THE FUNDAMENTALS OF NETWORKING

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The Fundamentals of Networking

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1. OSI MODELS

The OSI also known as the Open Systems Interconnection model describes the seven layers that computer systems use to communicate over a network. This was the first standard model adopted by major computer and telecommunication companies in the early 1980's.

1. **Physical Layer:** This first layer is responsible for the cable or wireless connection between network nodes. It connects various devices together and is responsible for the transmission of raw data which in computer language is basically a series of 0's and 1's, and also takes care of bit rate control [1].

2. **Data link layer:** this layer creates and terminates a connection between two physically connected nodes on a network. It breaks packets into frames and moves them from one node to another. The data link layer is composed of two parts:
- **Logical Link Control**: which identifies network protocols, performs error checking and syncs frames.
- **Media access control:** this partition uses MAC addresses to connect devices and define permissions that send and receive data

3. **Network layer:** this layer performs two functions, breaking up segments into network packets and then reassembling them on the receiver's end. The other function is finding the best path across a physical network and routing packets across them to the destination node using network addresses.

4. **Transport layer:** this layer takes data sent and breaks it into segments on the receiver's end. After receiving the segments, it is turned back into data that can be used by the session layer. Its main responsibility is to carry out flow control, sending data at the correct internet speed and performing damage control to check if data was received correctly or not.

5. **Session layer:** this layer is responsible for creating various sessions which are basically communication channels between devices and ensuring that they remain open and are functional while the data is being transferred. Once the data is transferred, the session is closed.

6. **Presentation layer:** this layer's responsibility is to define the encoding, encrypting and compressing the data of two devices in order to ensure data is received correctly by the receiver. The presentation layer is connected with the application layer as it takes the created data and prepares it for transmission over the session layer.

7. **Application layer:** this layer is used by end user softwares like web browsers which basically provides protocols that lets users send and receive information and get back data. A few examples of application layer protocols are; HTTP,FTP,POP,SMTP and DNS. [1]
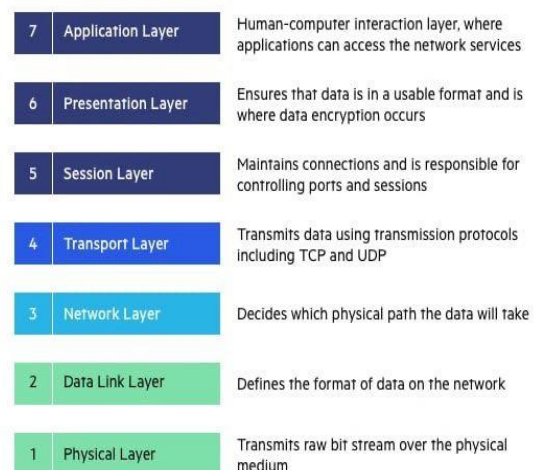

Fig. 1. Above figure summarizes the OS1 model in simple terms

2. NETWORKS

In this section we will review over the 2 types of networks, Circuit switched networks and packet switched networks.

Circuit switched networks: a type of network where before being able to communicate, the communications between the nodes/end devices need to be set up. Once the nodes are set up, the circuit is dedicated to the two nodes used during the connection. An example of this network can be an analog telephone network and dial up network connections.

Packet switched networks: this network breaks communication into packets and sends those packets individually to the connected networks. Unlike circuit-switched networks, packet switched do not establish dedicated communication channels between hosts, rather they effectively offer a network that can be used by variety of hosts at the same time.

There are many differences between circuit switching and packet switching, but below listed are 4 of the main differences between the two networks [2].

TABLE I. MAIN DIFFERENCES BETWEEN CIRCUIT SWITCHING AND PACKET SWITCHING

In circuit switching, every data unit knows the entire path provided by the source.	In packet switching, every data unit only knows the final destination while the router decides the intermediate path.
There is resource reservation because path is fixed for data transmission	Since bandwidth is shared among users, there is no resource reservation.
More resources are wasted in the process.	There is less resource wastage compared to circuit switching
There is a chance of congestion in the case where a request is being denied because of a channel already being occupied.	There is a case of congestion during data transfer where there is a transmission of a large number of packets.

3. 802 FAMILY OF STANDARDS

The professional organization responsible for administering the "802" suite of standards is the Institute of Electrical and Electronics Engineering. This organization first and foremost deals with networking and telecommunications technologies [3].

Most widely used and important 802 family of standards include Ethernet, Wi-Fi, bridging, WRAN's, WPAN's and Port based network access controls [4]:

IEEE 802.3 -ETHERNET: This is the most accredited standard in the 802 family [7]. It describes various specifications for Ethernet, which in today's world is the most used LAN technology used for wired connection. Some examples of data they cover are 10Mbps (802.3), 100Mbps (802.3u), 1Gbps (802.3ae), etc.

IEEE 802.11 -WIFI: This is a kind of wireless LAN technology. Their responsibility is to state rules for wireless communications between various devices based on their data rates and frequencies. Wi-Fi includes;802.11a, 802.11b, 802.11g,802.11n,802.11ac and 802.11ax.

IEEE 802.1 -BRIDGING: This is mainly used with architecture and works with WAN's, MAN's and LAN's. They divide LAN traffic.

IEEE 802.16 - WiMAX: This standard is mainly used in metropolitan area networks which means it is accessible over longer distances.

IEEE 802.22 - Wireless Regional Area Networks (WRANs): This standard provides wireless networks to remote and rural areas and makes use of unused TV broadcast spectrum known as white spaces.

IEEE 802.1X -Port-Based Network Access Control: This is mainly used for network security and connects to LAN or WLAN.

IEEE 802.15 -Wireless Personal Area Network (WPANs): This network connects short range communications often used for personal uses. Some common examples include; Bluetooth, 802.15.4 and body area networks

4. NETWORK TOPOLOGIES

Network topology defines the structure of a network and how various components like nodes and connections are connected in a network. Network topologies are very efficient because they allow enterprises to quickly identify problems and implement fixes that improve data transfer efficiency [5].

The 4 main types of network topologies are:

Bus Topology: In this topology, all computers collectively are connected through a single continuous coaxial cable known as the backbone cable, which is connected to the computer using a drop cable. The ends of the backbone cable are terminated through the terminators [6].
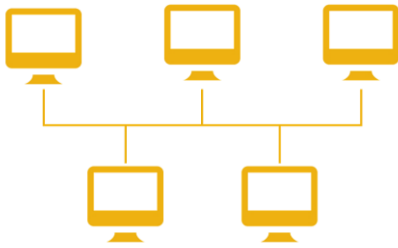

Fig. 2. Figure above demonstrates the backbone cable

Star Topology: In this topology, all devices are connected to a single hub through a cable. It is built in the shape of a star where the central node is the main hub and every other node is connected to the main node. To connect to the switch, every computer in the network utilizes a separate twisted cable, which uses RJ-45 connectors on both ends, which in turn means that the installation fee is expensive [6].
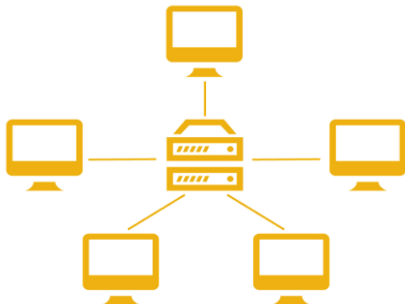

Fig. 3. Figure above is a simple diagram of Star Topology where all devices have separate cable connected to the main hub

Ring Topology: In this topology, multiple repeaters with a large number of nodes are used to form a ring which connects exactly two devices. Here, data only flows in one direction, but it can also flow in two directions with the use of Dual Ring Topology, which has two links between each network node. Just like star topology, this orientation also uses RJ-45 or a coaxial cable to connect [6].
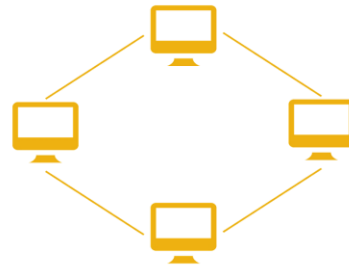

Fig. 4. It is evident that data flows in one direction from one device to another

Mesh Topology: Here, multiple paths exist between various end devices. There are two kinds of mesh topology; fully meshed and partially meshed. Fully meshed topology is when there is a direct path between each end device to other devices within the network. Whereas, if there are multiple paths between end devices, then this is a partially meshed network. The connections within mesh topology are usually wireless or wired [6].
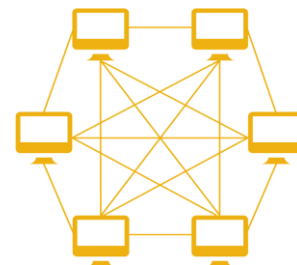

Fig. 5. There are multiple paths between each device so there is less traffic.

There are various uses for all these topologies, below listed are two scenarios of uses for star topology and mesh topology

Star topology: In an office setting where multiple devices are connected, the main switch can easily be accessible by all devices like computers, printers, etc. So if one device fails, then this interrupts the network of the entire office, but with the use of star topology we can easily avoid this fault.

Mesh topology: In an air traffic control system, there will be multiple pieces of information being passed around. If a part of a network fails to receive, transmit or collect the information, then the data flow will be interrupted, however with the use of mesh topology, the threat is lessened making the damage lower.

REFERENCES

[1] "What is OSI model: 7 layers explained: Imperva," Learning Center, https://www.imperva.com/learn/application-security/osi-model/ (accessed Oct. 11, 2023).

[2] C. B. T. Writer et al., "Packet-switched network vs. circuit-switched network," Spiceworks, https://www.spiceworks.com/tech/networking/articles/packet-switched-vs-circuit-switched-network/ (accessed Oct. 11, 2023).

[3] A. S. Gillis, "What are the IEEE 802 wireless standards?," Networking, https://www.techtarget.com/searchnetworking/reference/IEEE-802-Wireless-Standards-Fast-Reference#:~:text=IEEE%20802%20is%20divided%20into,Committee%2C%20also%20called%20the%20LMSC. (accessed Oct. 11, 2023).

[4] "IEEE 802," IEEE Standards Association, https://standards.ieee.org/featured/ieee-802/#:~:text=The%20most%20widely%20used%20IEEE,providing%20focus%20for%20each%20area (accessed Oct. 11, 2023).

[5] ComputerNetworkingNotes, "Network topologies explained with examples," ComputerNetworkingNotes, https://www.computernetworkingnotes.com/networking-tutorials/network-topologies-explained-with-examples.html (accessed Oct. 11, 2023).

[6] A. S. Gillis and T. Nolle, "What is network topology? - definition from searchnetworking," Networking, https://www.techtarget.com/searchnetworking/definition/network-topology (accessed Oct. 11, 2023).

[7] A. S. Gillis, "What are the IEEE 802 wireless standards?," Networking, https://www.techtarget.com/searchnetworking/reference/IEEE-802-Wireless-Standards-Fast-Reference (accessed Oct. 11, 2023).