2.4 kbps	**64 kbps**	**2 mbps**	**100 mbps**

Protocols for Chat and Video Conferencing

Chat: It is an application to communicate with a person, a group, or a site on the Internet in real time by typing text. The text appears on the screen(s) of all the other participants in the "chat".

Video Conferencing

It is a conference between two or more participants at different locations over the Internet or a private network. Each user has a video camera, microphone, and speakers mounted on his or her computer. As the participants speak to one another, they hear each other's voices and see a video image of the other participant(s).

Voice over Internet Protocol (**Voice over IP**, **VoIP**) is communication protocols and transmission technologies for delivery of voice communications and multimedia sessions over Internet Protocol (IP) networks, such as the Internet. Also, we can say, VoIP are *IP telephony*, *Internet telephony* and *broadband telephony*.

Wireless Technologies

Wi-Fi is a trademark of the Wi-Fi Alliance. It is not a technical term. However, the Alliance has generally enforced its use to describe only a narrow range of connectivity technologies including wireless local area network (WLAN) based on the IEEE 802.11standards

Worldwide Interoperability for Microwave Access (WiMAX) is a telecommunications protocol, which provides fixed and fully mobile Internet access. The current WiMAX revision provides up to 40 mbps and with the IEEE 802.16m update expected to offer up to 1 gbps fixed speeds.

Network Security Concepts

Threats and Prevention

Computer Virus: A computer virus can spread from one computer to another (in some form of executable code) when its host is taken to another computer; for instance because a user sent it over a network or the Internet, or carried it on a removable medium such as a floppy disk, CD, DVD, or USB drive. Viruses can increase their chances of spreading to other computers by infecting files on a network file system or a file system that is accessed by another computer.

Computer Worm: A **computer worm** is a self-replicating computer program. It uses a network to send copies of itself to other nodes (computers on the network) and it may do so without any user intervention. Unlike a virus, it does not need to attach itself to an existing program.

TROJAN HORSE: "Malware" computer programs presented as useful or harmless in order to induce the user to install and run them.

SPAM: Spam is the abuse of electronic messaging systems (including most broadcast media, digital delivery systems) to send unsolicited bulk messages indiscriminately. While the most widely recognized form of spam is e-mail spam, the term is applied to similar abuses in other media: instant messaging spam, Usenet newsgroup spam, Web search engine spam, spam in blogs, wiki spam, online classified ads spam, mobile phone messaging spam, Internet forum spam, junk fax transmissions, social networking spam, and file sharing network spam.

Use of Cookies: A small piece of information that a server sends to a client. When you visit a Web site with cookie capabilities, its server sends certain information about you to your browser, which is stored on your hard drive as a text file. At some later time (such as returning to the site the next day), the server retrieves the cookie. It's a way for the server to remember things about you.

Protection using Firewall: Any of a number of security schemes (hardware/software) that prevent unauthorized users from gaining access to a computer network or that monitor transfers of information to and from the network.

India IT Act: An Act to provide legal recognition for the transactions carried out by means of electronic data interchange and other means of electronic communication, commonly referred to as "Electronic Commerce", which involve the use of alternatives to paper based methods of communication and storage of information , to facilitate electronic filings of documents with the Government agencies and further to amend the Indian Penal Code, Indian Evidence Act, 1872,, The Bankers' Books Evidence Act, 1891, and the Reserve Bank of India Act, 1934 and for matters connected therewith or incidental thereto.

Cyber law encompasses a wide variety of political and legal issues related to the Internet and other communications technology, including intellectual property, privacy, freedom of expression, and jurisdiction.

Cyber-crime refers to any crime that involves a computer and a network, where the computers may or may not have played an instrumental part in the commission of a crime. Issues surrounding this type of crime have become high profile, particularly those surrounding hacking, copyright infringement, etc. There are also problems of privacy when confidential information is lost or intercepted, lawfully or otherwise.

Intellectual Property Right (IPR) - Under intellectual property law, owners are granted certain exclusive rights to a variety of intangible assets, such as musical, literary, and artistic works;

discoveries and inventions; and words, phrases, symbols, and designs. Common types of Intellectual Property include copyrights, trademarks, patents, industrial design rights and trade secrets in some jurisdictions.

Hacking: The process in which people break and enter a computer/network without having authorised access and with no malicious intent is known as hacking. It is the duty of an ethical hacker to inform the system administrator of the security flaw as soon as he/she identifies it.

Introduction to Web Services

WWW: WWW, the World Wide Web (commonly known as the Web) is a system of interlinked hypertext documents that are accessed via the Internet. One can view web pages that may contain text, images, videos, and other multimedia and navigate between them via hyperlinks.

HTML(Hyper Text Markup Language): The coding language used to create Hypertext documents for use on the World Wide Web.

XML (eXtensible Markup Language): XML is a programming language that enables designers to create their own tags to indicate specific information.

HTTP: Hyper Text Transfer Protocol - The protocol that allows use of HTML on the World Wide Web.

Domain Name: It is the unique name that identifies an Internet site. Domain Names always have 2 or more parts, separated by dots (or periods). The part on the left is the most specific, and the part on the right is the most general. A given machine may have more than one Domain Name but a given Domain Name points to only one machine. Example: **w3schools.com**, **microsoft.co.in, cbse.nic.in**

URL (Uniform Resource Locator): It is the global address of documents and other resources on the World Wide Web. The first part of the address indicates what protocol to use, and the second part specifies the IP address or the domain name where the resource is located. In other words, it is a specific character string that constitutes a reference to an Internet resource.

For example, in the URL "**http://www.w3schools.com/html/default.asp**", the domain name is "**w3schools.com**"

Website: It is a group of Web Pages that collectively represent information of a company, or individual on the World Wide Web. A group of web pages that have been developed together to present information on specific subjects is also a Web Site.

Web Browser: It is a Client software program that is used to access various kinds of Internet resources using HTTP. Examples: Mozilla Firefox, Internet Explorer, Netscape Navigator, Opera, Safari etc.

Web Server: It is a computer that stores Web documents and makes them available to the rest of the world. A server may be dedicated, meaning its sole purpose is to be a Web server, or non-dedicated, meaning it can be used for basic computing in addition to acting as a server.

Web Hosting: It is a service that allows you to upload and store a site's HTML documents and related files on a Web server. This makes the files available on the World Wide Web for viewing by the public. It is also called site hosting.

Web Scripting – CLIENT and SERVER Side

VBScript or Javascript codes are embedded in Web pages to be executed on the client's computer, whereas ASP, JSP and PHP codes are embedded in the Web Pages to be executed on the Server.

Web page: It is a single document written in HTML having extension as .htm or .html. It is viewable in any Internet Browser. It can be edited in any text editor.

IP Address: It is a unique, numeric identifier used to specify hosts and networks. Internet Protocol (IP) numbers are part of a global standardized scheme for identifying machines that are connected to the Internet. Technically speaking, IP numbers are 32 bit addresses that consist of **four** octets, and they are expressed as four numbers between 0 and 255, separated by periods, for example: 198.41.0.52

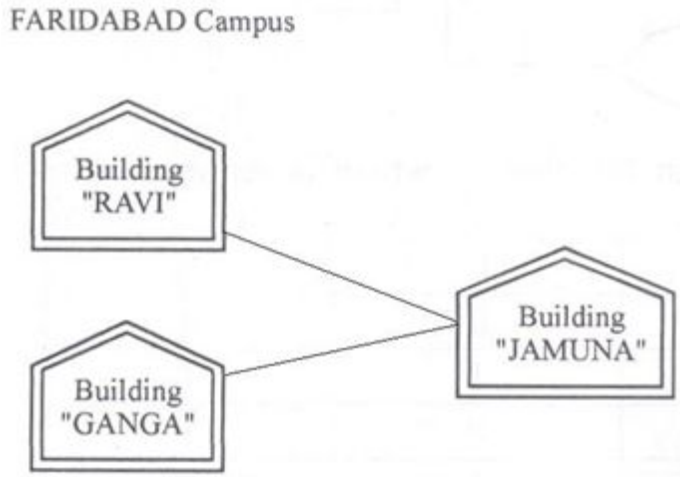
Web 2.0 for Social Networking

Web 2.0 terms is commonly associated with web applications that facilitate interactive systemic biases, interoperability, user-centered design, and administrating the World Wide Web. A Web 2.0 site allows users to interact and collaborate with each other in a social media dialogue as consumers of user-generated content in a virtual community, in contrast to websites where users are limited to the active viewing of content that they created and controlled. Examples of Web 2.0 include Social networking sites, Blogs, Wikis, Video-sharing sites etc.

Q Granuda Consultants are setting up a secured network for their office campus at Faridabad for their day to day office and web based activities. They are planning to have connectivity between 3 building and the head office situated in Kolkata. Answer the questions (i) to (vi) after going through the building positions in the campus and other details, which are given below.

Distances between various buildings :

Building "RAVI" to Building "JAMUNA"	120 m
Building "RAVI" to Building "GANGA"	50 m
Building "GANGA" to Building "JAMUNA"	65 m
Faridabad Campus to Head Office	1460 KM

	Number of Computers Building "RAVI" 25 Building "JAMUNA" 150 Building "GANGA" 51 Head Office 10	
(i)	**Suggest the most suitable place (i.e. block) to house the server of this organization. Also give a reason to justify your suggested location.**	
Ans	**Building "Jamuna", since it contains maximum number of computers** **OR** **Building "Ganga", since it is closest to the other two buildings "Jamuna" and "Ravi"**	
	(½ Mark for writing any correct place) *(½ Mark for correct justification)*	
(ii)	**Suggest a cable layout of connections between the buildings inside the campus.**	
Ans		
	(1 Mark for drawing /writing any valid connectivity or topology or diagram connecting various buildings inside the campus)	
(iii)	**Suggest the placement of the following devices with justification** **(i) Switch** **(ii) Repeater**	
Ans	**(i) Switch:** **In each of the buildings, since a network switch is a networking device that joins multiple computers together within one local area network (LAN).** **(ii) Repeater:**	

	Between buildings "Jamuna" and "Ravi", since distance between these two buildings is greater than 70 m which will otherwise lead to loss of signal intensity for data to be transferred.	
	(½ Mark for writing correct placement and justification of Switch) ***(½ Mark for writing correct placement and justification of Repeater, according to layout drawn for ii)***	
(iv)	**The organization is planning to provide a high speed link with its head office situated in the KOLKATA using a wired connection. Which of the following cable will be most suitable for this job?** **(i) Optical Fibre** **(ii) Co-axial Cable** **(iii) Ethernet Cable**	
Ans	**(i) Optical Fibre**	
	(1 Mark for writing correct option)	
(v)	**What type of network out of LAN, MAN or WAN will be formed, when you will connect the Faridabad Campus with its Kolkata office?**	**1**
Ans	**WAN**	
	(1 Mark for writing correct answer)	
(vi)	**What type of network out of LAN, MAN or WAN will be formed, when you will connect the buildings of Faridabad Campus with each other?**	**1**
Ans	**LAN**	
	(1 Mark for writing correct answer)	

Communication Technologies - Abbreviations

ASP	Active server Page	PPP	Point-to-Point Protocol
CDMA	Code Division Multiple Access	PSTN	Public Switched Telephone Network
FTP	File Transfer Protocol	SMS	Short Message Service
GPRS	General Packet Radio Service	SMTP	Simple Mail Transfer Protocol
GSM	Global System for Mobile Communication	TCP/IP	Transmission Control Protocol / Internet Protocol
HTML	Hyper Text Markup Language	URL	Uniform Resource Locator
HTTP	HyperText Transfer Protocol	VoIP	Voice over Internet Protocol (Voice over IP)
iMAP	Internet Message Access Protocol	WiFi	Wireless Fidelity
JSP	Java Server Page	WLL	Wireless Local Loop
PHP	Personal Home Page	WiMAX	Worldwide Interoperability for Microwave Access
POP	Post Office Protocol	XML	eXtensible Markup Language