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Computer Network

1) Network Topology refers to the layout or arrangement of various elements like in a computer Network. Different Types of Topologies serve different purpose based on network size. Efficiency and reliability

1.) Bus Topology

→ In a bus Topology, all devices share a single communication line or cable.

Star topology : Each node is connected to a central hub or switch. This is commonly used for its simplicity, scalability, and ease of troubleshooting.

Ring topology :-

Each Node is connected to a central hub or switch. This is commonly used for its simplicity, scalability, and ease of troubleshooting.

mesh topology :

Every node is connected to every other node. It offeres high redundancy and reliability but is costly to implement and maintain

2> Circuit Switching and Packet Switching :-

* Circuit Switching :

This method establishes a dedicated communication Path between nodes before data is transmitted. It is often used in traditional telephony networks. The Path remains active for the entire duration of the connection, Providing a Stable connection with minimal delay but low efficiency for bursty data traffic.

* Packet Switching :-

Data is divided into Packets, each traveling independently through the network to its destination. The Path can vary for each packet, making it highly efficient for data transfer in networks where data is set in bursts. Packet Switching is widely used in the internet and other data networks.

3. Guided media;

Guided media refers to communication media that use physical conduits to transmit signals. Types of guided media Include;

- Twisted Pair cable: Made of two insulated copper wires twisted around each other, often used in LANs. It comes in two types: Shielded Twisted Pair (STP) and unshielded Twisted Pair (UTP).

- Coaxial cable:-
consists of a central conductor, insulating layer, metallic shield, and outer plastic covering. commonly used for cable television and internet.

- Fiber optic cable:-
uses light to transmit data at high speeds over long distances. It's immune to electromagnetic interference and can handle high bandwidth but is more expensive.

4. Unguided media :-

Unguided media, also called wireless media, transmits data through the air without using physical conductors. Types include:

- Radio waves :- Suitable for long-distance communication, used in radio and TV broadcasting, and mobile networks. It's reliable but susceptible to interference.
- Microwaves :-

Used in Point-to-Point communication, where line-of-Sight

communication, where line-of-sight communication is Possible. common in satellite networks and cellular networks.

- Infrared : used for short-range communication, like remote controls and some wireless peripheral devices.

5. Given,

Packet size = 5000 bits

Link Bandwidth = 1 Gbps

Propagation Delay per link = 10 microseconds

From the given Information:-

- Transmission Delay per link = (Packet size / Link Bandwidth) = $\frac{5000 \text{ bits}}{1 \text{ Gbps}}$

=> 5 microseconds

- Total Delay per link (Transmission + propagation)
= 5 + 10 = 15 microseconds

(a) scenario with 1 switch and 2 links

The data travels across 2 links with 1 switch in between.

1. Link 1 (sender to switch):
   - Transmission Delay = 5 microseconds
   - Propagation Delay = 10 microseconds
   - Total Delay for link 1 = 5 + 10 = 15 microseconds

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2. Switch Processing:

- The switch starts forwarding only after receiving the entire packet, so no extra processing delay is added.

3. Link 2 (Switch to Receiver):

- Transmission Delay = 5 microseconds
- Propagation Delay = 10 microseconds
- Total Delay for Link 2 = 5+10 = 15 microseconds

Total latency for (a) = Delay for Link 1 + Delay for Link 2 = 15+15 = 30 microseconds

(b) Link 1:

- Transition Delay = 5 micro seconds
- Propagation Delay = 10 microseconds
- Total delay for link 1 = 5+10 = 15 microseconds

Link 2:

its the same.

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Total latency for (b) = Delay for (1) + (2)+(3)+4
= 15+15+15+15 => 60 microseconds.

6. Given an address in a block:-
185.28.17.9

Without knowing the subnet mask, we can't calculate the number of addresses precisely. However, assuming it's a class C IP address (default subnet mask 255.255.255.0):

1. Number of Addresses: In a class C network, the default mask /24 allows for 256 addresses (2^8).

2. First Address : 185.28.17.0

3. Last Address : 185.28.17.255

7. An organization with a class A IP has an adddress 10.200.240.4

For a class A address with a default subnet mask 255.0.0.0(/8):

1. Number of Addresses: 2^{24} = 16,777,216 addresses in the network.

2. Network Address: 10.0.0.0 (all the host bits set to 0).

3. Broadcast Address: 10.255.255.255 (all host bits set to 1.

So, these are the number of addresses in the block, the first address and the last address.

8. Subnet

216.21.5.0 into 30 hosts per subset.

1. To accommodate 30 hosts, we need 32 address
(since $2^5 = 32$).

2. Subnet mask: using 5 bits for hosts, the subnet mask is /27 or 255.255.255.224.

3. Subnets: Each subnet provides 32 addresses (30 usable for hosts).

- First subnet: 216.21.5.0 to 216.21.5.31
- second subnet: 216.21.5.32 to 216.21.5.63
- Contin as well.

9. Subnet 150.15.0.0 into 500 hosts per subnet.

1. To support 500 hosts, we need 512 addresses (since $2^9 = 512$).

2. Subnet mask: using 9 bits for hosts, the subnet mask is /23 or 255.255.254.0.

3. Subnets: Each subnet has 512 addresses (510 usable for hosts).

- First subnet: 150.15.0.0 to 150.15.1.255
- Second subnet: 150.15.2.0 to 150.15.3.255

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10. Subnet 10.0.0.0 into 100 hosts per subnet.

1. To support 100 hosts, we need 128 addresses (since $2^7 = 128$).

2. Subnet mask: using 7 bits for hosts, the subnet mask is /25 or 255.255.255.128.

3. Subnets: Each subnet provides 128 addresses (126 usable for hosts).

- First subnet: 10.0.0.0 to 10.0.0.127
- Second subnet: 10.0.0.128 to 10.0.0.255

Continue up to 100 hosts per subnet.

11. A Host in a block has

25.34.12.56/16

1. First Address (network address):

25.34.0.0

2. Last Address (Broadcast Address):

25.34.255.255

The /16 mask indicates that the network portion is the first two octets.

12. Class B network with subnet mask

255.255.248.0

1. Subnet Mask (in binary):

11111111.11111111.11111000.00000000

(/21)

2. Host Bits: 11 host bits are available.

3. Maximum host per subnet: $2^{11} - 2 = 2046$ host (subtracting 2 for network and broadcast addresses).

13. Determine if A: 10.105.1.113 and B: 10.105.1.191 belong to the same Network

(a) 255.255.255.0 (/24)

- Network Address for A: 10.105.1.0
- Network Address for B: 10.105.1.0
- Match (They Belong to the same network).

(b) 255.255.255.128 (/25)

- Network Address for A: 10.105.1.0
- Network Address for B: 10.105.1.128
- No match (Do not belong to the same network).

(c) 255.255.255.192 (/26)

- Network Address for A: 10.105.1.64
- Network Address for B: 10.105.1.128
- No match (Do not belong to the same network).

(d) 255.255.255.224 (/27)

- Network Address for A: 10.105.1.96
- Network Address for B: 10.105.1.160
- No match (Do not belong to the same network).

Thus, Subnet masks (b), (c), and (d) should not be used if A and B should belong to the same network.

17. Define NAT and its types:-

Network Address translation is a method used in networks to modify network address information in IP Packet headers while in transit. It allows a local network with private IP addresses to communicate with external networks, like the internet, using a single or limited number of Public IP addresses. NAT helps conserve IPv4 addresses and provides security by hiding internal IP addresses.

Types of NAT:-

1. Static NAT:-

Maps a single Private IP address to a single Public IP address. It is often used when an internal device needs to be accessible from outside.

2. Dynamic NAT: map a private IP address to any available public IP address from a pool of addresses. Each time a private IP tries to access the internet, it gets assigned a different public IP.

3. PAT (Port Address Translation): A form of dynamic NAT where multiple private IP address are mapped to a single public IP address but with different port numbers. This is the most common type of NAT, allowing multiple devices to share a single public IP.

18. Supernetting is the Process of combining multiple contiguous networks into a single, larger network, often used to simplify routing by reducing the number of entries in a routing table. supernetting is also known as CIDR (classless Inter-Domain Routing).

Given

- Supernet mask : ~~255.~~ 255.255.248.0 (or /21)
- Class C Default mask : 255.255.255.0 (or /24)

1. Number of Networks combined :
   Supernetting from /24 to /21 increases the network Porting by 3 bits (from 24 to 21).
   - This allows $2^3 = 8$ class C networks to be combined.

2. IP Address: 199.15.119.189

- Converting to binary for supernetting:
- 199.15.119.189 is in the 199.15.112.0 - 199.15.119.255 range based on the /21 mask.

3. Supernet ID: 199.15.112.0

4. Range of supernet:
   - First Address: 199.15.112.0
   - Last Address: 199.15.119.255

19. Given:-

- Supernet Mask: 255.255.252.0 (or /22)
- Class C Default Mask: 255.255.255.0 (or /24)

1. Number of Networks combined:
   Supernetting from /24 to /22 changes the network portion by 2 bits.
   - This allows $2^2 = 4$ class c networks to be combined.

2. IP address: 202.89.69.119

- Based on the /22 mask, this IP belongs to the 202.89.68.0 - 202.89.71.255 range.

3. Supernet IP: 202.89.68.0

4. Range of supernet:
   - First Address: 202.89.68.0
   - Last Address: 202.89.71.255.

20. HUB:

A simple Network device that connects multiple computers in a LAN. It operates at the Physical layer and broadcasts data to all devices connected to it, regardless of the intended recipient. It is not efficient, as it can create network congestion.

SWITCH:-

A more intelligent device than a hub, operating at the data link layer. A switch can filter and forward data to specific devices based on their MAC addresses, reducing unnecessary data transmission and network congestion. Some switches also operate at the network layer and can perform routing.

REPEATER:

A device that amplifies or regenerates singnals in a network. It operates at the physical layer and is used to extend the reach of a network by boosting weak signals to ensure data cana travel longer distances without degradation.

BRIDGE:-

A device that connects two or more LAN segments, operating at the data link layer. It filters traffic by forwarding only the necessary packets based on MAC address, reducing network traffic between segments.

Bridges are often used to divide ~~a~~ a network into smaller segments for efficiency.

ROUTER:-

A device that routes data packets between different networks, operating at the network layer. Routers use IP addresses to determine the best path for connecting different network, such as linking a home network to the internet.

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21. Bandwidth = 10 mbps = 10^6 bps

Data network can pass on average = 12,000 frames in 60 seconds.

1 frame = 10,000 bits.

Calculation:

∴, data network can pass in 60 seconds = 12,000 × 10,000

Throughput is data network can pass in 1 second

$$\text{Throughput} = \frac{12,000 \times 10,000}{60} \Rightarrow 2,000000 \text{ bps}$$

= 2 mbps.

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22. Given data :-

- Frame size : 10 million bits (10^7 bits)
- Number of routers : 20
- Queuing time per router : 2 μs (2×10^{-6} s)
- length of the link : 5000 km (5×10^6 m)
- Speed of light inside the link : 2×10^8 m/s
- Link bandwidth : 6 Mbps (6×10^6 bits/s)

Steps to calculate Delay:

Transmission Delay : [

$$\text{transmission Delay} = \frac{\text{Frame size}}{\text{Link Bandwidth}}]$$

[transmission delay $= \dfrac{10^7 \text{ bits}}{6 \times 10^6 \text{ bits/s}} = \dfrac{10}{6}$ seconds $\approx$

1.6667 seconds.

Propagation Delay :

$$\text{propagation Delay} = \frac{\text{Length of Link}}{\text{Speed of Light in the medium}}$$

[propagation Delay $= \dfrac{5 \times 10^6 \text{ m}}{2 \times 10^8 \text{ m/s}} = 0.02$

Seconds.

Queuing Delay Per Router:

- Total Queuing Delay = Number of Routers × Queuing Time Per Router.
- Total Queuing Delay = $20 \times 2 \times 10^{-6}$ s = 40×10^{-6} = 40 μs = 0.00004 s.

Queuing Delay Per Router:

- Total Queuing delay = Number of Routers × Queuing time per Router
- Total Queuing Delay = $20 \times 1 \times 10^{-6}$ s = 20×10^{-6} s = 20 μs = 0.00002 s

total delay:

- Total Delay = transmission Delay + propagation delay + Total Queuing Delay + total processing delay.
- Total = 1.6667 s + 0.025 s + 0.00004 s + 0.00002 s = 1.69176 s.

3. The OSI model is a conceptual framework developed by the International organization for Standardization (ISO) to understand and implement network communication. It divides networking into seven layers, each with specific functions.

Layers of the OSI model:

1. Physical layer: Deals with the physical connection between devices. It involves transmission of raw binary data over a physical medium like cables or radio frequencies. examples include Ethernet cables and physical hardware components.

2. Data link layer:-
Provides error, free transfer of data frames between two nodes connected by a physical layer. It's divided into two sublayers.

- MAC : Controls how devices on a network gain access to data and permission to transmit it.

- LLC : Manages frame synchronization, flow control, and error checking.

Network layer, Transport layer, session layer, Presentation layer, Application layer.

24. TCP/IP model.

The TCP/IP (Transmission control Protocol / Internet protocol) model is a simpler, practical framework developed by the U.S. Department of defense to support the creation of the internet. It's based on standard protocols.

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1. Network Interface layer:-

Combines the functions of the OSI model's Physical and data link layers. It handles the physical transmission of data over network media and manages access to the physical network.

2. Internet Layer:-

Corresponds to the OSI model's network layer. It is responsible for packet forwarding, addressing, and routing across different networks. The primary protocol in the layer is the Internet protocol, which includes IPv4 and IPv6.

3. Application layer:-

Combines the OSI model's session, presentation, and application layers. It enables software application layers. It enables software application to communicate with each other, and protocols include HTTP, FTP, SMTP, DNS, etc.

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25. Fixed length subnetting involves dividing a network into smaller, equally sized subnets by borrowing bits from the host portion of the IP address. Every subnet has the same number of host addresses, which provides simplicity but limits flexibility.

Example :- consider a class C network with an IP address 192.168.1.0/24.

1. Default subnet mask : 255.255.255.0 (allows 256 addresses).

2. Fixed-Length Subnetting : suppose we want four subnets.

- Borrow 2 bits from the host portion, resulting in a new subnet mask of 255.255.255.192 (or /26).
- Each subnet can now have $2^6 = 64$ address (62 usable hosts per subnet, as 2 are reserved for network and broadcast)

Subnets :-

1. Subnet 1 : 192.168.1.0/26 (Range: 192.168.1.1 - 192.168.1.62,
Broadcast: 192.168.1.63)

2. Subnet 2 :
192.168.1.64/26 (Range: 192.168.1.65 - 192.168.1.126,
Broadcast : 192.168.1.127)

3. Subnet 3 :
192.168.1.128/26 (Range :- 192.168.1.129 - 192.168.1.190,
Broadcast : 192.168.1.255)

Fixed-length subnetting is easy to calculate but inefficient if subnet sizes vary because all subnets have the same fixed size, regardless of need.

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26. VLSM :-

Variable- length Subnet masking (VLSM) allows the creation of subnets with different sizes based on the specific requirements of the network. It's more efficient than fixed-length subnetting, as it uses IP addresses more effectively.

Example: consider the 192.168.10.0/24 network.

1. Requirement:
   - Subnet A needs 100 hosts.
   - Subnet B needs 50 hosts.
   - subnet C needs 25 hosts.
   - Subnet D needs 10 hosts.

2. Subnetting using VLSM:-
   - For subnet A (100 hosts): we need 128 addresses, so /25 (subnet mask 255.255.255.128) will be used.
   - Subnet A : 192.168.10.0/25

(Range: 192.168.10.1 - 192.168.10.126,)

Broadcast: 192.168.10.127)

- For subnet B (50 hosts): we need 64 addresses, so /26 will be used.
  - subnet B: 192.168.10.128/26
  (Range: 192.168.10.129 - 192.168.10.190,)
  Broadcast: 192.168.10.191)
- For subnet C (25 hosts): we need 32 addresses, so /27 will be used.
  - subnet C: 192.168.10.192/27
  (Range: 192.168.10.193 - 192.168.10.222,
  Broadcast: 192.168.10.223)
- For subnet D (10 hosts): we need 16 address, so /28 will be used.
  - Subnet D: 192.168.10.224/28
  Range: 192.168.10.225 - 192.168.10.238,
  Broadcast: 192.168.10.239)