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A Study and Comparison of Wired, Wireless and Optical Networks

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ABSTRACT: Topology is planned for both small and large networks. Topology takes different types to build those networks based on their needs. In this paper, I will discuss how the topology types work, analyze and compare those different types of networks and toplology through graph representation and make comparison table and determine which one is the best for dataflow of all the topologies for the different networks.
Previously, wired network has proven its potential but nowadays wireless communication has emerged as a robust and most intellect communication technique. As technology advances in society the need for wired, wireless and optical networking has become essential. Each of these types of networking has their advantages and disadvantages according to its network characteristics. The aim of the paper is to compare the Wired, Wireless and optical networks.

KEYWORDS: Optical network, Topology, Wired network, Wireless network

I. INTRODUCTION

OVER THE past few years, traffic patterns in access net- works have been propelled to the broadband evolution from voice- and text-based services to video-based interactive and multimedia services due to the continuing remarkable growth in the Internet. By the estimations in [1] and [2],50% of the revenues of large telephone companies will be based on video services in 2010. In addition to the high-speed, symmetric, and guaranteed bandwidth demands for future video services, the next-generation access networks are driving the needs for the convergence of wired and wireless services to offer end users greater choice, convenience, and variety in an efficient way [3]. This scenario will require the delivery of voice, data, and video services with mobility feature to serve the fixed and mobile users in a unified networking platform.
The most widely deployed access networks based on twisted-pair copper cable are approaching their upper limit of a bandwidth–distance product (10 Mb/s · km) [4]. For a distance under 1.5 km, the asymmetric digital-subscriber-loop technology can deliver about 8 Mb/s, whereas the latest very high speed digital-subscriber-loop technology can deliver up to 26 Mb/s for distances under 1 km. Another dominant access medium is the hybrid of fiber and coaxial cables (HFC). The guaranteed bandwidths per subscriber are only 2.8–5.6 Mb/s for the downstream and 0.15–0.3 Mb/s for the upstream due to the bandwidth shared within a cell (500–1000 subscribers) [5]. It is quite obvious that the two technologies cannot meet the bandwidth demands for the future video services and will have limited lifetimes [6]. With the trend to deploy optical fiber deeper and deeper and with the development of highly recognized passive optical network (PON), it is expected that time-division-multiplexing (TDM)-PON and wavelength- division-multiplexing (WDM)-PON will be the most promising candidates for the next-generation access systems. A TDM- PON [7], including an asynchronous-transfer-mode and broadband PON (A/BPON), an Ethernet PON (EPON), and a Gigabit PON (GPON), shares a single transmission channel to be a satisfactory solution for the near-future bandwidth needs. A WDM-PON [8] provides a point-to-point optical connectivity to multiple end users through a single feeder fiber and will be a future-proof access network.
On the other hand, broadband wireless access (BWA) [9] technologies have surged in popularity because they are more convenient, scalable, and flexible for roaming connections. The most widely used technologies are the local multipoint distribution service and the multichannel multipoint distribution service [10]. World Interoperability for Microwave Access is another BWA technology being standardized by IEEE 802.16 [11]. These technologies can provide wireless connection but are severely constrained by the required bandwidth particularly for the video-centric services with high-definition TV (HDTV) quality.

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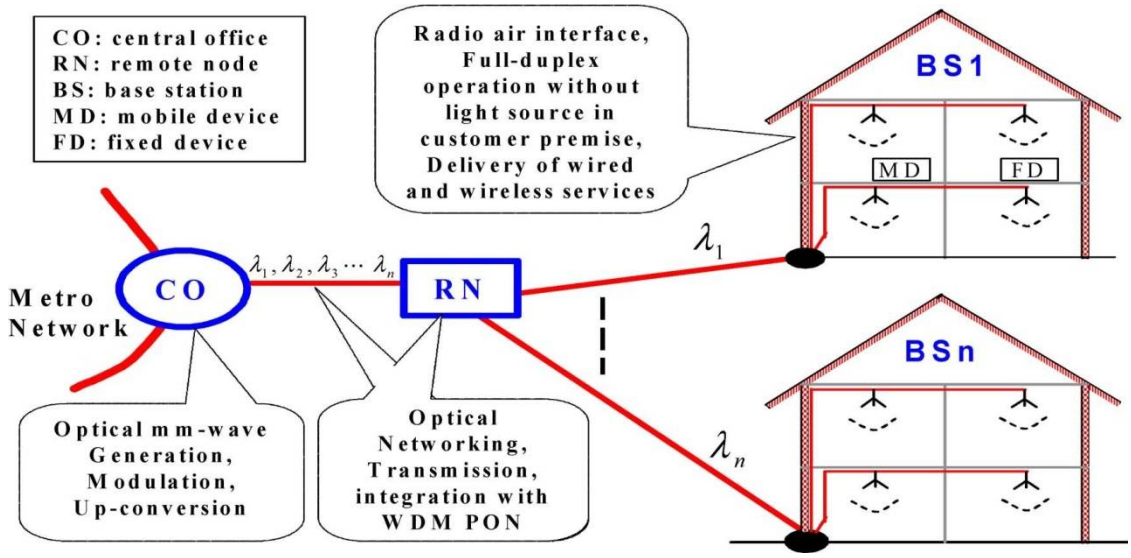

Fig. 1. Generic architecture of an optical–wireless network.

To make full use of the huge bandwidth offered by fiber and the mobile feature presented via a wireless scheme, the integration of wireless and optical networks is a potential solution for increasing the capacity and mobility as well as decreasing the costs in the access network. Thus, the radio- over-fiber (ROF)-based optical–wireless networks came into play and have emerged as an affordable alternative solution in environments such as conference centers, airports, hotels, shopping malls, and ultimately homes and small offices [12]. It has been expected that the millimeter-wave (mm-wave) bands would be utilized to meet the requirement for higher signal bandwidth and to overcome the frequency congestion in the future optical–wireless access networks [13]. In this situation, it is necessary to minimize the cost of the base station (BS) and to shift the system complexity and expensive devices to the central office (CO) because the BS pico cell has small coverage due to high atmospheric attenuation in the mm-wave band. Fig. 1 shows the generic architecture of the optical–wireless network and the enabling technologies that

1. Network: A network is a collection of computers, servers, mainframes, network devices, peripherals, or other devices connected to one another to allow the sharing of data. An excellent example of a network is the Internet, which connects millions of people all over the world. Below is an example image of a home network with multiple computers and other network devices all connected to each other and the internet. [1]

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Fig.1 Network [2]

Examples of network devices are Desktop computers, laptops, mainframes, and servers Firewalls, Bridges, Repeaters, Network Interface cards, Switches, hubs, modems, and routers, Smart phones and tablets, Webcams etc.

II. NETWORK TOPOLOGIES

2. Network Topologies: Network Topology is the schematic description of a network arrangement, connecting various nodes (sender and receiver) through lines of connection. [3] [4] [7]

2.1 Bus Topology: In Bus Network Topology a single cable is used to connect all devices on the net. This cable is often referred to as the network Backbone. When communication occurs between nodes the device sending the message broadcasts to all nodes on the network, but only the desired recipient digests the message. Advantages of this type of Physical Topology include ease of installation and minimization of the required cabling. Further, failure of a node attached to the network has no effect on other nodes attached to the network. Also messages from one node can be seen near simultaneously by all other nodes on the network. Disadvantages of this configuration include performance limits on the number of network nodes, and complete network communication stoppage if the cable fails. Figure 2 shows an example of Bus Network Topology. [3] [4] [5]

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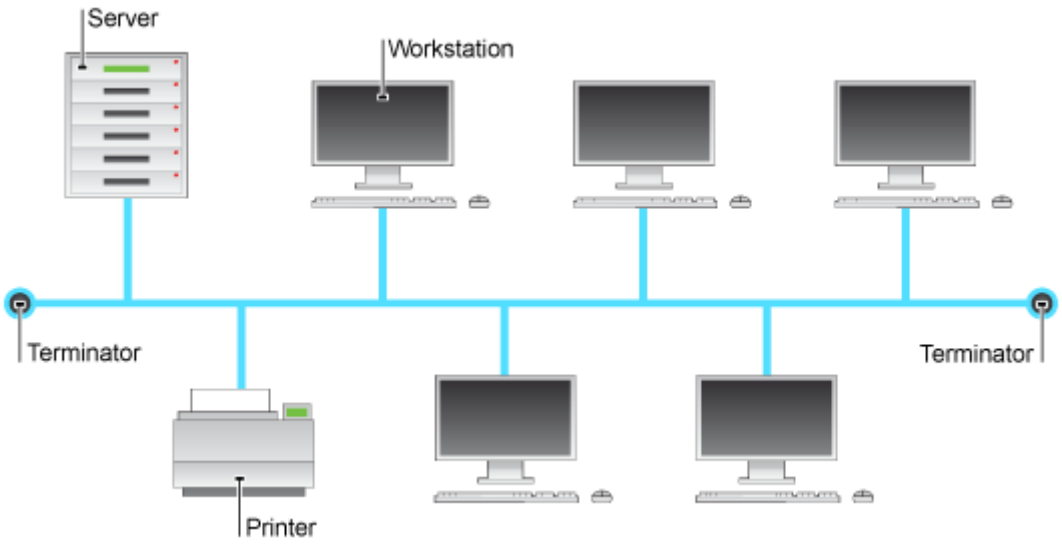

Fig.2. Bus Topology [6]

Features of Bus Topology

1. It transmits data only in one direction.
2. Every device is connected to a single cable

Advantages of Bus Topology

1. It is cost effective.
2. Cable required is least compared to other network topology.
3. Used in small networks.
4. It is easy to understand.
5. Easy to expand joining two cables together.

Disadvantages of Bus Topology

1. Cables fails then whole network fails.
2. If network traffic is heavy or nodes are more the performance of the network decreases.
3. Cable has a limited length.
4. It is slower than the ring topology.

2.2 Mesh Topology: Mesh Network Topologies capitalize on path redundancy. This Topology is preferred when traffic volume between nodes is large. A proportion of nodes in this type of network have multiple paths to another destination node. With the exception of the Bi-directional Ring (and this was only when a failure was detected) each of the topologies discussed so far had only one path from message source to message destination. Thus the probability of single point network failure is greatly minimized with Mesh Network Topology. A major advantage of the Mesh Network Topology is that source nodes determine the best route from sender to destination based upon such factors connectivity, speed, and pending node tasks. A disadvantage of Mesh Network Topologies is the large cost incurred in setting up the network. A further disadvantage of this type of network is the requirement for each node to have routing algorithm for path computation. A full mesh is described as each node being directly connected to every other node in the network. This type of topology is usually restricted to networks with a small number of nodes. A partial mesh is described as having some nodes in the network being indirectly connected to others in the network. Figure 3 provides an example of both full and partial mesh networks. The internet employs

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Mesh Network Topology.. [3] [4] [5]

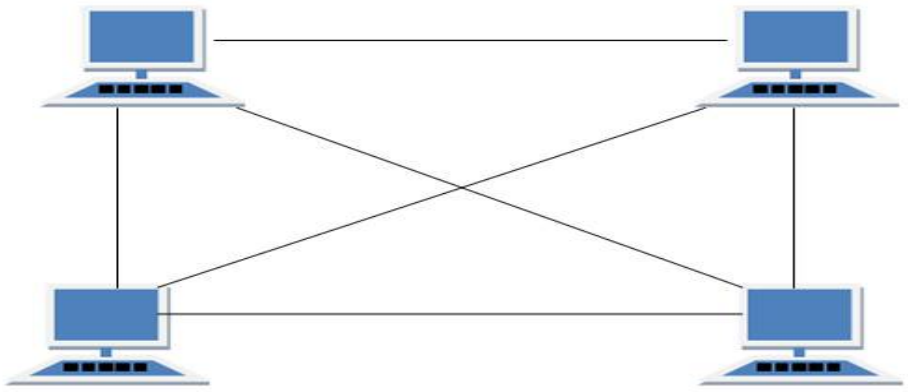

Fig.3 Mesh Topology [6]

There are two techniques to transmit data over the Mesh topology, they are :

1. Routing
2. Flooding

Routing

In routing, the nodes have a routing logic, as per the network requirements. Like routing logic to direct the data to reach the destination using the shortest distance. Or, routing logic which has information about the broken links, and it avoids those node etc. We can even have routing logic, to re-configure the failed nodes.

Flooding

In flooding, the same data is transmitted to all the network nodes, hence no routing logic is required. The network is robust, and the its very unlikely to lose the data. But it leads to unwanted load over the network.

Types of Mesh Topology

1. **Partial Mesh Topology :** In this topology some of the systems are connected in the same fashion as mesh topology but some devices are only connected to two or three devices.
2. **Full Mesh Topology :** Each and every nodes or devices are connected to each other.

Features of Mesh Topology

1. Fully connected.
2. Robust.
3. Not flexible.

Advantages of Mesh Topology

1. Each connection can carry its own data load.
2. It is robust.

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3. Fault is diagnosed easily.
4. Provides security and privacy.

Disadvantages of Mesh Topology

1. Installation and configuration is difficult.
2. Cabling cost is more.
3. Bulk wiring is required.

2.3 Ring Topology: Ring Network Topology has each node in a network connected to two other nodes in the network in conjunction with the first and last nodes being connected. Messages from one node to another then travel from originator to destination via the set of intermediate nodes. The intermediate nodes serve as active repeaters for messages intended for other nodes. Some forms of Ring Network Topology have messages traveling in a common direction about the ring (either clockwise or counterclockwise) while other forms of this type of configuration (called Bi-directional Rings) have messages flowing in either direction with the help of two cables between each connected node. In some cases blocking devices are required in a Ring Topology Network in order to prevent packet storming, the condition where packets not consumed by a network node fall into an unlimited loop about the ring. Ring Network Topology is typically employed in networks where inter node traffic volume is small. A disadvantage of the basic Ring Network Topology is the relatively long transmission time between nodes in the ring as compared with Bus Network Topology. Further, like Bus Network Topology, failure of the cabling between any two nodes has a broader impact on network communication as a whole, possibly leaving no path from message originator to recipient. Relative inter node communication delays are still a disadvantage of the Bi-directional Ring network, however the dual nature of the cabling between nodes allows traffic to be shunted to an alternate path, thereby rectifying connection disruption between any two nodes in the network. This is a considerable reliability advantage over the basic Ring Network Topology or the Bus Network Topology. Ring Network Topologies do have unique disadvantages relative to other topologies concerning expansion or reconfiguration. If a node is added new cabling is required to connect the node to its two neighbors. Networks are not often constructed with pre-wired positions to account for expansion. Figure 4 shows examples of Ring Network Topologies.. [3] [4] [5]

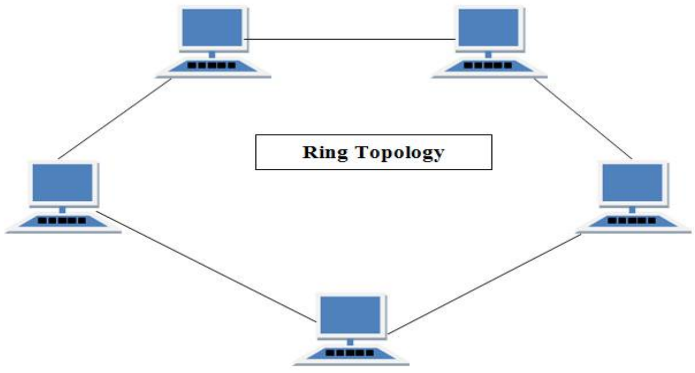

Fig.4 Ring Topology [6]

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Features of Ring Topology

1. A number of repeaters are used for Ring topology with large number of nodes, because if someone wants to send some data to the last node in the ring topology with 100 nodes, then the data will have to pass through 99 nodes to reach the 100th node. Hence to prevent data loss repeaters are used in the network.
2. The transmission is unidirectional, but it can be made bidirectional by having 2 connections between each Network Node, it is called **Dual Ring Topology**.
3. In Dual Ring Topology, two ring networks are formed, and data flow is in opposite direction in them. Also, if one ring fails, the second ring can act as a backup, to keep the network up.
4. Data is transferred in a sequential manner that is bit by bit. Data transmitted, has to pass through each node of the network, till the destination node.

Advantages of Ring Topology

1. Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data.
2. Cheap to install and expand

Disadvantages of Ring Topology

1. Troubleshooting is difficult in ring topology.
2. Adding or deleting the computers disturbs the network activity.
3. Failure of one computer disturbs the whole network.

2.4 Star Topology:

Star Network Topology requires the use of a central top level node to which all other nodes are connected. This top level node may be a computer, or a simple switch, or just a common connection point. Messages received by the top level node can either be broadcast to all subordinate nodes, or if the top level device is of high enough fidelity, sent only to the desired subordinate node. Inter node messaging delays are reduced with this configuration. An important advantage of the Star Network Topology comes from the localization of cabling failures inherent in this configuration. Failure in the connection between the top level node and any subordinate node, or failure in a subordinate node will not disrupt the entire network. Because Star Network Topologies are commonly used in LANs spanning a larger geometric area than Bus or Ring Network Topologies. One disadvantage of this configuration is the need for more cabling. Another disadvantages lies with the top level node. Any failure in this device will halt any communication on the network. One additional limitation of the Star Network Topology concerns the limited number of top level node connection points. Figure 6 shows an example of Star Network Topology.. [3] [4] [5]

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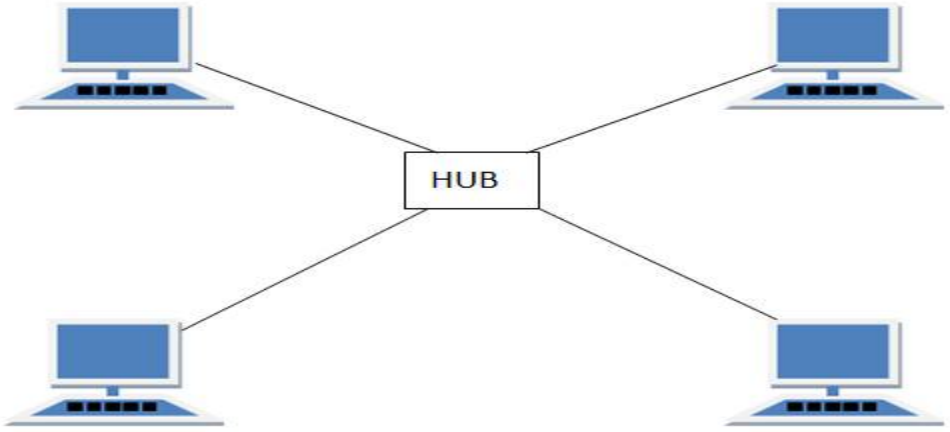

Fig.5 Star Topology [6]

Features of Star Topology

1. Every node has its own dedicated connection to the hub.
2. Hub acts as a repeater for data flow.
3. Can be used with twisted pair, Optical Fibre or coaxial cable.

Advantages of Star Topology

1. Fast performance with few nodes and low network traffic.
2. Hub can be upgraded easily.
3. Easy to troubleshoot.
4. Easy to setup and modify.
5. Only that node is affected which has failed, rest of the nodes can work smoothly.

Disadvantages of Star Topology

1. Cost of installation is high.
2. Expensive to use.
3. If the hub fails then the whole network is stopped because all the nodes depend on the hub.
4. Performance is based on the hub that is it depends on its capacity

2.5 Tree topology:

Tree Network Topology is constructed from either making a set of Star Network Topologies subordinate to a central node, or by linking a set of Star Network Topologies together directly via a bus, thereby distributing the functionality of the central node among several Star Network Topology top level nodes . Figure 5 provides an example of each configuration. The top level nodes from each Star Network are the elements linked via a bus in the second arrangement. In simple Tree Network Topology no Star Network Topology subordinate nodes are connected to the bus. Messages in a Tree Network Topology can be either broadcast from the central node to all interconnected Star Networks, or targeted to select Star Networks. One major advantage of the Tree Network Topology is the ease at which the network can be expanded. Expansion can be as simple as linking in an additional Star Network Topology onto the bus. Also, like the Star Network Topology there is localization of cabling failures

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with this configuration. However, if a Star Network top level node in the fails, or cabling to it fails an entire section of the network is lost to communication as opposed to just one subordinate node as in pure Star Network Topology.

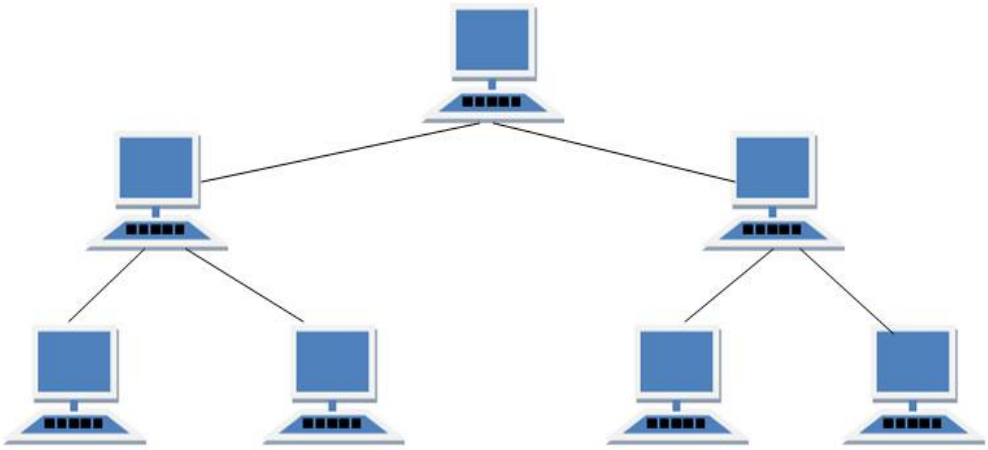

Fig.5 Hybrid Topology [6]

Features of Tree Topology

1. Ideal if workstations are located in groups.
2. Used in Wide Area Network.

Advantages of Tree Topology

1. Extension of bus and star topologies.
2. Expansion of nodes is possible and easy.
3. Easily managed and maintained.
4. Error detection is easily done.

Disadvantages of Tree Topology

1. Heavily cabled.
2. Costly.
3. If more nodes are added maintenance is difficult.
4. Central hub fails, network fails.

2.6 Hybrid Topology:

It is two different types of topologies which is a mixture of two or more topologies. For example if in an office in one department ring topology is used and in another star topology is used, connecting these topologies will result in Hybrid Topology (ring topology and star topology). [3] [4] [5]

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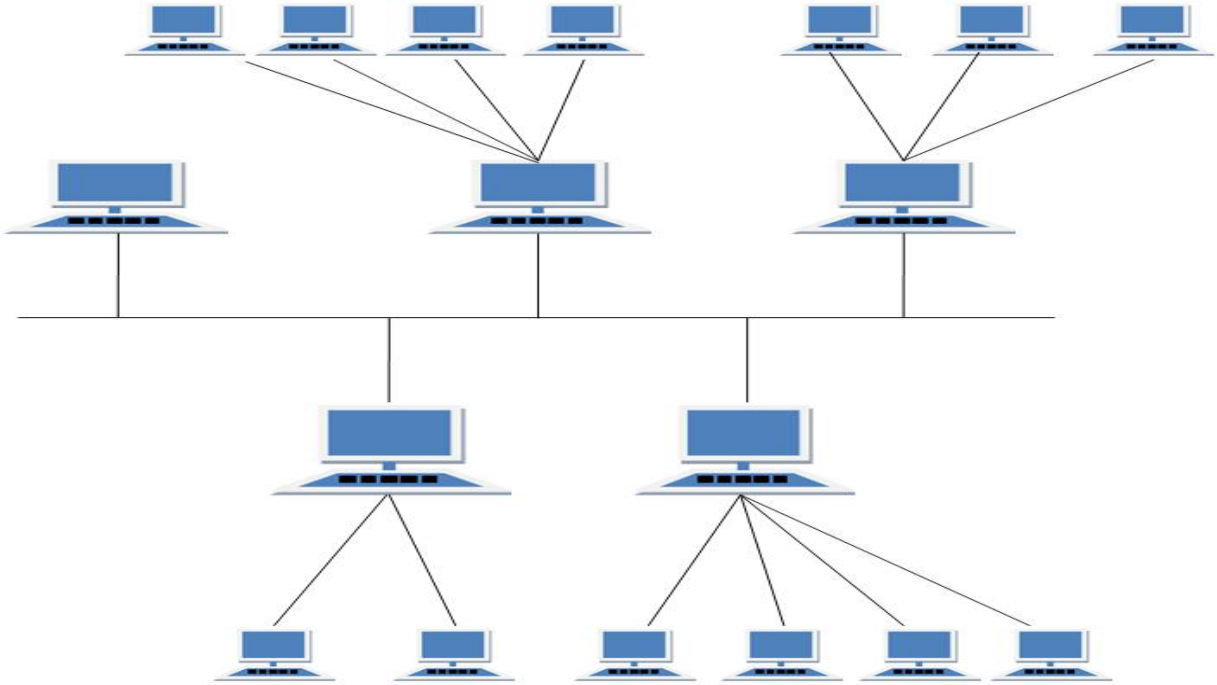

Fig.7 Hybrid Topology [6]

Features of Hybrid Topology

1. It is a combination of two or topologies
2. Inherits the advantages and disadvantages of the topologies included

Advantages of Hybrid Topology

1. Reliable as Error detecting and trouble shooting is easy.
2. Effective.
3. Scalable as size can be increased easily.
4. Flexible.

Disadvantages of Hybrid Topology

1. Complex in design.
2. Costly.

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COMPARISON OF TOPOLOGY

Comparison of topology gives various knowledge/ideas to determine the performance of the network, efficiency of dataflow, cost and cable requirement of specified topology as shown in Table I

Topology Criteria	Bus	Ring	Star	Mesh
Network performance	Small	Small/Large	Small	Small
Cable Length Requirement	Less	Neither less nor more	More	More
Traffic	Less	High	Medium	No
Dataflow Efficiency	More	Neither less nor more	More	More
Failure	Easy to solve	Difficult to solve	Easy to solve except hub/switch fails	Easy to solve
Cost	Low	High	High	High

TABLE -1 Analysis of Different Topologies [3] [8]

Table II shows the analysis of different topologies that can be used for designing of a network. It compares different topologies based on some parameters like cost, flexibility, reliability, robustness etc. Based on the analysis we can say different topologies can be used according to the needs of the networks.

A chart is a graphical representation of data, in which "the data is represented by symbols, such as bars in a bar chart, lines in a line chart, or slices in a chart. A chart can represent tabular numeric data, functions or some kinds of qualitative structure and provides different information. Line Chart analysis will do here.

A line chart is a two-dimensional scatter plot of ordered observations where the observations are connected following their order.

Charts are often used to ease understanding of large quantities of data and the relationships between parts of the data. Charts can usually be read more quickly than the raw data that they are produced from.

They are used in a wide variety of fields, and can be created by hand (often on graph paper) or by computer using a charting application

The relationship between nodes and physical link of different topologyas shown in Table II

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Table II. Relationship between nodes and physical link of different topology

Topology / Node	Mesh	Ring	Star	Bus
	Physical Link			
1	0	0	0	0
2	1	1	1	3
3	3	3	2	4
4	6	4	3	5
5	10	5	4	6
6	15	6	5	7
7	21	7	6	8

In the above analyses, I have shown the chart representation for number of physical links of different topology over nodes (X-axis: Nodes, Y-axis: Number of physical Link). For listening the chart Fig. 8, number of physical Link is more high level in the mesh topology compared to other topology(No disturbance of data flow, No traffic).

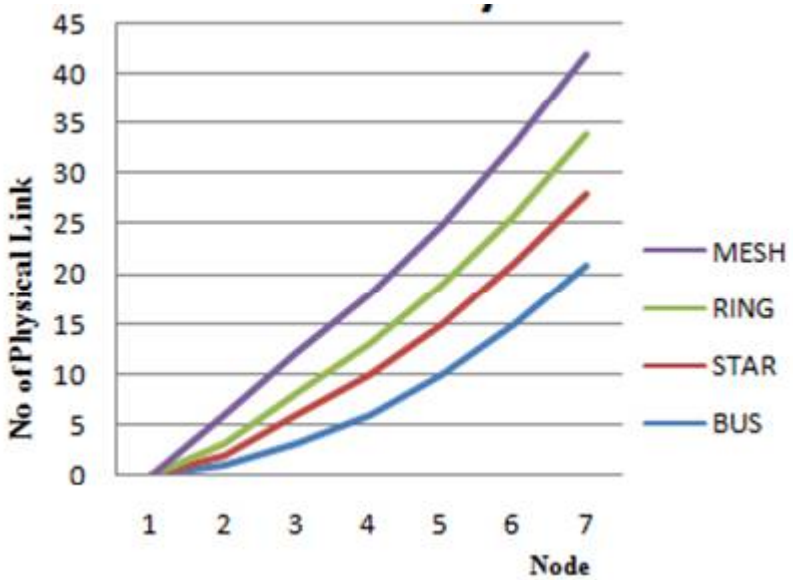

Fig 8 Number of physical links of different topology over node(s)

III. TYPES OF NETWORKS

3. Types of Networks: **On The Basis of Size**

There are several different types of computer networks. Computer networks can be characterized by their size as well as their purpose. The size of a network can be expressed by the geographic area they occupy and the number of computers that are part of the network. Networks can cover anything from a handful of devices within a single room to millions of devices spread across the entire globe. [8]

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Some of the different networks based on size are:

- Personal area network, or PAN
- Local area network, or LAN
- Metropolitan area network, or MAN
- Wide area network, or WAN [8]

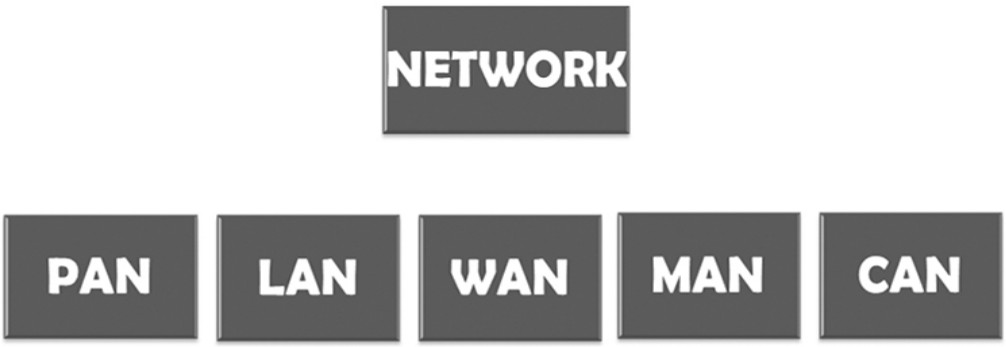

Fig. 8 Types of Network [8]

3.1 Personal Area Network: A personal area network, or PAN, is a computer network organized around an individual person within a single building. This could be inside a small office or residence. A typical PAN would include one or more computers, telephones, peripheral devices, video game consoles and other personal entertainment devices. If multiple individuals use the same network within a residence, the network is sometimes referred to as a home area network, or HAN. In a very typical setup, a residence will have a single wired Internet connection connected to a modem. This modem then provides both wired and wireless connections for multiple devices. The network is typically

managed from a single computer but can be accessed from any device. This type of network provides great flexibility. For example, it allows you to, Send a document to the printer in the office upstairs while you are sitting on the couch with your laptop. Upload a photo from your cell phone to your desktop computer. Watch movies from an online streaming service to your TV. If this sounds familiar to you, you likely have a PAN in your house without having called it by its name. [10] [11]

3.2 Local Area Network: A Local Area Network is a privately owned computer network covering a small Networks geographical area**,** like a home, office, or groups of buildings e.g. a school Network. A LAN is used to connect the computers and other network devices so that the devices can communicate with each other to share the resources. The resources to be shared can be a hardware device like printer, software like an application program or data. The size of LAN is usually small. The various devices in LAN are connected to central devices called Hub or Switch using a cable.
Now-a-days LANs are being installed using wireless technologies. Such a system makes use of access point or APs to transmit and receive data. One of the computers in a network can become a server serving all the remaining computers called Clients.
For example, a library will have a wired or wireless LAN Network for users to interconnect local networking devices e.g., printers and servers to connect to the internet.LAN offers high speed communication of data rates of 4 to 16 megabits per second (Mbps). IEEE has projects investigating the standardization of 100 Gbit/s, and possibly 40 Gbit/s. LANs Network may have connections with other LANs Network via leased lines, leased services [9] [10] [11]
There are basically two types of Local Area Networks namely: ARCnet and Ethernet.

ARCNET (Attached Resource Computer NETwork)

ARCNET is one of the oldest, simplest, and least expensive types of Local-Area Network protocol, similar in purpose to Ethernet or Token Ring. ARCNET was the first widely available networking system for microcomputers and became popular in the 1980s for office automation tasks. ARCnet was introduced by Data point Corporation in 1977.

A special advantage of ARCNET is that it permits various types of transmission media - twisted-pair wire, coaxial cable, and

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fiber optic cable - to be mixed on the same network. The specification is ANSI 878.1. It can have up to 255 nodes per network. A new specification, called ARCnet Plus, will support data rates of 20 Mbps

Ethernet is a family of computer networking technologies for local area networks commercially introduced in 1980. Standardized in IEEE 802.3, Ethernet has largely replaced competing wired local area network technologies. Ethernet uses a bus or star topology Network and supports data transfer rates of 10 Mbps.

Ethernet Network uses the CSMA/CD access method to handle simultaneous demands. It is one of the most widely implemented LAN standards. A newer version of Ethernet Network, called 100Base-T (or Fast Ethernet), supports data transfer rates of 100 Mbps.

the newest version, Gigabit Ethernet supports data rates of 1 gigabit (1,000 megabits) per second. Ethernet is a physical and data link layer technology for local area networks (LANs). Ethernet Network was invented by engineer Robert Metcalfe.

3.3 Metropolitan Area Network: MAN stands for Metropolitan Area Networks is one of a number of types of networks. A MAN is a relatively new class of network. MAN is larger than a local area network and as its name implies, covers the area of a single city. MANs rarely extend beyond 100 KM and frequently comprise a combination of different hardware and transmission media. It can be single network such as a cable TV network, or it is a means of connecting a number of LANs into a larger network so that resources can be shared LAN to LAN as well as device to device. [9] [10]

A MAN can be created as a single network such as Cable TV Network, covering the entire city or a group of several Local Area Networks (LANs). It this way resource can be shared from LAN to LAN and from computer to computer also. MANs are usually owned by large organizations to interconnect its various branches across a city.

MAN is based on IEEE 802.6 standard known as DQDB (Distributed Queue Dual Bus). DQDB uses two unidirectional cables (buses) and all the computers are connected to these two buses. Each bus has a specialized device that initiates the transmission activity. This device is called head end. Data that is to be sent to the computer on the right hand side of the sender is transmitted on upper bus. Data that is to be sent to the left hand side of the sender is transmitted on lower bus.

The two most important components of MANs are security and standardization. Security is important because information is being shared between dissimilar systems. Standardization is necessary to ensure reliable data communication.

A MAN usually interconnects a number of local area networks using a high-capacity backbone technology, such as fiber-optical links, and provides up-link services to wide area networks and the Internet.

The Metropolitan Area Networks (MAN) protocols are mostly at the data link level (layer 2 in the OSI model), which are defined by IEEE, ITU-T, etc.

3.4 Wide Area Network: A wide area network (WAN) is a telecommunication network. A wide area network is simply a LAN of LANs or Network of Networks. WANs connect LANs that may be on opposite sides of a building, across the country or around the world. WANS are characterized by the slowest data communication rates and the largest distances. WANs can be of two types: an enterprise WAN and Global WAN. [9] [10]

Computers connected to a Wide Area Networks are often connected through public networks, such as the telephone system. They can also be connected through leased lines or satellites. The largest WAN in existence is the Internet. Some segments of the Internet, like VPN based extranets, are also WANs in themselves. Finally, many WANs are corporate or research networks that utilize leased lines.

Numerous WANs have been constructed, including public packet networks, large corporate networks, military networks, banking networks, stock brokerage networks, and airline reservation networks.

Organizations supporting WANs using the Internet Protocol are known as Network Service Providers (NSPs). These form the core of the Internet.

By connecting the NSP WANs together using links at Internet Packet Interchanges (sometimes called "peering points") a global communication infrastructure is formed.

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WANs (wide area networks) generally utilize different and much more expensive networking equipment than do LANs (Local Area Networks). Key technologies often found in WANs (wide area networks) include SONET, Frame Relay, and ATM.

Clarify Enterprise WANs.

An enterprise WAN (wide area networks) connects an entire organization including all LANs (Local Area Networks) at various sites. This term is used for large, widespread organizations such as corporations, universities and governments.

Clarify Global WANs.

Global WANs (wide area networks) also span the world but they do not have to connect LANS (Local Area Networks) within a single organization. The Internet is an example of a global WAN. It connects diverse locations, organizations and institutions throughout the world. Global WANS (wide area networks) can be public or private. Private WANs (wide area networks) are called Intranet which belongs to an organization. Public WANs (wide area networks) are open to everybody so that anybody can connect and use the resources and services available.

3.5 Private Networks: One of the benefits of networks like PAN and LAN is that they can be kept entirely private by restricting some communications to the connections within the network. This means that those communications never go over the Internet.
For example, using a LAN, an employee is able to establish a fast and secure connection to a company database without encryption since none of the communications between the employee's computer and the database on the server leave the LAN. But, what happens if the same employee wants to use the database from a remote location? What you need is a private network. [9] [10]

IV. ON THE BASIS OF CONNECTION: TYPES OF NETWORKS

4.1 Wired Networks: A wired network is a common type of wired configuration. Most wired networks use Ethernet cables to transfer data between connected PCs. In a small wired network, a single router may be used to connect all the computers. Larger networks often involve multiple routers or switches that connect to each other. One of these devices typically connects to a cable modem, T1 line, or other type of Internet connection that provides Internet access to all devices connected to the network.
Wired may refer to peripheral devices as well. Since many keyboards and mice are now wireless, "wired" is often used to describe input devices that connect to a USB port. Peripherals such as monitors and external hard drives also use cables, but they are rarely called wired devices since wireless options are generally not available. [12]

Fig.9 Wired Network [2]

4.2 Wireless network: WLANs (Wireless Local Area Networks or sometimes referred to as LAWN, for local area wireless network) provide wireless network communication over short distances using radio or infrared signals instead of traditional network cabling.WLANs (Wireless Local Area Networks) is one in which a mobile user can connect to a local area network (LAN) through a wireless (radio) connection

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Norman Abramson, a professor at the University of Hawaii, developed the world's first wireless computer communication network,

A WLAN typically extends an existing wired local area network. WLANs (Wireless Local Area Networks) are built by attaching a device called the access point (AP) to the edge of the wired network. Clients communicate with the AP using a wireless network adapter similar in function to a traditional Ethernet adapter.

Network security remains an important issue for WLANs (Wireless Local Area Networks). Random wireless clients must usually be prohibited from joining the WLAN. Technologies like WEP raise the level of security on wireless networks to rival that of traditional wired networks.

The IEEE 802.11 group of standards specify the technologies for wireless LANs. 802.11 standards use the Ethernet

WLAN (Wireless Local Area Networks) hardware was initially so expensive that it was only used as an alternative to cabled LAN in places where cabling was difficult or impossible.

All components that can connect into a wireless medium in a network are referred to as stations. All stations are equipped with wireless network interface controllers (WNICs). Wireless stations fall into one of two categories: access points, and clients. Access points (APs), normally routers, are base stations for the wireless network.

They transmit and receive radio frequencies for wireless enabled devices to communicate with. Wireless clients can be mobile devices such as laptops, personal digital assistants, IP phones and other smartphones, or fixed devices such as desktops and workstations that are equipped with a wireless network interface. [12]

Fig.10 Wireless Network [2]

WLAN (Wireless Local Area Networks) types

Private home or small business WLAN

Commonly, a home or business WLAN employs one or two access points to broadcast a signal around a 100- to 200-foot radius. You can find equipment for installing a home WLAN in many retail stores.

With few exceptions, hardware in this category subscribes to the 802.11a, b, or g standards (also known as Wi-Fi); some home and office WLANs now adhere to the new 802.11n standard. Also, because of security concerns, many home and office WLANs adhere to the Wi-Fi Protected Access 2 (WPA2) standard.

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Enterprise class WLAN

An enterprise class WLAN employs a large number of individual access points to broadcast the signal to a wide area. The access points have more features than home or small office WLAN equipment, such as better security, authentication, remote management, and tools to help integrate with existing networks. These access points have a larger coverage area than home or small office equipment, and are designed to work together to cover a much larger area. This equipment can adhere to the 802.11a, b, g, or n standard, or to security-refining standards, such as 802.1x and WPA2.

Examples:

For WLANs that connect to the Internet, Wireless Application Protocol (WAP) technology allows Web content to be more easily downloaded to a WLAN and rendered on wireless clients like cell phones and PDAs.

4.3 Optical Networks: Optical networking is a means of communication that uses signals encoded onto light to transmit information among various nodes of a telecommunications network. They operate from the limited range of a local-area network (LAN) or over a wide-area network (WAN), which can cross metropolitan and regional areas all the way to national, international and transoceanic distances. It is a form of optical communication that relies on optical amplifiers, lasers or LEDs and wave division multiplexing (WDM) to transmit large quantities of data, generally across fiber-optic cables. Because it is capable of achieving extremely high bandwidth, it is an enabling technology for today's Internet and the communication networks that transmit the vast majority of all human and machine-to-machine information. [13] [14]

Optical Transport Network (OTN) is a large complex network of server hubs at different locations on ground, connected by Optical fiber cable or optical network carrier, to transport data across different nodes. The server hubs are also known as head-ends, nodes or simply, sites. OTNs are the backbone of Internet Service Providers and are often daisy chained and cross connected to provide network redundancy. Such a setup facilitates uninterrupted services and fail-over capabilities during maintenance windows, equipment failure or in case of accidents. [13] [14]

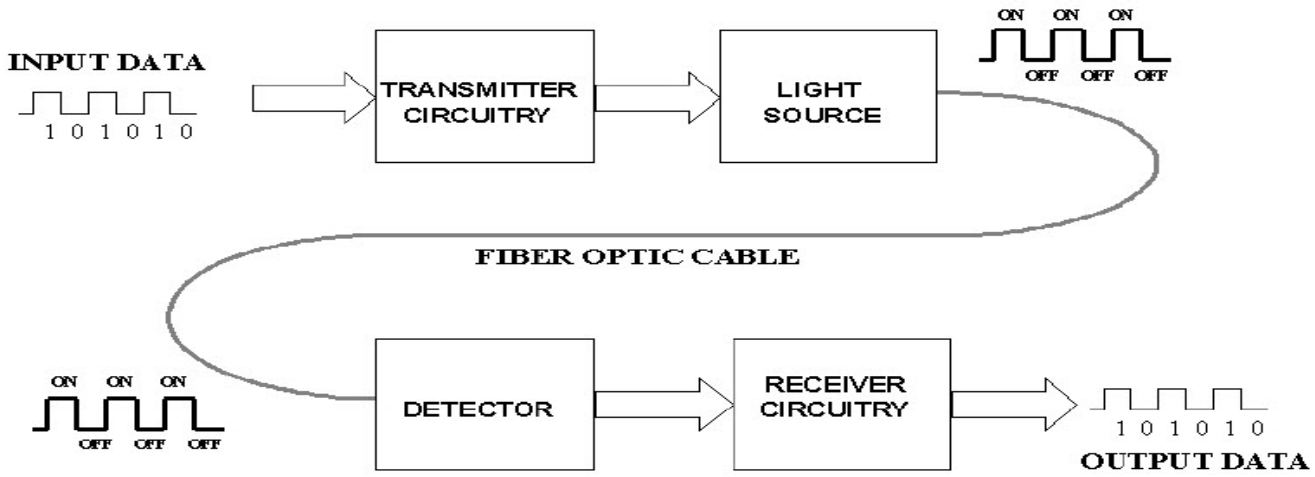

Fig.11 Basic optical fiber communication [15]

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TABLE-III COMPARISION OF WIRED, WIRELESS AND OPTICAL NETWORKS [12][16] [17]

Sr.no.	Characteristics	Wired Networks	Wireless Networks	Optical Networks
1.	Installation	Installation: Difficult to moderate (Because More no. of components are used during installation and require cables to be connected to each and every computer in the network	Easy installation (neat and clean, no untidy cables are used in this)	Installation: Difficult to moderate
2.	Visibility Node to Node on same Network	All of the nodes on a wired network can hear all other nodes	Many nodes on a wireless network cannot hear all of the other wireless nodes on the same network	All of the nodes on a optical network can hear all other nodes
3.	Visibility Network to Network	Networks are invisible to other wired networks. The presence of one wired network has no effect on the performance of another wired network	Wireless networks are often visible to other wireless networks. One wireless network can affect the performance of other wireless networks.	Networks are invisible to other wired networks.
4.	Time to Installation	More (due to connection of each and every computer in the network)	Less (no untidy cable connections involves in this)	More (due to connection of each and every computer in the network)
5.	User connectivity	Connectivity is possible only to or from those physical locations where the network cabling extends	Connectivity is possible beyond the bounds of physical network cabling.	Connectivity is possible on some physical locations
6.	Mobility	Limited (because it operates only on a connected computers linked with the network)	Outstanding (enable wireless user to connect to network and communicate with other users anytime, anywhere)	Limited
7.	Speed and Bandwidth	High Up to 100 mbps	Low Up to 54 mbps(depends upon standards 802.11g)	Very High Up to 43 Tbps for single fiber
8.	Security	Good (by using some software like free wall software etc.)	Weak (because wireless communication signals travel through the air and can easily be intercepted but it can improve by encryption technique)	Better than other networks
9.	Hubs and switches	Need hubs and switches for connections	No need of hubs and switches	Need hubs and switches for connections
10.	Cables	Ethernet, copper	Works on radio waves and microwaves	Optical fibre cables
11.	Reliability	High (Ethernet cables, switches are reliable because manufactures have improving technology over several decades)	Reasonably high(because if the major section like router break down the whole network will	Very high

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			be affected)	
12.	Cost	Less (such Ethernet, cables, switches are not expensive)	More (wireless adapters and access points are quite expensive)	More costly than other networks

Table-III shows the comparison of wired, wireless and optical networks in general. It compares the characteristics of these different types of networks under analysis. we thus see that optical networks that can be wired and wireless both offer high speed and high bandwidth as compared to wired and wireless networks in general. Also optical networks have many useful characteristics like reliability, security etc.

V. APPLICATIONS

1 Wired Networks:
Teleconferencing:
• It is the simplest wired application for voice communication by using PSTN.
• A telephone is used to conduct a conference between more than two people who are separated by a distance.
Videoconferencing:
• Two or more people can have a face-to-face meeting when they are geographically separated.
• Cameras, a computer, and videoconferencing. [12]

2 Wireless Networks:
Enterprise Network: An enterprise network is an enterprise's communications backbone that helps connect computers and related devices across departments and workgroup networks, facilitating insight and data accessibility. An enterprise network reduces communication protocols, facilitating system and device interoperability, as well as improved internal and external enterprise data management. [12]
Home Network or Home Area Network (HAN) is a type of local area network that develops from the need to facilitate communication and interoperability among digital devices present inside or within the close vicinity of a home. [12]
Wireless Sensor Network (WSN) Wireless sensor network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location. [12]

3. Optical Networks:
The use and demand for optical fiber has grown tremendously and optical fiber applications are numerous. Telecommunications are wide spread, ranging from global network to desktop computers. These involve the transmission of voice, data or video over distances of less than a metre to hundreds of kilometres, using one of a few standard fiber designs in one of several cable designs.
Optical fiber is also used extensively for transmission of data in multinational firms need secure, reliable systems to transfer data and financial information between buildings to the desktop terminals or computers and to transfer data around the world. [18]

VI. CONCLUSIONS

Networks are very common in the workplace as well as in the home. The wired Computer Networks provide a secure and faster means of connectivity but the need of mobility i.e. anywhere, anytime and anyone access is tilting the network users towards wireless technology. Wireless technology has high mobility. Technology has been created to store, transmit and receive data through networks at very high rates of speed. Users can now store detailed information at a very low cost. In the future, the speed of networks will increase as they have in past years. **Optical networks**

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provide higher capacity and reduced costs for new applications such as internet, video and multimedia interaction and advanced digital services. As computing technology increases in power, and decreases in size, the price of creating a high-powered full featured network will decrease rapidly.

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