UNIT - 1

Introduction To Computer Networks

Modern world scenario is ever changing. Data Communication and network have changed the way business and other daily affair works. Now, they highly rely on computer networks and internetwork.

A set of devices often mentioned as nodes connected by media link is called a Network.

A node can be a device which is capable of sending or receiving data generated by other nodes on the network like a computer, printer etc. These links connecting the devices are called **Communication channels**.

Computer network is a telecommunication channel using which we can share data with other computers or devices, connected to the same network. It is also called Data Network. The best example of computer network is Internet.

Computer network does not mean a system with one Control Unit connected to multiple other systems as its slave. That is Distributed system, not Computer Network.

A network must be able to meet certain criterias, these are mentioned below:

1. Performance
2. Reliability
3. Scalability

Computer Networks: Performance

It can be measured in the following ways:

- **Transit time:** It is the time taken to travel a message from one device to another.
- **Response time:** It is defined as the time elapsed between enquiry and response.

Other ways to measure performance are:

1. Efficiency of software
2. Number of users
3. Capability of connected hardware

Basic Communication Model

A Communication model is used to exchange data between two parties. For example: communication between a computer, server and telephone (through modem).

Communication Model: Source

Data to be transmitted is generated by this device, example: telephones, personal computers etc.

Communication Model: Transmitter

The data generated by the source system is not directly transmitted in the form its generated. The transmitter transforms and encodes the data in such a form to produce electromagnetic waves or signals.

Communication Model: Transmission System

A transmission system can be a single transmission line or a complex network connecting source and destination.

Communication Model: Receiver

Receiver accepts the signal from the transmission system and converts it into a form which is easily managed by the destination device.

Communication Model: Destination

Destination receives the incoming data from the receiver.

Morden communication

Wireless communication networks have become more popular than expected at the time of 1960s and 1970s when the cellular concept was first developed. According to ITU's latest status, there are 76.2 mobile subscriptions for each 100 people which is 4.4 times the number of fixed telephone lines. On World Statistics Day, October 20, 2010. The International Telecommunication Union (ITU), the UN Agency for ICT, announced its eagerly awaited mobile estimates for 2010. By the end of the year there will be 5.3 billion mobile subscriptions. That is equivalent to 76 per cent of the world population and is a huge increase from 4.6 billion mobile subcriptions at the end of 2009. Nearly a billion of these are 3G subcriptions, and potentially mobile Web users. The mobile telephony is becoming more and more ubiquitous. In developed countries, the growth is slowing down with average penetration rates above 100 per cent. But in developing countries, growth is still strong and therefore more and more people will be connected to telephones who never had access to a telephone at all in the past, thus mobile revolution is continuing. The telecom story continues to grow in India also. As the number of users are increasing so there is need to invent new technologies to fulfil the requirement of users.

telephony
Telephony is technology associated with interactive communication between two or more physically distant parties via the electronic transmission of speech or other data. Long associated with voice communication, telephony has evolved to also include text messaging, video calling, video conferencing, voicemail, call recording and faxing.

A telephonic exchange historically required the use of traditional fixed-line telephones, handheld devices containing both speakers (transmitters) and receivers that connected to local exchange networks via physical wiring. Telephonic communication increasingly happens using modern computing and cellular technology, thus blurring the line between the fields of telephony and telecommunication. The definition of telephony and its scope have expanded accordingly.

Internet telephony enables users to make calls over Internet Protocol (IP) networks, at much lower cost than over the traditional public switched telephone network (PSTN). Computer applications called *softphones* behave like legacy telephones but without the need for standalone devices. IP telephony software can reside on a variety of computing hosts, including personal computers (PCs), smart desk phones, smart mobile phones and tablets.

How telephony works

- How traditional telephony works. Traditional phone systems convert sound waves at one end of a call into electrical signals that travel to their destination via the wires and cables of the PSTN -- the circuit-switched telephone network that crisscrosses the globe. The recipient's phone then converts the transmission back into sound signals, enabling a real-time conversation.

  Also known as the plain old telephone service (POTS), the PTSN is operated by international,

national, regional and local carriers. Its underlying infrastructure originally featured copper lines but now includes fiber-optic cabling, cellular technology and satellite systems.

- How mobile telephony works. Using cellular technology, a mobile phone converts sound into electrical signals that it broadcasts via radio waves to a local cell tower. The cellular network uses radio signaling to forward this information to the recipient's phone, which, in turn, converts the signals back into sound.
- How internet telephony Internet telephony software converts sound waves into data that travels over packet-switched computer networks, enabling voice calls to occur online and independent of the PSTN and cellular systems. Voice over IP (VoIP), a Layer 3 protocol and subset of IP telephony, delivers voice and other communication services, such as video conferencing and text messaging, across broadband and private IP networks.
- How faxing works. Legacy fax (short for facsimile) technology is similar to traditional voice telephony. Instead of using sound waves as the mechanism for converting data, a fax machine's sensor encodes a printed document, which it interprets as a two-dimensional, fixed bitmap The machine then converts that graphic into electronic signals. Those signals traverse the telephone network and arrive at the receiving fax machine, which reconverts and decodes the signals, reassembling and printing them to reflect the original document.
  IP faxing, also known as fax over IP (FoIP) or virtual faxing, functions much like traditional faxing but via the internet. Software encodes a scanned document and converts it into data that can travel over local or wide area IP networks before being decoded and reconverted on the receiving end.

History of telephony

The word telephony comes from the Greek root words for far, tele, and speak, phone. In 1876, Alexander Graham Bell famously patented the telephone as a way to electronically transmit human speech, building on the success of the telegraph system. A few days later, he spoke the first words ever communicated via telephone to his assistant, Thomas Watson, who was in the next room: "Mr. Watson, come here. I want to see you." The following year, he made the first distanced phone call in history -- from Salem, Mass., to Boston -- and founded the Bell Telephone Company, which would later become part of AT&T.

Telephony or voice telecommunications refers to the communication of sound over a distance using wire or wireless telephones and related technology. Telephony is one domain of telecommunications, which includes:

1. Data communications, which involves the transfer of numbers and text through computer networks.
2. Video communications, which refers to the transfer of images through broadcast, cable, and satellite television.
3. Voice communications, which involves the transfer of sounds—especially the human voice—through telephone systems.

These domains are not mutually exclusive, however, because the differences between various kinds of telecommunications are beginning to disappear. For example, telephone lines are used for telephones, fax machines, and modems. Despite the overlap, the distinction between these kinds of telecommunication remains useful, since each may employ separate technology and serve different purposes.

Telephony has played and is expected to continue to play a significant and increasing role in business and has become just as essential to companies as personnel, capital, and marketing. Not surprisingly, voice communications is the most important form of telecommunications for businesses, because of its use for communication among employees and between employees and customers and for the dissemination of information. Consequently, voice communications is a business resource that can improve internal and external communication, maintain good internal

and external relationships, save time and money, and even help earn money. Key business applications of telephony include telemarketing, teleconferencing, and telecommuting.

CDMA: Code Division Multiple Access

Code Division Multiple Access is *a channel access method used by several radio communication technologies*. It is a digital cellular technology and an example of multiple access. It is generally used for mobile communication.

Multiple access means that several transmitters can send information simultaneously over a single communication channel. In this system, different CDMA codes are assigned to different users and the user can access the whole bandwidth for the entire duration. It optimizes the use of available bandwidth as it transmits over the entire frequency range and does not limit the user's frequency range.

Thus, CDMA allows several users to share a band of frequencies without undue interference between the users. It is used as a access method in many mobile phone standards.

Usage

- It is used in the Global Positioning System (GPS).
- It is used by several mobile phone companies (e.g. Qualcomm standard IS-2000 also known as CDMA2000)
- W-CDMA is used in UTMS 3G mobile phone standard.
- CDMA has been used in OmniTRACS satellite system for transportation.

GSM: Global System for Mobile communication

GSM stands for Global System for Mobile communication. It is *a standard* developed by European Telecommunication Standards Institute (ETSI) to *describe protocols for second generation (2G) digital cellular networks*. It was a replacement for the first generation (1G) cellular networks. The idea of developing GSM originated from a cell-based mobile radio system at the Bell Laboratories in the early 1970s.

GSM is an open, digital cellular radio network operating in over 200 countries worldwide. It uses narrowband time division multiple access (TDMA) technology. It covers almost complete Western Europe and growing in America and Asia. It is not only used for voice calls, it can also be used for data computing and sending text messages. A user can connect his GSM-enabled phone with his laptop to send or receive e-mails, faxes, browse internet, check security etc.

The GSM standard operates on three different frequencies which are as follows:

- **900 MHz:** It was used by the original GSM system.
- **1800 MHz:** It was used to support the growing number of subscribers.
- **1900 MHz:** It is mainly used in the US.

Data applications supported by GSM

GSM provides following functionalities when you connect your GSM phone with a computer system.

Internet: GSM provides the most ubiquitous and robust wireless data connectivity to access the internet.

Mobile Fax: With GSM, you can send and receive faxes to any place where GSM service is available.

Secured LAN access: GSM provides secured access for corporate LAN. It encrypts the air links and provides additional security for confidential e-mails and faxes.

Advantages of GSM

- Since GSM service is obtained over 200 countries, so it provides worldwide roaming for its clients to roam throughout the world.
- GSM is extremely secured because its devices and facilities cannot be easily duplicated.
- It has an extensive coverage in all over the world.
- Clear voice calls and efficient use of spectrum.
- Compatible with wide range of handsets and accessories.
- Advanced features such as short messages, caller ID, Call hold, Call forwarding etc.
- Compatible with Integrated Services Digital Network (ISDN) and other telephone company services.

Disadvantages of GSM

- The biggest disadvantage of GSM is that multiple users share the same bandwidth. This may cause interference and due to interference bandwidth limitation occurs.
- The other disadvantage of GSM is that it may cause electronic interference. That is the reason why sensitive locations like hospitals and airplanes require cell phone to be turned off otherwise it can create interference with the equipments of hospitals and airplanes.

Difference between CDMA and GSM

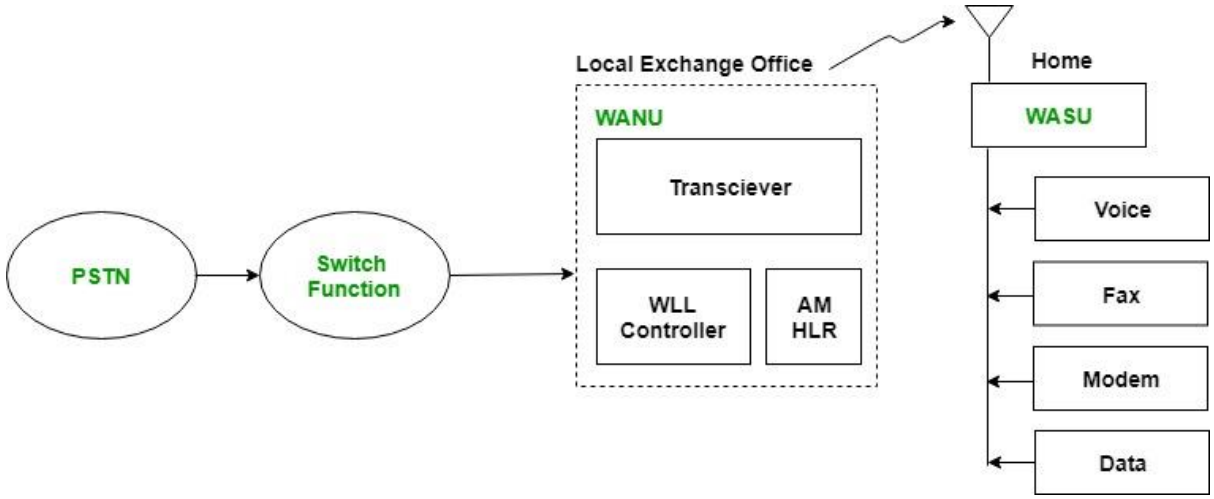
Criteria	CDMA	GSM
Technology	CDMA is based on spread-spectrum technology which makes the optimum use of available bandwidth.	GSM operates on the wedge spectrum. it uses both time division multiple access (TDMA) and frequency division multiple access (fdma). TDMA provide multi-user access by cutting up the channel into different time slice and fdma provides the multi-user access by separating the used frequency.
Security	CDMA is more secure than GSM.	GSM is less secure than CDMA.
Global reach	CDMA is used in USA and some part of Canada and Japan. CDMA is used only	GSM is used over 80% of the world network in over 210 countries.

	by 24% of the users worldwide.	GSM is used 76% of the users worldwide.
Data Transfer Rate	CDMA has faster data transfer as compared to GSM.	GSM has slower data transfer as compared to CDMA.
Radiation exposure	CDMA phones emits less radiation than GSM phones.	GSM phones emits continuous wave pulses and emits almost 28 times more radiation than CDMA phones.

WLL:- Wireless Local Loop

Local loop is a circuit line from a subscriber's phone to the local central office (LCO). But the implementation of local loop of wires is risky for the operators, especially in rural and remote areas due to less number of users and increased cost of installation. Hence, the solution for it is the usage of wireless local loop (WLL) which uses wireless links rather than copper wires to connect subscribers to the local central office.

WLL Architecture:



WLL components:

1. **PSTN:**
   It is Public Switched Telephone Network which is a circuit switched network. It is a collection of world's interconnected circuit switched telephone networks.

2. **SwitchFunction:**
   Switch Function switches the PSTN among various WANUs.

3. **WANU:**
   It is short for Wireless Access Network Unit. It is present at the local exchange office. All local WASUs are connected to it. Its functions includes: Authentication, Operation & maintenance, Routing, Transceiving voice and data. It consists of following sub-components:

   - Transceiver: It transmits/receives data.
   - WLL Controller: It controls the wireless local loop component with WASU.
   - AM: It is short for Access Manager. It is responsible for authentication.
   - HLR: It is short for Home Location Register. It stores the details of all local WASUs.

4. **WASU:**
   It is short for Wireless Access Subscriber Units. It is present at the house of the subscriber. It connects the subscriber to WANU and the power supply for it is provided locally.

Advantages of WLL:

- It eliminates the first mile or last mile construction of the network connection.
- Low cost due to no use of conventional copper wires.
- Much more secure due to digital encryption techniques used in wireless communication.
- Highly scalable as it doesn't require the installation of more wires for scaling it.

Features of WLL:

- Internet connection via modem
- Data service
- Voice service
- Fax service

What is VoIP Telephony?

IP telephony (Internet Protocol telephony, also called VoIP, is the telephony as we have always used it but cheaper thanks to Internet.

If you have Internet connection you can have access to VoIP Telephony and save a lot of money every month, while having the same service but improved thanks to technology.

VoIP is a technology that makes possible to make phone calls with your landline over the internet, instead of doing them through the traditional companies. It turns analog phone signals into digital signals to send the voice over Internet. Thanks to it there is no need to spend a lot of money in maintaining a big infrastructure of telecommunications, as traditional companies do. This way we can offer you really good prices to save money in your communications.

Millions of people have already turned their fixed-line to VoIP to save money every month and gain advanced functionalities.

What do I need to start using VoIP telephony?

With VoIP the voice is sent over the internet, so you need a phone that turns voice in digital signals in order to use this technology. You have different choices of devices to use:

- **Analogue telephone with a** VoIP adapter

This adapter **turns any telephone into a VoIP phone**. It changes analogue signal into digital signals, and connects your traditional phone to Internet.

- **VoIP phone**

VoIP phones turn themselves voice to digital signals. They use VoIP technology and they normally have advanced functionalities in order to take advantage of the benefits of VoIP.

- **A smartphone, tablet or computer**

Another advantage of using VoIP is that **you can use these 3 devices to make phone calls** when having internet connection and a softphone. A softphone is a program or app that emulates a phone. Furthermore, you will be able to **use your fixed line from anywhere as far as you have configured it in your phone and have Internet connection.**

BLUETOOTH

Bluetooth is a wireless protocol for exchanging data over short distances from fixed and mobile devices, creating personal area networks (PANs). It can connect several devices, overcoming problems of synchronization. Bluetooth uses a radio technology called frequency hopping spread spectrum in its basic mode, the modulation is Gaussian frequency shift keying (GFSK). It can achieve a gross data rate of 1 Mb/s. Bluetooth provides a way to connect and exchange information between devices such as mobile phones, telephones, laptops, personal computers,
printers, GPS receivers, digital cameras, and video game consoles through a secure, globally unlicensed industrial, scientific and medical (ISM) 2.4 GHz short range radio frequency bandwidth transmitter uses spread-spectrum transmitting automatically, it is unlikely that the 2 transmitters will be on the same frequency at the same time. This technique minimizes the risk that portable phones will disturb Bluetooth devices, since any interference on a particular frequency will last only for a tiny fraction of a second.
When Bluetooth-capable devices come within the range of one another, an electronic conversation takes place to determine whether they have data to share or whether one needs to control the other. The user doesn't have to press a button or give a command—the electronic conversation happens automatically. Then the devices form a network. Bluetooth creates a personal area network (PAN) or piconet, that may fill a room or may encompass no more distance than that between the cell phone on a belt-clip and the headset on your head. Once the piconet is established, the members randomly hop frequencies, so they stay in touch with one another and avoid other piconets that may be operating in the same room.

Bluetooth Security

Bluetooth offers several security modes, and device manufacturers determine which mode to include in a Bluetooth-enabled gadget. In almost all cases, Bluetooth users can establish "trusted devices" that can exchange data without permission. When any other device tries to establish a connection to the users' gadget, the user has to decide to allow it. Service-level security and device-level security work together to protect Bluetooth devices from unauthorized data transmissions. Security methods include authorization and identification procedures that limit the use of Bluetooth services to register user and require that users make a conscious decision to open a file or accept a data transfer. As long as these measures are
enabled on the user's phone or other device, unauthorized access is unlikely. A user can also simply switch his Bluetooth mode to non-discoverable and avoid connecting with other Bluetooth devices entirely. Still, early cell phone virus writers have taken advantage of Bluetooth's automated connection process to send out infected files. However, since most
cell phones use a secure Bluetooth connection that requires authorization and authentication before accepting data from an unknown device, the infected file typically doesn't get very far, when the virus arrives in the user's cell phone, the user has to agree to open it and then agree to install it. This has, so far, stopped most cell phone viruses from doing such damage.

Wi-Fi is a wireless networking technology that allows devices such as computers (laptops and desktops), mobile devices (smart phones and wearables), and other equipment (printers and video cameras) to interface with the Internet. It allows these devices--and many more--to exchange information with one another, creating a network.
Internet connectivity occurs through a wireless router. When you access Wi-Fi, you are connecting to a wireless router that allows your Wi-Fi-compatible devices to interface with the Internet.

A Brief Introduction About Wi-Fi:

Wi-Fi is a popular wireless networking technology. Wi-Fi stands for "wireless fidelity". The Wi-Fi was invented by NCR corporation/AT&T in Netherlands in 1991. By using this technology we can exchange the information between two or more devices. Wi-Fi has been developed for mobile computing devices, such has laptops, but it is now extensively using for mobile applications and consumer electronics like televisions, DVD players and digital cameras. There should be two possibilities in communicating with the Wi-Fi connection that may be through access point to the client connection or client to client connection. Wi-Fi is a one type of wireless technology. It is

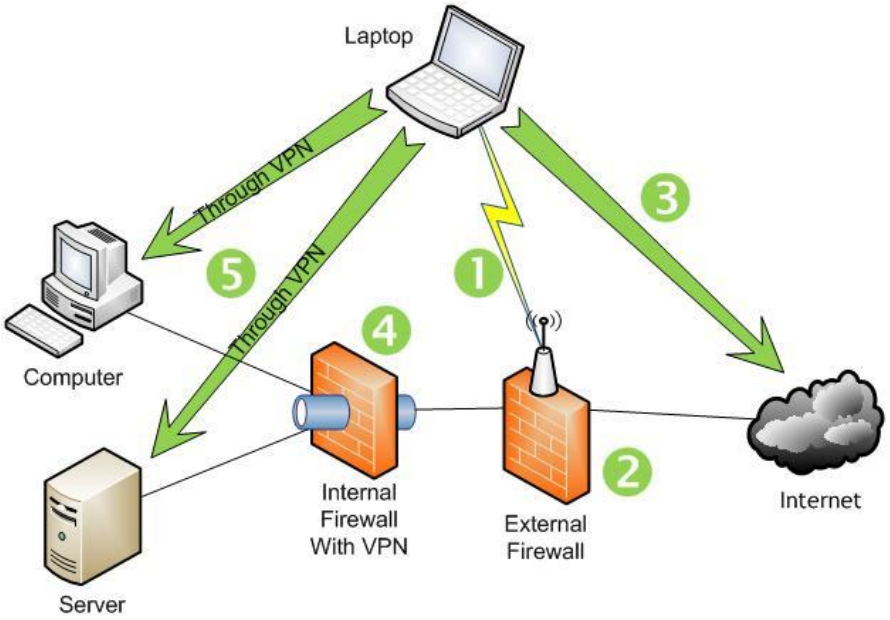
commonly called as wireless LAN (local area network). Wi-Fi allows local area networks to operate without cable and wiring. It is making popular choice for home and business networks. A computer's wireless adaptor transfers the data into a radio signal and transfers the data into antenna for users.

WIFI Technology

Working Principle:

Wi-Fi is a high speed internet connection and network connection without use of any cables or wires. The wireless network is operating three essential elements that are radio signals, antenna and router. The radio waves are keys which make the Wi-Fi networking possible. The computers and cell phones are ready with Wi-Fi cards. Wi-Fi compatibility has been using a new creation to constituent within the ground connected with community network. The actual broadcast is connected with in sequence in fact it is completed by way of stereo system surf as well as the worth of wires with monitor to classification prone. Wi-Fi allows the person in order to get access to web any place in the actual provided area. You can now generate a system within Resorts, library, schools, colleges, campus, personal institutes, as well as espresso stores as well as on the open public spot to help to make your company much more lucrative as well as interact with their own customer whenever. Wi-Fi compatibility can make surf with stare to company using their inspiring cable television much a smaller amount force down.

The radio signals are transmitted from antennas and routers that signals are picked up by Wi-Fi receivers, such has computers and cell phones that are ready with Wi-Fi cards. Whenever the computer receives the signals within the range of 100-150 feet for router it connect the device immediately. The range of the Wi-Fi is depends upon the environment, indoor or outdoor ranges. The Wi-Fi cards will read the signals and create an internet connection between user and network. The speed of the device using Wi-Fi connection increases as the computer gets closer to the main source and speed is decreases computer gets further away.



WI-FI Connections

Many new laptops, mobile phones have inbuilt Wi-Fi card you don't have to do any thing which is one of the best thing. If it is a free- based type of network connection the user will be promoted with a login id and password. The free base network connections also well in some areas. The Wi-Fi network connection is creating hot spots in the cities. The hot spots are a connection point of Wi-Fi network. It is a small box that is hardwired in to the internet. There are many Wi-Fi hot spots available in public places like restaurants, airports, and hotels offices, universities etc.

WiFi stands for **Wi**reless **Fi**delity. WiFiIt is based on the IEEE 802.11 family of standards and is primarily a local area networking (LAN) technology designed to provide in-building broadband coverage.

Current WiFi systems support a peak physical-layer data rate of 54 Mbps and typically provide indoor coverage over a distance of 100 feet.

WiFi has become the *de facto* standard for *last mile* broadband connectivity in homes, offices, and public hotspot locations. Systems can typically provide a coverage range of only about 1,000 feet from the access point.

WiFi offers remarkably higher peak data rates than do 3G systems, primarily since it operates over a larger 20 MHz bandwidth, but WiFiWiFi systems are not designed to support high-speed mobility.

Types of WI-FI Technologies:

Currently they are four major types of WIFI technologies.

- Wi-Fi-802.11a
- Wi-Fi-802.11b
- Wi-Fi-802.11g
- Wi-Fi-802.11n

Wi-Fi-802.11a:

802.11a is the one of a series of wireless technology. That defines the format and structure of the radio signals sent out by WI-FI networking routers and antennas.

Wi-Fi-802.11b:

802.11b is the one of a series of wireless technology. 802. 11b support bandwidth 11mbps. Signal in unregulated frequency spectrum around 2.4 GHz. This is a low frequency compared with Wi-Fi-802.11a means it is working reasonable distance. It is interference with micro owns cordless phones and other appliance. It is low-cost; signal range is good using home appliance.

Wi-Fi-802.11g:

In 2002 and 2003, This Technology supporting a newer slandered products. It is best technology of 802.11a and 802.11b. The 802.11 b support bandwidth upto 54mbps and it use a 2.4 GHz frequency for greater range. This cost is more than 802.11b. It is fast accessing and maximum speed.

Wi-Fi-802.11n:

The 802.11n is the newest WIFI technology. It was designed to improve on 802.11g .The amount of bandwidth supported by utilizing multiple wireless signals and antennas instead of one. It supports 100 mbps bandwidth and increased signal intensity.

Applications:

- Mobile applications
- Business applications
- Home applications
- Computerized application
- Automotive segment
- Browsing internet
- Video conference'

Advantages:

- Wireless laptop can be moved from one place to another place
- Wi-Fi network communication devices without wire can reduce the cost of wires.
- Wi-Fi setup and configuration is easy than cabling process
- It is completely safe and it will not interfere with any network
- We can also connect internet via hot spots
- We can connect internet wirelessly

Disadvantages:

- Wi-Fi generates radiations which can harm the human health
- We must disconnect the Wi-Fi connection whenever we are not using the server
- There are some limits to transfer the data, we cant able to transfer the data for long distance
- Wi-Fi implementation is very expensive when compared to the wired connection

There are a few issues that are assumed to be the cause behind the sluggish adoption of WiFi technology −

- **Security Problems** − Security concerns have held back WiFi adoption in the corporate world. Hackers and security consultants have demonstrated how easy it can be to crack the current security technology known as wired equivalent privacy (WEP) used in most WiFi connections. A hacker can break into a WiFi network using readily available materials and software.
- **Compatibility and Interoperability** − One of the major problems with WiFi is its compatibility and interoperability. For example, 802.11a products are not compatible with 802.11b products. Due to different operating frequencies, 802.11a hotspots would not

help an 802.11b client. Due to lack of standardization, harmonization, and certification, different vendors come out with products that do not work with each other.

- **Billing Issues** − WiFi vendors are also looking for ways to solve the problem of back-end integration and billing, which have dogged the roll-out of commercial WiFi hotspots. Some of the ideas under consideration for WiFi billing such as per day, per hour, and unlimited monthly connection fees.

4G technology has become an integral part of everyday life – it paved the way for the popularity and wide-ranging use of sophisticated mobile devices, providing a lightning-fast connection wherever you may go.

However, while we may use 4G in business and our personal lives every day, there's still some confusion about what it is and why it is important.

In this article, we explore the question of "what does 4G mean", how fast it is, and why it's important.

What is a 4G Network?

To put it simply, 4G is defined as the fourth generation of mobile technology which follows the 2G and 3G networks that came before it. It is also sometimes referred to as 4G LTE, but this is not technically correct as LTE is only a single type of 4G. It is currently the most advanced technology that's adopted by the majority of mobile network service providers.

However, as you may have read, 5G is growing and starting to work alongside existing 3G and 4G data networks.

When it initially came out, 4G quickly changed how we use mobile internet. While 3G networks were relatively fast, 4G network connections allowed users to browse the web and stream HD videos on mobile devices, which basically turned smartphones into the computers of the modern age.

Today, you can perform most of the tasks that you could on a laptop or desktop computer on mobile devices such as smartphones or tablets. 4G networks ensure that no matter how much data you need, you can maintain stable speeds almost everywhere.

How Fast is 4G?

4G networks are very fast compared to 3G.

Standard 4G offers download speeds of around 14 Mbps, which is almost five times faster than what its predecessor, the 3G network, was able to offer. In fact, 4G networks can reach speeds as high as 150 Mbps, allowing users to download gigabytes of data in minutes or even seconds, instead of hours like with 3G networks.

Uploading data is much faster as well – standard 4G upload speeds are around 8 Mbps, with theoretical speeds reaching as high as 50 Mbps, while 3G caps off at around 0.5 Mbps. It's a significant difference, no matter how you look at it.

Today, with data plans becoming more affordable, many users have blended the use of mobile and local WiFi networks since both exhibit similar speeds. Some providers even offer home-based 4G networks for people who want to have a mobile hotspot that they can take with them wherever they go.

Why is 4G Important?

4G data networks have revolutionized the mobile industry and paved the way for the widespread use of today's mobile devices.

Another advantage of 4G networks is its much lower latency. Low latency is important when real-time interaction is required, for instance, in video conferencing or online gaming. Unified Communication apps used on mobile devices remain clear, responsive, and fast – helping distant colleagues collaborate and work together seamlessly as if they were in the same office.

What's more, 4G was also immensely useful in the Voice over LTE (VoLTE) industry. It provides a much more stable and clearer connection for voice calls, making it easier for businesses to switch to internet-based telephone systems.

A benefit to enterprise businesses is the ease and speed of 4G network set up. If a company needs to quickly set up a network in a new location, 4G can be installed in a matter of hours, compared to days or even weeks of setting up a wired connection.

Even the automotive industry has started using LTE-based car connectivity features, some even offering 4G network hotspots in their vehicles. Hotspots have also been shown to be incredibly helpful to remote workers when a WiFi connection isn't feasible.

The importance and impact of 4G networks stretch through numerous other industries, as companies and individual users now have the freedom to stay connected in a less restrictive way. Mobile networks will become more important as new uses and applications are discovered.

Companies of all sizes find that a 4G network solution makes sense. The flexibility, speed, and reliability that it can offer are hard to match by any other type of technology.

4G is the fourth generation of mobile network technology. It is a level beyond 3G, which offers an internet connection at much higher speeds and is more reliable. There are several benefits of using a 4G connection over 3G-

- enhanced internet speeds (both upload and download)
- clear voice and video calling
- beneficial for using multimedia services (video streaming, live TV, etc.
- offers a vast area of coverage
- security/privacy of 4G networks are assured
- multiple data plans offered that are very affordable

Now, there are very few points that might be seen as a drawback for utilizing 4G technology. Chief among them is the necessity to buy a phone that is 4G enabled, which might add to costs that users may have to incur. To that end, Reliance Jio has launched the most advanced feature phone, JioPhone 2, which offers WhatsApp, Facebook, etc and most importantly, can connect to Jio's 4G network. What's more it is priced at just Rs. 2,999.

4G Technology advantages

4G wireless network is a pure data connection , It is an end-to-end Internet Protocol connection , The cellular providers have the opportunity to offer the data access to a wide variety of devices , 4G technology provides mobility , It is more flexible , It is more reliable , It is easier to standardize and it offers affordability .

You can easily access Internet , IM , Social Networks , streaming media , video calling and the other broadband services , It is very stable when connected to the internet without any disruption & it doesn't throttle .

WiMAX , LTE , and HSPA+ are all versions of 4G , WiMAX is used by Sprint , LTE is used by Verizon and AT&T, HSPA+ is used by AT&T and TMobile , 4G LTE network supports the global

access , the service portability & scalable mobile services , It supports IP based mobile system- High speed , high capacity & low cost per bit .

4G LTE network is very fast & 10 times faster than the 3G network , It offers extremely high voice quality , It is very fast when downloading huge files over a wireless network , It very good & clear when streaming videos , watching online videos , playing online musics , watching online TV & the others streaming stuffs .
The younger generation of mobile device users can stream the music , videos and movies at a much faster rate than ever before and they can also easily share the information online , 4G technology is affordable , It is more expensive than the traditional Wi-Fi networks but it also has a lot more advantages to offer to the users .

4G mobile network offers amazing speed , It has higher bandwidth , Increased bandwidth leads to much faster data transfer speed , that is especially advantageous for the mobile devices , The users of the 4G network get the benefit of superior , uninterrupted connectivity , especially for the advanced tasks like video chats & conferences .

4G networks present much more coverage than the other systems such as Wi-Fi , that forces the users to depend upon hotspots in each area they visit , Since 4G offers a coverage of 30 miles and more , as also overlapping network ranges , The users would be assured of complete connectivity at all times .

One of the biggest drawbacks with Wi-Fi networks is online security , This is especially true for the mobile devices , 4G networks present complete privacy , security and safety , This is especially beneficial for corporate establishments & business persons , who hold sensitive information on their respective mobile devices .

4G technology provides the users with many options to choose from , Many mobile carriers offer special introductory offers for new customers , that works out to be very reasonable for them , Seamless switching & a variety of Quality of Better spectral efficiency , Service driven services , Better scheduling & call admission control techniques .

4G Technology disadvantages
Obtaining the information from the people illegally becomes easier , 4G technology involves the possibility of some interference though not much , It is capable of being attacked (jamming frequencies) and the invasion of the privacy increased .

The consumer is forced to buy a new device to support the 4G , New frequencies means new components in the cell towers , Higher data prices for the consumers , Your current equipment can not be compatible with the 4G network , It has different network bands for different phones It is expensive & hard to implement .

4G LTE network has higher data prices for the consumers (expensive) , The consumers are forced to buy a new device to support 4G LTE , It consumes a lot of battery when in use , It consumes the data very fast & your battery becomes hot when it is used for a very long time (like a microwave) .

4G LTE network needs complex hardware , 4G technology is still limited to certain specified carriers & regions but the number of cities which have 4G coverage is increasing by the day , it would take its own time for this network to be available in all the major cities of the world .

Mobiles compatible with 4G network is cheaper than earlier but this new equipment would have to be installed to supply these services , But it is a cumbersome process for most mobile carriers planning to launch these services , 4G mobile technology is still fairly new but it will most likely have its initial glitches & bugs , which could be quite annoying for the user .

4G technology use many antennae & transmitters , You would experience much poorer battery life on your mobile , while on this network , So , you would have to use larger mobile devices with more battery power to be able to stay online for longer periods of time .

The users would be forced to use 3G or Wi-Fi connectivity in the areas that do not yet have 4G mobile network coverage , While this is a problem in itself , the worse issue is that they would still have to pay the same amount as specified by the 4G network plan , This situation can only be resolved once mobile carriers expand their 4G network coverage to include more regions .

4G technology requires expensive infrastructure for operation , This is embodied in the eNodeB's (Access Points) & mainly EPC's (Gateways or Routers) , 4G is optimal for data rates , but not necessarily the best for Voice services , Some of these services are offloaded (delegated) to Wi-Fi or 3G/GSM cellular technologies on your phone .

5G is the 5th generation mobile network. It is a new global wireless standard after 1G, 2G, 3G, and 4G networks. 5G enables a new kind of network that is designed to connect virtually everyone and everything together including machines, objects, and devices.

5G wireless technology is meant to deliver higher multi-Gbps peak data speeds, ultra low latency, more reliability, massive network capacity, increased availability, and a more uniform user experience to more users. Higher performance and improved efficiency empower new user experiences and connects new industries.

Broadly speaking, 5G is used across three main types of connected services, including enhanced mobile broadband, mission-critical communications, and the massive IoT. A defining capability of 5G is that it is designed for forward compatibility—the ability to flexibly support future services that are unknown today.

Enhanced mobile broadband
In addition to making our smartphones better, 5G mobile technology can usher in new immersive experiences such as VR and AR with faster, more uniform data rates, lower latency, and lower cost-per-bit.

Mission-critical communications
5G can enable new services that can transform industries with ultra-reliable, available, low-latency links like remote control of critical infrastructure, vehicles, and medical procedures.

Massive IoT
5G is meant to seamlessly connect a massive number of embedded sensors in virtually everything through the ability to scale down in data rates, power, and mobility—providing extremely lean and low-cost connectivity solutions.

5G is already here today, and global operators started launching new 5G networks in early 2019. In 2020, many countries expect nationwide 5G mobile networks. Also, all major Android phone manufacturers are commercializing 5G phones. And soon, even more people may be able to access 5G.

5G has been deployed in 35+ countries and counting. We are seeing much faster rollout and adoption compared with 4G. Consumers are very excited about the high speeds and low latencies. But 5G goes beyond these benefits by also providing the capability for mission-critical services, enhanced mobile broadband and massive IoT. While it is hard to predict when everyone will have access to 5G, we are seeing great momentum of 5G launches in its first year and we expect more countries to launch their 5G networks in 2020 and beyond.

While earlier generations of cellular technology (such as 4G LTE) focused on ensuring connectivity, 5G takes connectivity to the next level by delivering connected experiences from the cloud to clients. 5G networks are virtualized and software-driven, and they exploit cloud technologies.
The 5G network will also simplify mobility, with seamless open roaming capabilities between cellular and Wi-Fi access. Mobile users can stay connected as they move between outdoor wireless connections and wireless networks inside buildings without user intervention or the need for users to reauthenticate.

The new Wi-Fi 6 wireless standard (also known as 802.11ax) shares traits with 5G, including improved performance. Wi-Fi 6 radios can be placed where users need them to provide better geographical coverage and lower cost. Underlying these Wi-Fi 6 radios is a software-based network with advanced automation.
5G technology should improve connectivity in underserved rural areas and in cities where demand can outstrip today's capacity with 4G technology. New 5G networks will also have a dense, distributed-access architecture and move data processing closer to the edge and the users to enable faster data processing.

How does 5G technology work?

5G technology will introduce advances throughout network architecture. 5G New Radio, the global standard for a more capable 5G wireless air interface, will cover spectrums not used in 4G. New antennas will incorporate technology known as massive MIMO (multiple input, multiple output), which enables multiple transmitters and receivers to transfer more data at the same time. But 5G technology is not limited to the new radio spectrum. It is designed to support a converged, heterogeneous network combining licensed and unlicensed wireless technologies. This will add bandwidth available for users.

5G architectures will be software-defined platforms, in which networking functionality is managed through software rather than hardware. Advancements in virtualization, cloud-based technologies, and IT and business process automation enable 5G architecture to be agile and flexible and to provide anytime, anywhere user access. 5G networks can create software-defined sub network constructs known as network slices. These slices enable network administrators to dictate network functionality based on users and devices.

5G also enhances digital experiences through machine-learning (ML)-enabled automation. Demand for response times within fractions of a second (such as those for self-driving cars) require 5G networks to enlist automation with ML and, eventually, deep learning and artificial intelligence (AI). Automated provisioning and proactive management of traffic and services will reduce infrastructure cost and enhance the connected experience.

5G service is already available in some areas in various countries. These early-generation 5G services are called 5G non-standalone (5G NSA). This technology is a 5G radio that builds on existing 4G LTE network infrastructure. 5G NSA will be faster than 4G LTE. But the high-speed, low-latency 5G technology the industry has focused on is 5G standalone (5G SA). It should start becoming available by 2020 and be commonly available by 2022.

What is the real-world impact of 5G technology?

5G technology will not only usher in a new era of improved network performance and speed but also new connected experiences for users.

In healthcare, 5G technology and Wi-Fi 6 connectivity will enable patients to be monitored via connected devices that constantly deliver data on key health indicators, such as heart rate and blood pressure. In the auto industry, 5G combined with ML-driven algorithms will provide information on traffic, accidents, and more; vehicles will be able to share information with other vehicles and entities on roadways, such as traffic lights. These are just two industry applications of 5G technology that can enable better, safer experiences for users.

Latency is the delay between a user's action and a web application's response to that action, often referred to in networking terms as the total round trip time it takes for a data packet to travel

MICRO WAVE SYSTEM:

Microwave data transmission is the transport of information through microwave radio communication waves. This type of communication is designed to operate in a cost-effective and flexible way in order to deliver reliable bandwidth.

A microwave system is a system of gear used for microwave data transmission. The typical microwave system includes radios located high atop microwave towers, which are used for the transmission of microwave communications using the line of sight microwave radio technology.

Microwave Towers are the Most Visible Component of the Microwave System

A microwave system is composed of at least two microwave towers. At the top of these towers are antennas. These antennas are what allow the transmitter hardware of the system to transmit microwave signals and data from site to site.

The area between the system components must be clear of any major structures, such as tall buildings, mountains, or other objects that could obstruct microwave transmission. Only when this has been achieved can data travel through the microwave system.

This is why microwave communication is grouped as a 'line of sight' technology. When planning a microwave radio system, one must remember the requirements of microwave gear. Microwave antennas must be placed at the top of tall radio towers to provide a clear path. This allows the microwave system data to travel the long distances required by telecom service providers.

A disadvantage is that microwaves are limited to line of sight propagation. This means that they can't pass through or around hills or mountains as lower frequency radio waves can.

Microwave communication is the transmission of signals via radio waves using a series of radio wavelengths measured in small numbers of centimeters. A Microwave Radio System is a system of equipment used in broadcasting and telecommunications transmissions. The microwave system includes radios located high atop microwave towers, which are used for the transmission of microwave communications using line of sight microwave radio technology. Microwaves are widely used for point-to-point communications because their small wavelength allows conveniently-sized antennas to direct them in narrow beams, which can be pointed directly at the receiving antenna. This allows nearby microwave equipment to use the same frequencies without interfering with each other, as lower frequency radio waves do. Line of sight between point-to-point communications is very important to prevent any interference due to tall buildings and blockages, thus specialist experts are usually needed to engage for preliminary site surveys.

Satellite communication, in telecommunications, the use of artificial satellites to provide communication links between various points on Earth. Satellite communications play a vital role in the global telecommunications system. Approximately 2,000 artificial satellites orbiting Earth relay analog and digital signals carrying voice, video, and data to and from one or many locations worldwide.

Satellite communication has two main components: the ground segment, which consists of fixed or mobile transmission, reception, and ancillary equipment, and the space segment, which primarily is the satellite itself. A typical satellite link involves the transmission or uplinking of a signal from an Earth station to a satellite. The satellite then receives and amplifies the signal and retransmits it back to Earth, where it is received and reamplified by Earth stations and terminals. Satellite receivers on the ground include direct-to-home (DTH) satellite equipment, mobile reception equipment in aircraft, satellite telephones, and handheld devices.

How Satellites Work

A satellite is basically a self-contained communications system with the ability to receive signals from Earth and to retransmit those signals back with the use of a transponder—an integrated receiver and transmitter of radio signals. A satellite has to withstand the shock of being accelerated during launch up to the orbital velocity of 28,100 km (17,500 miles) an hour and a hostile space environment where it can be subject to radiation and extreme temperatures for its projected operational life, which can last up to 20 years. In addition, satellites have to be light, as the cost of launching a satellite is quite expensive and based on weight. To meet these challenges, satellites must be small and made of lightweight and durable materials. They must operate at a very high reliability of more than 99.9 percent in the vacuum of space with no prospect of maintenance or repair.

In general terms, a **satellite** is a smaller object that revolves around a larger object in space. For example, moon is a natural satellite of earth.

We know that **Communication** refers to the exchange (sharing) of information between two or more entities, through any medium or channel. In other words, it is nothing but sending, receiving and processing of information.

If the communication takes place between any two earth stations through a satellite, then it is called as **satellite communication**. In this communication, electromagnetic waves are used as carrier signals. These signals carry the information such as voice, audio, video or any other data between ground and space and vice-versa.

Soviet Union had launched the world's first artificial satellite named, Sputnik 1 in 1957. Nearly after 18 years, India also launched the artificial satellite named, Aryabhata in 1975.

Need of Satellite Communication

The following two kinds of propagation are used earlier for communication up to some distance.

- **Ground wave propagation** − Ground wave propagation is suitable for frequencies up to 30MHz. This method of communication makes use of the troposphere conditions of the earth.
- **Sky wave propagation** − The suitable bandwidth for this type of communication is broadly between 30–40 MHz and it makes use of the ionosphere properties of the earth.

The maximum hop or the station distance is limited to 1500KM only in both ground wave propagation and sky wave propagation. Satellite communication overcomes this limitation. In this method, satellites provide **communication for long distances**, which is well beyond the line of sight.

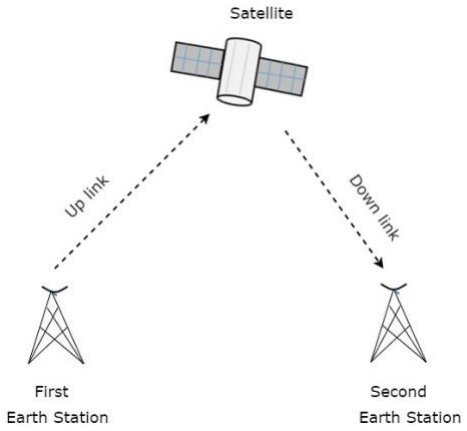
Since the satellites locate at certain height above earth, the communication takes place between any two earth stations easily via satellite. So, it overcomes the limitation of communication between two earth stations due to earth’s curvature.

How a Satellite Works

A **satellite** is a body that moves around another body in a particular path. A communication satellite is nothing but a microwave repeater station in space. It is helpful in telecommunications, radio and television along with internet applications.

A **repeater** is a circuit, which increases the strength of the received signal and then transmits it. But, this repeater works as a **transponder**. That means, it changes the frequency band of the transmitted signal from the received one.

The frequency with which, the signal is sent into the space is called as **Uplink frequency**. Similarly, the frequency with which, the signal is sent by the transponder is called as **Downlink frequency**. The following figure illustrates this concept clearly.



The transmission of signal from first earth station to satellite through a channel is called as **uplink**. Similarly, the transmission of signal from satellite to second earth station through a channel is called as **downlink**.

Uplink frequency is the frequency at which, the first earth station is communicating with satellite. The satellite transponder converts this signal into another frequency and sends it down to the second earth station. This frequency is called as **Downlink frequency**. In similar way, second earth station can also communicate with the first one.

The process of satellite communication begins at an earth station. Here, an installation is designed to transmit and receive signals from a satellite in an orbit around the earth. Earth stations send the information to satellites in the form of high powered, high frequency (GHz range) signals.

The satellites receive and retransmit the signals back to earth where they are received by other earth stations in the coverage area of the satellite. Satellite's **footprint** is the area which receives a signal of useful strength from the satellite.

Pros and Cons of Satellite Communication

In this section, let us have a look at the advantages and disadvantages of satellite communication.

Following are the **advantages** of using satellite communication:

- Area of coverage is more than that of terrestrial systems
- Each and every corner of the earth can be covered
- Transmission cost is independent of coverage area
- More bandwidth and broadcasting possibilites

Following are the **disadvantages** of using satellite communication −

- Launching of satellites into orbits is a costly process.
- Propagation delay of satellite systems is more than that of conventional terrestrial systems.
- Difficult to provide repairing activities if any problem occurs in a satellite system.
- Free space loss is more
- There can be congestion of frequencies.

Applications of Satellite Communication

Satellite communication plays a vital role in our daily life. Following are the applications of satellite communication −

- Radio broadcasting and voice communications
- TV broadcasting such as Direct To Home (DTH)

- Internet applications such as providing Internet connection for data transfer, GPS applications, Internet surfing, etc.
- Military applications and navigations
- Remote sensing applications
- Weather condition monitoring & Forecasting

RADAR

RADAR stands for Radio Detection and Ranging System. It is basically an electromagnetic system used to detect the location and distance of an object from the point where the RADAR is placed. It works by radiating energy into space and monitoring the echo or reflected signal from the objects. It operates in the UHF and microwave range.

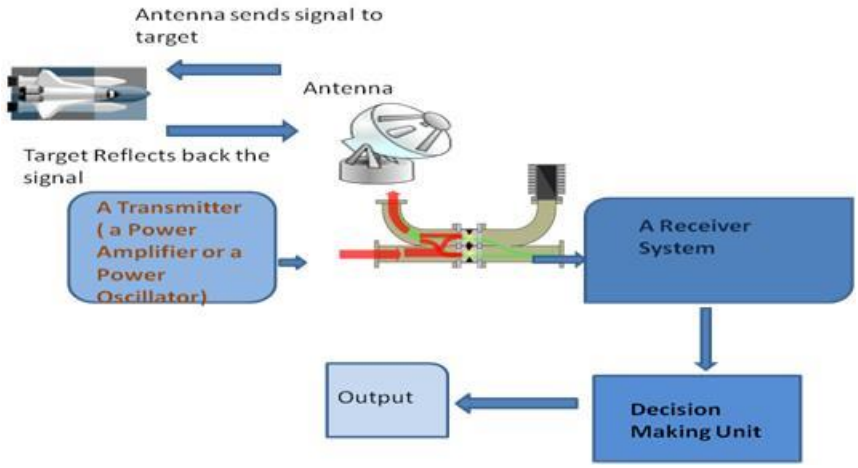
A Basic Idea of RADAR

The RADAR system generally consists of a transmitter which produces an electromagnetic signal which is radiated into space by an antenna. When this signal strikes any object, it gets reflected or reradiated in many directions. This reflected or echo signal is received by the radar antenna which delivers it to the receiver, where it is processed to determine the geographical statistics of the object. The range is determined by the calculating the time taken by the signal to travel from the RADAR to the target and back. The target's location is measured in angle, from the direction of maximum amplitude echo signal, the antenna points to. To measure range and location of moving objects, Doppler Effect is used.

A Basic RADAR System

Given below are 6 major parts of a RADAR System:

- **A Transmitter:** It can be a power amplifier like a Klystron, Travelling Wave Tube or a power Oscillator like a Magnetron. The signal is first generated using a waveform generator and then amplified in the power amplifier.
- **Waveguides:** The waveguides are transmission lines for transmission of the RADAR signals.
- **Antenna:** The antenna used can be a parabolic reflector, planar arrays or electronically steered phased arrays.
- **Duplexer:** A duplexer allows the antenna to be used as a transmitter or a receiver. It can be a gaseous device that would produce a short circuit at the input to the receiver when transmitter is working.
- **Receiver:** It can be super heterodyne receiver or any other receiver which consists of a processor to process the signal and detect it.
- **Threshold Decision:** The output of the receiver is compared with a threshold to detect the presence of any object. If the output is below any threshold, the presence of noise is assumed.



What is fiber optics?

We're used to the idea of information traveling in different ways. When we speak into a landline telephone, a wire cable carries the sounds from our voice into a socket in the wall, where another cable takes it to the local telephone exchange. Cellphones work a different way: they send and receive information using invisible radio waves—a technology called wireless because it uses no cables. Fiber optics works a third way. It sends information coded in a beam of light down a glass or plastic pipe. It was originally developed for endoscopes in the 1950s to help doctors see inside the human body without having to cut it open first. In the 1960s, engineers found a way of using the same technology to transmit telephone calls at the speed of light (normally that's 186,000 miles or 300,000 km per second in a vacuum, but slows to about two thirds this speed in a fiber-optic cable).

Light travels down a fiber-optic cable by bouncing repeatedly off the walls. Each tiny photon (particle of light) bounces down the pipe like a bobsleigh going down an ice run. Now you might expect a beam of light, traveling in a clear glass pipe, simply to leak out of the edges. But if light hits glass at a really shallow angle (less than 42 degrees), it reflects back in again—as though the glass were really a mirror. This phenomenon is called total internal reflection. It's one of the things that keeps light inside the pipe.

The other thing that keeps light in the pipe is the structure of the cable, which is made up of two separate parts. The main part of the cable—in the middle—is called the core and that's the bit the light travels through. Wrapped around the outside of the core is another layer of glass called the cladding. The cladding's job is to keep the light signals inside the core. It can do this because it is made of a different type of glass to the core. (More technically, the cladding has a lower refractive index.)

Optical technology

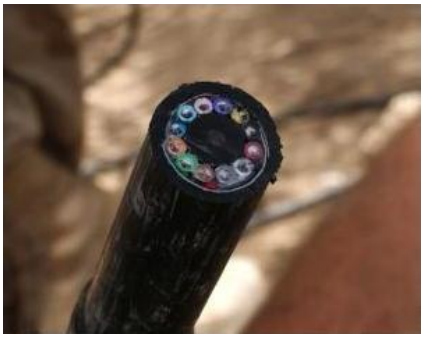


Photo: A section of 144-strand fiber-optic cable. Each strand is made of optically pure glass and is thinner than a human hair. Picture by Tech. Sgt. Brian Davidson, courtesy of US Air Force.

A fiber-optic cable is made up of incredibly thin strands of glass or plastic known as optical fibers; one cable can have as few as two strands or as many as several hundred. Each strand is less than a tenth as thick as a human hair and can carry something like 25,000 telephone calls, so an entire fiber-optic cable can easily carry several million calls. The current record for a "single-mode" fiber (that's explained below) is 178 terabits (trillion bits) per second—enough for 100 million Zoom sessions (according to fiber expert Jeff Hecht)!

Fiber-optic cables carry information between two places using entirely optical (light-based) technology. Suppose you wanted to send information from your computer to a friend's house down the street using fiber optics. You could hook your computer up to a laser, which would convert electrical information from the computer into a series of light pulses. Then you'd fire the laser down the fiber-optic cable. After traveling down the cable, the light beams would emerge at the other end. Your friend would need a photoelectric cell (light-detecting component) to turn the pulses of light back into electrical information his or her computer could understand. So the whole apparatus would be like a really neat, hi-tech version of the kind of telephone you can make out of two baked-bean cans and a length of string!

How fiber-optics works

Light travels down a fiber-optic cable by bouncing repeatedly off the walls. Each tiny photon (particle of light) bounces down the pipe like a bobsleigh going down an ice run. Now you might expect a beam of light, traveling in a clear glass pipe, simply to leak out of the edges. But if light hits glass at a really shallow angle (less than 42 degrees), it reflects back in again—as though the glass were really a mirror. This phenomenon is called total internal reflection. It's one of the things that keeps light inside the pipe.

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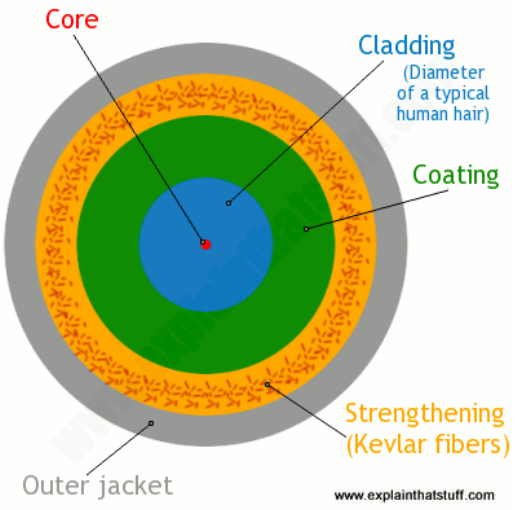


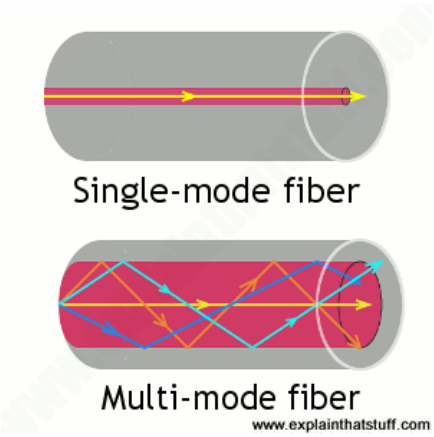
The simplest type of optical fiber is called single-mode. It has a very thin core about 5-10 microns (millionths of a meter) in diameter. In a single-mode fiber, all signals travel straight down the

middle without bouncing off the edges (yellow line in diagram). Cable TV, Internet, and telephone signals are generally carried by single-mode fibers, wrapped together into a huge bundle. Cables like this can send information over 100 km (60 miles).

Another type of fiber-optic cable is called multi-mode. Each optical fiber in a multi-mode cable is about 10 times bigger than one in a single-mode cable. This means light beams can travel through the core by following a variety of different paths (yellow, orange, blue, and cyan lines)—in other words, in multiple different modes. Multi-mode cables can send information only over relatively short distances and are used (among other things) to link computer networks together.

Even thicker fibers are used in a medical tool called a gastroscope (a type of endoscope), which doctors poke down someone's throat for detecting illnesses inside their stomach. A gastroscope is a thick fiber-optic cable consisting of many optical fibers. At the top end of a gastroscope, there is an eyepiece and a lamp. The lamp shines its light down one part of the cable into the patient's stomach. When the light reaches the stomach, it reflects off the stomach walls into a lens at the bottom of the cable. Then it travels back up another part of the cable into the doctor's eyepiece. Other types of endoscopes work the same way and can be used to inspect different parts of the body. There is also an industrial version of the tool, called a fiberscope, which can be used to examine things like inaccessible pieces of machinery in airplane engines.

Types of fiber-optic cables



Optical fibers carry light signals down them in what are called modes. That sounds technical but it just means different ways of traveling: a mode is simply the path that a light beam follows down the fiber. One mode is to go straight down the middle of the fiber. Another is to bounce down the fiber at a shallow angle. Other modes involve bouncing down the fiber at other angles, more or less steep.

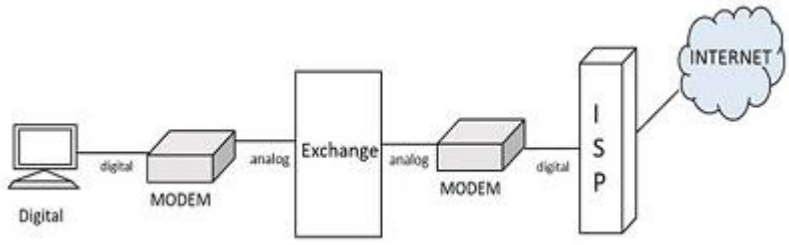
Uses for fiber optics

Shooting light down a pipe seems like a neat scientific party trick, and you might not think there'd be many practical applications for something like that. But just as electricity can power many types of machines, beams of light can carry many types of information—so they can help us in many ways. We don't notice just how commonplace fiber-optic cables have become because the laser-powered signals they carry flicker far beneath our feet, deep under office floors and city streets. The technologies that use it—computer networking, broadcasting, medical scanning, and military equipment (to name just four)—do so quite invisibly.

ISDN:-

Earlier, the transmission of data and voice both were possible through normal POTS, Plain Old Telephone Systems. With the introduction of Internet came the advancement in telecommunication too. Yet, the sending and receiving of data along with voice was not an easy task. One could use either the Internet or the Telephone. The invention of ISDN helped mitigate this problem.

The process of connecting a home computer to the Internet Service Provider used to take a lot of effort. The usage of the modulator-demodulator unit, simply called the MODEM was the essential thing to establish a connection. The following figure shows how the model worked in the past.



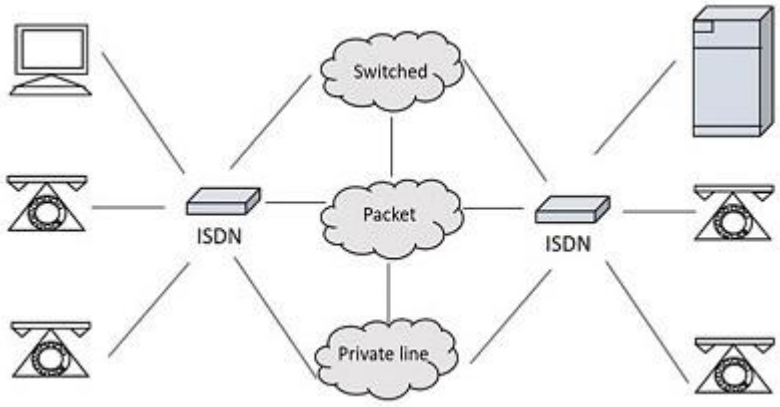
The above figure shows that the digital signals have to be converted into analog and analog signals to digital using modem during the whole path. What if the digital information at one end reaches to the other end in the same mode, without all these connections? It is this basic idea that lead to the development of **ISDN.**

As the system has to use the telephone cable through the telephone exchange for using the Internet, the usage of telephone for voice calls was not permitted. The introduction of ISDN has resolved this problem allowing the transmission of both voice and data simultaneously. This has many advanced features over the traditional PSTN, Public Switched Telephone Network.

ISDN

ISDN was first defined in the CCITT red book in 1988.The **Integrated Services of Digital Networking**, in short ISDN is a telephone network based infrastructure that allows the transmission of voice and data simultaneously at a high speed with greater efficiency. This is a circuit switched telephone network system, which also provides access to Packet switched networks.

The model of a practical ISDN is as shown below.



ISDN supports a variety of services. A few of them are listed below −

- Voice calls
- Facsimile
- Videotext
- Teletext
- Electronic Mail
- Database access

- Data transmission and voice
- Connection to internet
- Electronic Fund transfer
- Image and graphics exchange
- Document storage and transfer
- Audio and Video Conferencing
- Automatic alarm services to fire stations, police, medical etc.

Types of ISDN

Among the types of several interfaces present, some of them contains channels such as the **B-Channels** or Bearer Channels that are used to transmit voice and data simultaneously; the **D-Channels** or Delta Channels that are used for signaling purpose to set up communication.

The ISDN has several kinds of access interfaces such as −

- Basic Rate Interface (BRI)
- Primary Rate Interface (PRI)
- Narrowband ISDN
- Broadband ISDN

Basic Rate Interface (BRI)

The Basic Rate Interface or Basic Rate Access, simply called the **ISDN BRI Connection** uses the existing telephone infrastructure. The BRI configuration provides **two data** or bearer channels at **64 Kbits/sec** speed and one control or delta channel at **16 Kbits/sec**. This is a standard rate.

The ISDN BRI interface is commonly used by smaller organizations or home users or within a local group, limiting a smaller area.

Primary Rate Interface (PRI)

The Primary Rate Interface or Primary Rate Access, simply called the ISDN PRI connection is used by enterprises and offices. The PRI configuration is based on T-carrier or T1 in the US, Canada and Japan countries consisting of **23 data** or bearer channels and one control or delta channel, with 64kbps speed for a bandwidth of 1.544 M bits/sec. The PRI configuration is based on E-carrier or E1 in Europe, Australia and few Asian countries consisting of **30 data** or bearer channels and **two-control** or delta channel with 64kbps speed for a bandwidth of 2.048 M bits/sec.

The ISDN BRI interface is used by larger organizations or enterprises and for Internet Service Providers.

Narrowband ISDN

The Narrowband Integrated Services Digital Network is called the **N-ISDN**. This can be understood as a telecommunication that carries voice information in a narrow band of frequencies. This is actually an attempt to digitize the analog voice information. This uses 64kbps circuit switching.

The narrowband ISDN is implemented to carry voice data, which uses lesser bandwidth, on a limited number of frequencies.

Broadband ISDN

The Broadband Integrated Services Digital Network is called the **B-ISDN**. This integrates the digital networking services and provides digital transmission over ordinary telephone wires, as

well as over other media. The CCITT defined it as, “Qualifying a service or system requiring transmission channels capable of supporting rates greater than primary rates.”

The broadband ISDN speed is around 2 MBPS to 1 GBPS and the transmission is related to ATM, i.e., Asynchronous Transfer Mode. The broadband ISDN communication is usually made using the fiber optic cables.

As the speed is greater than 1.544 Mbps, the communications based on this are called **Broadband Communications**. The broadband services provide a continuous flow of information, which is distributed from a central source to an unlimited number of authorized receivers connected to the network. Though a user can access this flow of information, he cannot control it.

Advantages of ISDN

ISDN is a telephone network based infrastructure, which enables the transmission of both voice and data simultaneously. There are many advantages of ISDN such as −

- As the services are digital, there is less chance for errors.
- The connection is faster.
- The bandwidth is higher.
- Voice, data and video − all of these can be sent over a single ISDN line.

Disadvantages of ISDN

The disadvantage of ISDN is that it requires specialized digital services and is costlier.

However, the advent of ISDN has brought great advancement in communications. Multiple transmissions with greater speed are being achieved with higher levels of accuracy.

Spatial data:-

Spatial data support in database is important for efficiently storing, indexing and querying of data on the basis of spatial location. For example, suppose that we want to store a set of polygons in a database and to query the database to find all polygons that intersect a given polygon. We cannot use standard index structures, such as B-trees or hash indices, to answer such a query efficiently. Efficient processing of the above query would require special-purpose index structures, such as R-trees for the task.

Geographic data such as road maps, land-usage maps, topographic elevation maps, political maps showing boundaries, land-ownership maps, and so on. Geographical information system are special purpose databases for storing geographical data. Geographical data are differ from design data in certain ways. Maps and satellite images are typical examples of geographic data. Maps may provide not only location information associated with locations such as elevations. Soil type, land type and annual rainfall.

Geographical information system (GIS) and its Components

Geographical information system (GIS) is basically defined as a systematic integration of hardware and software for capturing, storing, displaying, updating manipulating and analyzing spatial data. GIS can also be viewed as an interdisciplinary area that incorporates many distinct fields of study such as:

1. Geodesy that is basically projection,

   surveying, cartography and so on.
2. Remote Sensing
3. Photogrammetry
4. Environmental Science
5. City Planning
6. Cognitive Science

As a result GIS relies on progress made in fields such as computer science, databases, statistics, and artificial intelligence. All the different problems and question that arises from the integration of multiple disciplines make a more than a simple tool.

Requirements for GIS –
Geographic Information requires a means of integration between different sources of data at different level of accuracy. System basically deals with the aspects of daily life, so it must be updated daily to keep it current and reliable. Much of the Information Stored in GIS are for practical use requires a special means of retrieval and manipulation.
GIS system and application basically deals with information that can be viewed as data with specific meaning and context rather than simple data.

Components of GIS system –
GIS system can be viewed as an integration of three components are hardware and software, data, people. Lets discuss them one by one:

1. **Hardware and software –**
   Hardware relates to device used by end users such as graphic devices or plotters and scanners. Data storage and manipulation is done using a range of processor. With the development of the Internet and Web based application, Web servers have become part of many system's architecture, hence most GIS's follows 3-Tier architecture.
   Software parts relates to the processes used to define, store and manipulate the data and hence it is akin to DBMS. Different models are used to provide efficient means of storage retrieval and manipulation of data.
2. **Data –**
   Geographic data are basically divided into two main groups are vector and raster.
   Vector data/layers in GIS refers to discrete objects represented by points, lines and polygons. Lines are formed by connecting two or more points and polygons are closed set of Lines. Layers represent geometries that share a common set of attributes. Objects within a layer have mutual topology. Vector sources include digitized maps, features extracted from image surveys and many more.

   Raster data is a continuous grid of cells in two dimension or the equivalent of cubic cells in three dimension. Raster data are divided conceptually into categorical and continuous. In a categorical raster every cell value is linked to a category in a separate table.Examples Soil type, vegetation types.land suitability, and so on. Continuous raster images usually describes continuous phenomena in space such as Digital Elevation Model where each pixel is an elevation value. Unlike categorical raster, a continuous raster doesn't have an attribute/category table attached. Typical Raster sources are aerial images, satellite images and scanned map images.
3. **People –**
   People are involved in all phases of development of a GIS system and in collecting data. They include cartographers and surveyors who create the maps and survey the land and the geographical features. They also include system users who collect the data, upload the data to system, manipulate the system and analyze the results.