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Exploring the Landscape of Computer Networking: An In-Depth Survey

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Abstract: ***Computer networks have become ubiquitous and now serve as sophisticated systems for sharing digital information. They play a crucial role in analysing, organizing, and distributing vital data for business profitability. Notably, the advent of intranets and internets, which are private networks built on internet technology, is reshaping the business landscape. The rapid adoption of intranets is driven by their ability to enhance information management and dissemination, ensuring that businesses stay competitive. In this article, we introduce fundamental networking concepts.***
Keywords: Peer-to-peer; Client / Server; Inter- networks; Intra-networks; Communication medium; Internet Protocol; Open Systems Interconnection.

I. INTRODUCTION

Introduction Refinement: Networking serves as the essential framework for enabling communication between software programs running on geographically separated machines. A computer network represents a union of computers, interconnected in various ways to facilitate the seamless exchange of data not only amongst themselves but also with other computers across the network. This network materializes when two or more computers establish connections with the purpose of sharing information and resources. These computers engage in the exchange of information following standardized protocols through various communication channels. Essentially, a computer network is a harmonious assembly of computers physically linked together to enable the mutual sharing of data and peripheral devices such as hard drives, CD-ROMs, fax- modems, printers, and more [2]. Within a computer network, you encounter an intricate interplay of autonomous computers, where "interconnected" signifies their ability to communicate with one another, and "autonomous" underscores the absence of one computer's control over others within the network. In Fig 1, we illustrate a practical example: a school network comprising a Local Area Network (LAN), connecting the school's computers not only with each other but also with the broader internet and various servers [4].

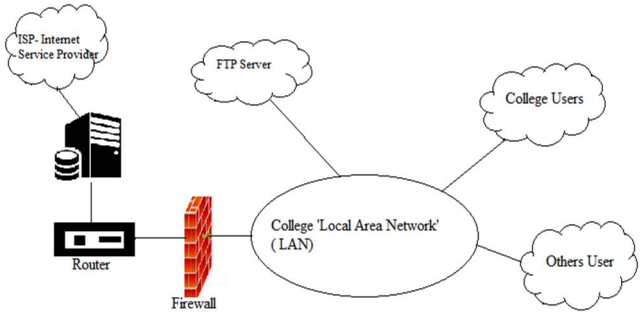

Fig. 1 Representation of Network in School

II. TYPES OF NETWORKCONFIGURATION

Broadly speaking, there are two types ofnetwork configuration, peer-to-peer networks and client/server networks.

A. Peer-to-peer Networks

Peer-to-peer networks find their primary use in scenarios involving fewer than ten computers, where stringent security measures are not a paramount concern. In such networks, all computers are considered equals, hence the term "peer," and they interact with one another on an equitable basis. This setup enables the seamless sharing of files among all connected computers, and it extends to the sharing of peripheral devices like printers or scanners, irrespective of the physical connection to any single computer. For a visual representation of how computers are interconnected within a peer-to-peer network, refer to Figure 2 [4].

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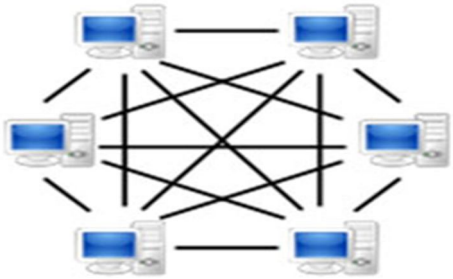

Fig. 2 Peer to Peer Network

B. Client/server Networks

Larger networks benefit from client/server networks. A central computer, or "server," serves as the repository for network-shared files and applications. The server is usually more powerful than a typical PC. The server also manages the network access of the other computers, known as "client computers." Only the network administrator will have access to the server; others will not. Others are only permitted to utilize client PCs. Figure 3 depicts how machines in a client/server network are linked [4]. area. By being confined it is possible in most cases to use only one transmission medium (cabling). This technology is less expensive to implement than WAN because you are keeping all of your expenses to a small area, and generally you can obtain higher speed. They are widely used to connect personal computers and workstations in offices and factories to share the resources. Traditional LANs runs at a speed of 10 to 100 mbps have low delay and make very few errors. Never LANs may operate at higher speed up to 100 mbps.

C. Common Physical Topologies

Physical and logical topologies can take severalforms. The most common and the most important for understanding the Ethernet and Token Ring topologies are

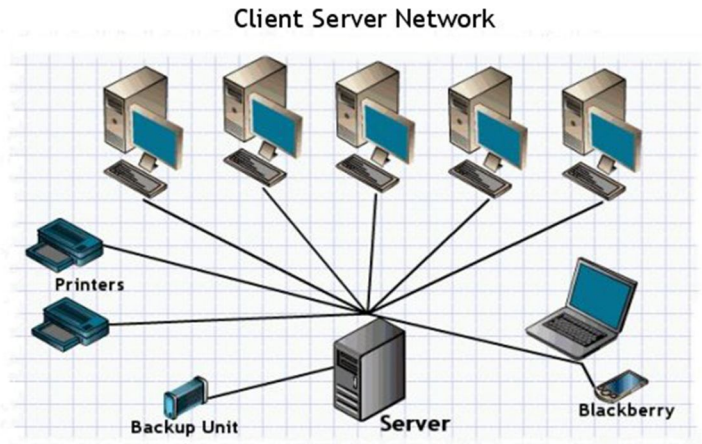

Fig. 3 Lient Server Networks

III. COMPONENTS OF A NETWORK

A Computer Network Comprises the Following Components

1) A minimum of at least two computers.
2) Cables that connect the computers each other, although wireless communication is becoming more common.
3) A network interface device on each computer (this is called a network interface card or NIC).
4) A „switch" used to switch the data from one point to another. Hubs are outdated.
5) Network operating system software [4].

IV. TYPES OF NETWORK

The network can be divided into geographicalareas and fall into these major categories.

1) Local Area Network (LANs).
2) Wide Area Network (WANs).
3) Metropolitan Area Network (MANs).
4) Wireless networks.

A. *Local Area Network*

A LAN is generally confined to a specificlocation, such as floor, building or some other small

1) *Bus Topology*

A bus physical topology connects all devices to a single shared cable. A physical bus topology network typically employs one long cable known as the backbone, to which machines (workstations and servers) are connected directly through Terrestrial microwave-connectors. To remove the signal from the wire once it has passed all devices, the backbone is terminated at both ends. The bus topology was the first to be used to connect computers in a network. This is the most basic type of topology. This is an example of a failure model. Electric or electro-magnetic impulses can go in both directions in most bus systems. Figure 4 shows a LAN using a BUS topology.

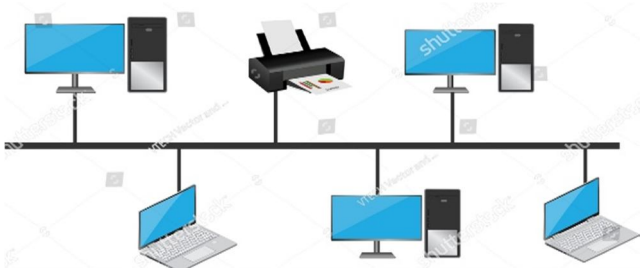

Fig: 4 LAN with BUS topology

2) *Ring Topology*

Ring topologies have circular wiring. Each node is connected to the nodes on each side and only moves in one way around the ring. Each unit functions as a repeater by combining a receiver and a transmitter and sending the signal to the following unit in the ring. Signal degradation is minimal because each device regenerates the signal. After some time, the RING topology was established. The RING topology was created in order to avoid the drawbacks of BUS topology. But this is also a model for failure. Ring topologies are the best choice for access methods that use token passing. Only the node holding the token is able to transmit data as it moves around the ring. Ring topologies are The token gets passed around the ring, and only the node that holds the token can transmit data. Ring topologies are quite rare. A LAN with RING topology is represented in Fig 5.

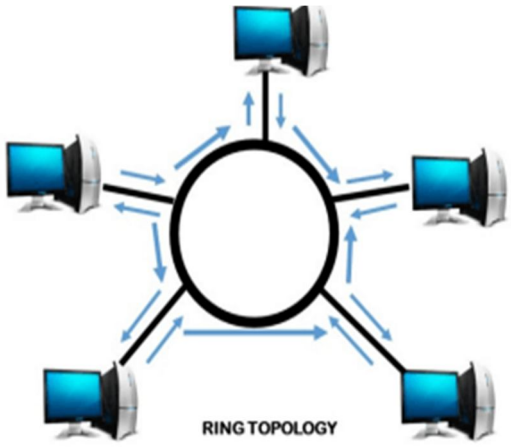

Fig: 5 LAN with RING topology

3) Star Topology

Star topologies use a central device with drop cables extending in all directions. Each networked device is connected via a point-to-point link to the central device called a hub or multiport repeater or switch. Additionally, star topologies can be nested within other stars to form tree or hierarchical network topologies. In star topology, electrical orelectromagnetic signals travel from the networked device, up its drop cable, to the switch, from there the signal is sent to other network. To avoid the disadvantages of BUS topology and RING topology, the STAR topology is invented. This is not a failure model. But it is a standard model and now-a-days this topology is commonly used everywhere. A LAN with STAR topology is represented in Fig 6.

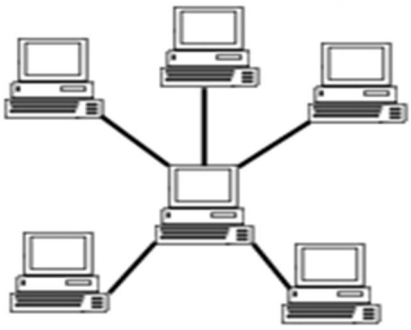

Fig: 6 LAN with STAR topology

4) Mesh Topology

A mesh network has a point-to-point connection between every device in the network. Because each device requires an interface for every other device onthe network, mesh topologies are not usually consideredpractical. However, mesh networks are extremely fault tolerant and each link provides guaranteed capacity.

5) Cellular Topology

A cellular topology combines wireless point-to-point and multipoint strategies to divide a geographic area into cells. Each cell represents the portion of the total network area in which a specific connection operates. Devices within the cell communicate with a central station or switch. Switches are interconnected to route data across the network and to provide the complete network infrastructure. For example, devices may roam from cell to cell while maintaining connection to the network.

B. Wide Area Network

A wide area network covers a vast geographic area, frequently a whole continent or nation. It multiplies a number of LANs that are connected but may be geographically separated by any distance. The majority of WANs have a network made up of multiple cables or phone lines, each of which connects a pair of routers. In order for two routers that do not share a cable to communicate, they must do it indirectly. To communicate indirectly with other computers on personal computers, we use a modem. Fig. 7 depicts a WAN connecting two distinct networks.

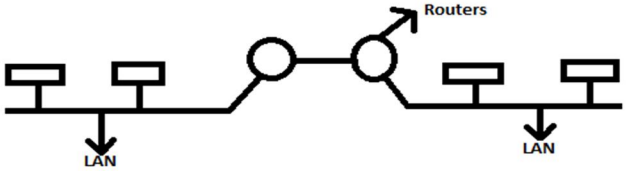

Fig: 7 WAN connecting two different networks

C. Metropolitan Area Network

Metropolitan Area Network is basically a bigger version of LAN and normally uses same technology. It might cover a group of nearby corporate offices or a city and might be either private or public. On the other hand, MAN is network running throughout a metropolitan area such as a backbone for a phone service carrier. A MAN just has one or two cables and does not contain switching elements.

D. Wireless Networks

Mobile computers such as notebook computers, laptops are the fastest growing segment of computer industry. Users want to connect this machine to their office LANs to see the data when they are out from the office, since the wired connection is not possible we have to use wireless networks.

For e.g. on aircraft single router will maintain a radio link with some other router on ground, changing routers as it flies along this configuration is just a traditional LAN, except that its connection to the outside world happens to be a radio link instead of a wired line.

V. COMMUNICATION LINKS

Various types and forms of communication medium are

1) Fiber-optic cable.
2) Twisted-pair copper wire.
3) Coaxial cable.
4) Wireless local-area links. (e.g. 802.11,Bluetooth)
5) Satellite channel [3].

VI. INTERNET PROTOCOL (IP)

To solve the scaling problem with Ethernet, and to allow support for other types of LANs and point-to- point links as well, the Internet Protocol was developed. To support universal connectivity, IP provides a global mechanism for addressing and routing, so that packets can actually be delivered from any host to any other host. IP addresses (for the most common version 4, which we denote IPv4) are 4 bytes (32 bits), [6] and are part of the IP header that generally follows the Ethernet header. The Ethernet header only stays with a packet for one hop; the IP header stays with the packet for its entire journey across the Internet. An essential featureof IPv4 addresses is that they can be divided into a “network” part and a “host” part [5]. There are differenttypes of classes in IPv4 and their ranges are shown in Table 1.

Table: 1 Range and types of classes

Class	Address Range
Class A	0 to 126
Class B	128 to 191
Class C	192 to 223
Class D	224 to 239
Class E	240 to 254

Range 127 is reserved for the loopback or localhost, for example, 127.0.0.1 is the common loopback address. Range 255.255.255.255 broadcasts toall hosts on the local network [9].

VII. OPEN SYSTEMS INTERCONNECTION(OSI) MODEL

The Open Systems Interconnection model, or OSI, a procedure for developing new network standards, was established by the International Organization for Standardization, or ISO, in 1977. The OSI initiative was an attempt to develop networking standards without the involvement of any one government. The seven-layer networking model of the OSI model is likely most known today. Table 2 lists the seven OSI model layers and their respective functions. The OSI uses its own variants of TCP and IP. Although OSI also provides a connection-oriented protocol, CMNS, it is the IP equivalent known as CLNP, or Connection Less Network Protocol. TP4 is the TCP equivalent.

Table: 2 Layers of OSI model and their purpose

Layer	Purpose
Application	Human-computer interaction layer, where applications can access the network services.
presentation	Ensures that data is in a usable format and is where data encryption occurs.
Session	Maintains connections and is responsible for controlling ports and sessions.
Transport	Transmits data using transmission protocols including TCP and UDP.
Network	Decides which format physical path, the data will take.
Data Link	Defines the format of data on the network.
Physical	Transmits raw bit stream over the physical medium.

VIII. CONCLUSION

The usage of computer communication as a networking tool appears to increase significantly as more people with similar interests have access to the technology. Although technology can speed up the creation of new interpersonal networks by removing the time and location constraints that hinder traditional networking strategies, getting individuals to use it still takes a lot of focused effort and resources. As technological advancements are more widely embraced by society, this issue should be reduced over the ensuing years.

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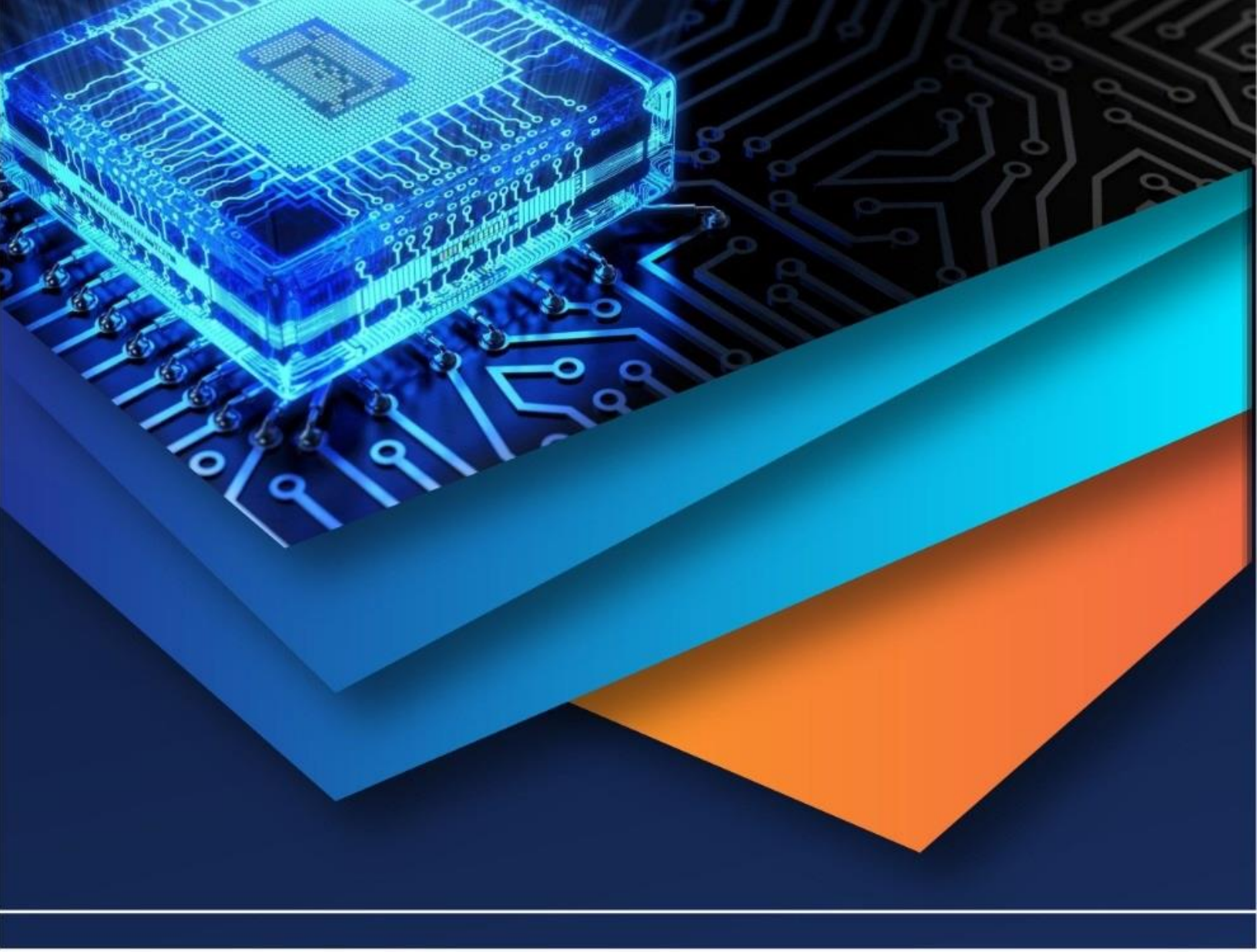

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