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A Study on Networks and Comparison of Wired, Wireless and Optical Networks

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ABSTRACT: 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

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]

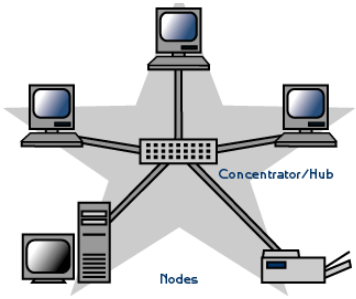

Fig.1 Network [2]

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: The term network topology describes the relationship of connected devices in terms of a geometric graph. Devices are represented as vertices 2 and their connections are represented as edges on the graph. It describes how many connections each device has, in what order, and it what sort of hierarchy.
There are many network configurations include the bus topology, mesh topology, ring topology, star topology, tree topology and hybrid topology. [3] [4] [7]

2.1 Bus Topology: A bus topology is a network setup in which each computer and network device are connected to a single cable or backbone. [3] [4] [5]

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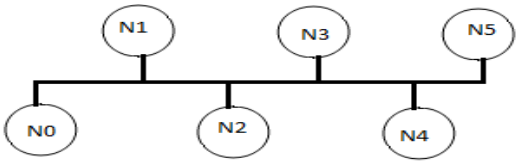

Fig.2. Bus Topology [6]

2.2 Mesh Topology: A network setup where each computer and network device is interconnected with one another, allowing for most transmissions to be distributed, even if one of the connections go down. This topology is not commonly used for most computer networks as it is difficult and expensive to have redundant connection to every computer. However, this topology is commonly used for wireless networks. [3] [4] [5]

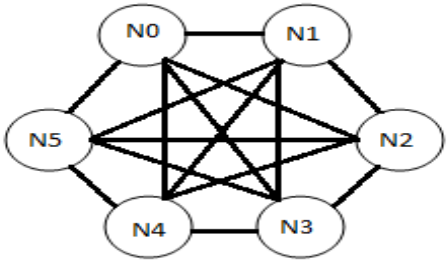

Fig.3 Mesh Topology [6]

2.3 Ring Topology: A ring topology is a computer network configuration where the devices are connected to each other in a circular shape. Each packet is sent around the ring until it reaches its final destination. Ring topologies are used in both local area network (LAN) and wide area network (WAN) setups. [3] [4] [5]

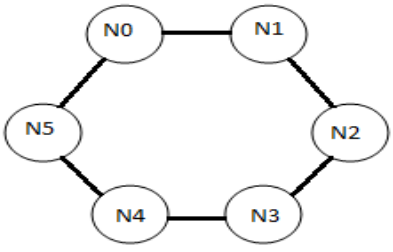

Fig.4 Ring Topology [6]

2.4 Star Topology: star topology is one of the most common network setups. In this configuration, every node connects to a central network device, like a hub, switch, or computer. The central network device acts as a server and the peripheral devices act as clients. [3] [4] [5]

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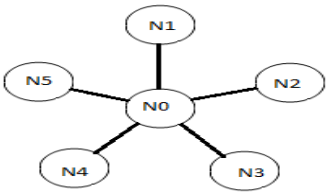

Fig.5 Star Topology [6]

2.5 Tree topology: A tree topology is a special type of structure in which many connected elements are arranged like the branches of a tree. There can be only one connection between any two connected nodes. Because any two nodes can have only one mutual connection, tree topologies form a natural parent-child hierarchy. [3] [4] [5]

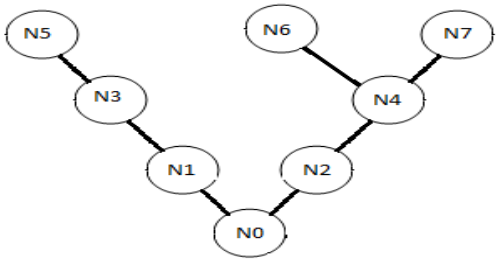

Fig.6 Tree Topology [6]

2.6 Hybrid Topology: A hybrid topology is a type of network topology that uses two or more other network topologies, including bus topology, mesh topology, ring topology, star topology, and tree topology. [3] [4] [5]

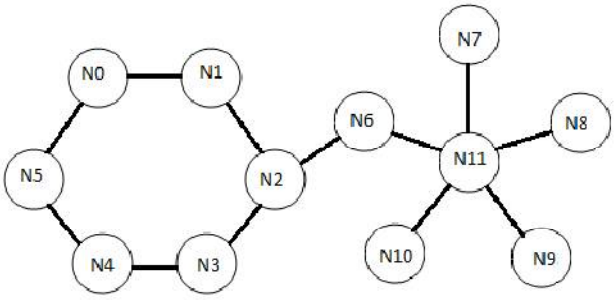

Fig.7 Hybrid Topology [6]

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

Parameters	**BUS**	**STAR**	**RING**	**MESH**	**TREE**
Installation	easy	easy	difficult	difficult	easy
Cost	inexpensive	expensive	moderate	expensive	less
Flexible	yes	yes	no	no	yes
Reliability	moderate	high	high	high	moderate
Extension	easy	easy	easy	poor	easy
Robust	no	yes	no	yes	no

Table 1 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.

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]

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]

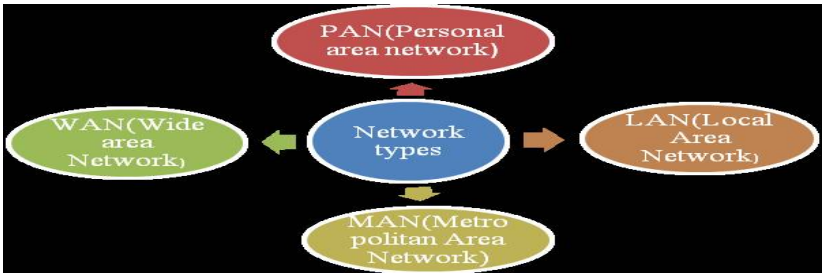

Fig. 8 Types of Network [8]

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

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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, or LAN, consists of a computer network at a single site, typically an individual office building. A LAN is very useful for sharing resources, such as data storage and printers. LANs can be built with relatively inexpensive hardware, such as hubs, network adapters and Ethernet cables. The smallest LAN may only use two computers, while larger LANs can accommodate thousands of computers. A LAN typically relies mostly on wired connections for increased speed and security, but wireless connections can also be part of a LAN. High speed and relatively low cost are the defining characteristics of LANs. LANs are typically used for single sites where people need to share resources among themselves but not with the rest of the outside world. Think of an office building where everybody should be able to access files on a central server or be able to print a document to one or more central printers. Those tasks should be easy for everybody working in the same office, but you would not want somebody just walking outside to be able to send a document to the printer from their cell phone! If a local area network, or LAN, is entirely wireless, it is referred to as a wireless local area network, or WLAN. [9] [10] [11]

3.3 Metropolitan Area Network: A metropolitan area network, or MAN, consists of a computer network across an entire city, college campus or small region. A MAN is larger than a LAN, which is typically limited to a single building or site. Depending on the configuration, this type of network can cover an area from several miles to tens of miles. A MAN is often used to connect several LANs together to form a bigger network. When this type of network is specifically designed for a college campus, it is sometimes referred to as a campus area network, or CAN. [9] [10]

3.4 Wide Area Network: A wide area network, or WAN, occupies a very large area, such as an entire country or the entire world. A WAN can contain multiple smaller networks, such as LANs or MANs. The Internet is the best-known example of a public WAN. [9] [10]

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: In computing terminology, the term “wired” is used to differentiate between wireless connections and those that involve cables to transfer data between different devices and computer systems. 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. [12]

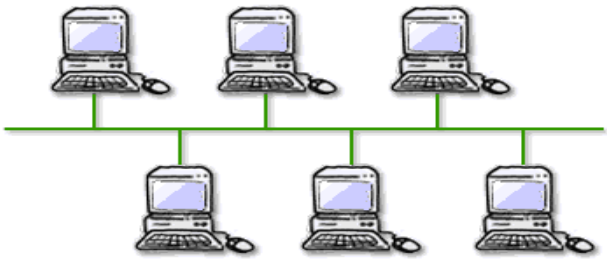

Fig.9 Wired Network [2]

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4.2 Wireless network: wireless network refers to the use of infrared or radio frequency signals to share information and resources between devices. Many types of wireless devices are available today; for examples, mobile terminals, pocket size PCs hand held PCs, laptops, PDAs, cellular phone, wireless sensors, and satellite receivers, among others. The emerging third generation cellular networks have enables a variety of higher speed mobile data services. Meanwhile, new standards for short range radio such as Bluetooth, 802.11, Hiperlan, and infrared transmission are helping to create a wide range of new applications for enterprise and home networking, enabling wireless broadband multimedia and data communication in the office and home.[12]

Fig.10 Wireless Network [2]

4.3 Optical Networks: Fiber optic communication is a communication technology that uses light pulses to transfer information from one point to another through an optical fiber. The information transmitted is essentially digital information generated by telephone systems, cable television companies, and computer systems. [13] [14]
An optical network connects computers (or any other device which can generate or store data in electronic form using optical fibers. Optical fibers are essentially very thin glass cylinders or filaments which carry signals in the form of light [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]

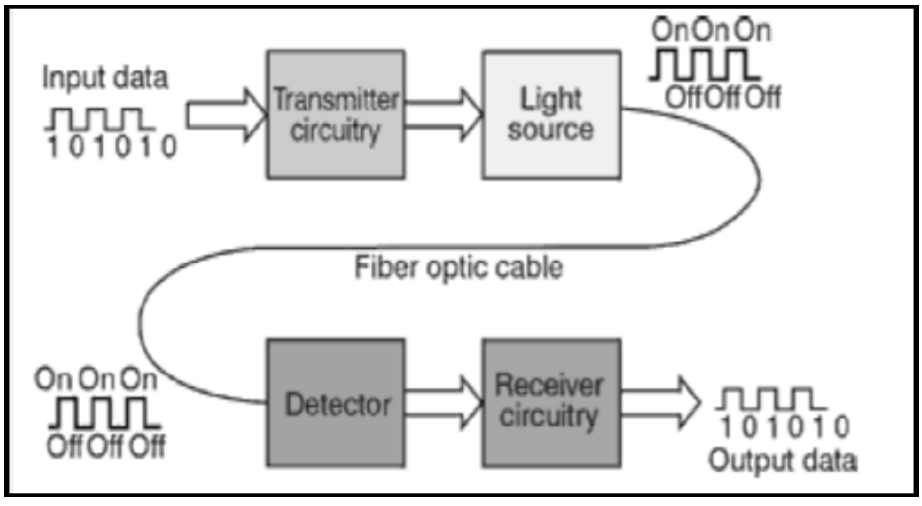

Fig.11 Basic optical fiber communication [15]

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TABLE-2 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-2 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 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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