Computer Networks 1

Lab 1a

Network Devices

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2. Understanding functions of network devices

a. Network Interface Card (NIC)

NIC functions: to allow make communication in between computer systems through local area network, and to make communications over large-scale network via Internet Protocol (IP)

Code of NIC processors: Intel 82574L, Realtek RTL8111, Broadcom BCM5721

Check NIC of a computer, what is its MAC address?

A unique identifier assigned to a network interface controller (NIC) for use as a network address in communications within a network segment . MAC address of my Computer:

```
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50-C2-E8-6B-E4-23
```

Cable to connect NIC to a network:

Type:

• 10Base2: The cable used is a thin coaxial cable.

• 10Base5: The cable used is a thick coaxial cable.

• 10Base-T: The cable used is a twisted-pair (T means twisted pair) and the speed achieved is around 10 Mbps.

• 100Base-FX: Makes it possible to achieve a speed of 100 Mbps by using multimode fiber optic (F stands for Fiber).

• 100Base-TX: Similar to 10Base-T, but with a speed 10 times greater (100 Mbps).

• 1000Base-T: Uses a double-twisted pair of category 5 cables and allows a speed up to one Gigabit per second.

• 1000Base-SX: Based on multimode fiber optic uses a short wavelength signal (S stands for short) of 850 nanometers (770 to 860 nm).

• 1000Base-LX: Based on multimode fiber optic uses a long-wavelength signal (L stands for long) of 1350 nm (1270 to 1355 nm). this network is a widely used network technology because the cost of such a network is not very high.

Standard: IEEE 803.3 10 base 5, IEEE 802.3 10 base 2, IEEE 802.3 10 base T RJ45.

b. Hubs

Roles of hub in a network:
A hub is a basic networking device used to connect multiple computers or other electronic devices within the same LAN (Local Area Network). A hub typically has between 4 to 24 ports and acts as a central connection point. When data is sent to one port, the hub copies it and transmits it to all other ports. Since the hub does not differentiate which port the data is coming from, it simultaneously broadcasts the data to all connected devices.

Main characteristics:

- Operates with shared bandwidth and broadcasts data to all ports.
- The hub functions at the physical layer of the OSI model and supports half-duplex transmission mode.
- Collisions may occur during transmission, especially when multiple computers are sending data at the same time through different ports.
- It is flexible and allows high transmission speeds to different connected devices

Weaknesses of hub:

- The hub cannot select the best path for network traffic.
- It lacks mechanisms such as collision detection and does not help reduce network traffic.
- The hub cannot filter data, as it transmits packets to all connected segments indiscriminately.
- Additionally, hubs are incapable of connecting different network architectures such as ring, token, and Ethernet networks.

Hub ports: A hub typically has between 4 to 24 ports.

c. Switches

Roles of switches in a network: Directs data only to the intended device, improving network efficiency.

Main characteristics of switches: An Ethernet switch separates network traffic into smaller units called microsegments. Each microsegment allows users on different segments to send data simultaneously without slowing down the network. Every segment is its own collision domain, and the switch manages bandwidth by forwarding packets only to the correct port

based on the Layer 2 MAC address. This helps to create smaller collision domains, ensuring more bandwidth for users. Each segment functions like an independent connection, such as a dedicated 100 Mbps lane, where servers can be placed on their own 100 Mbps connections for optimal performance.

Differences between hubs and switches:

Feature	**Hub**	**Switch**
Data Transmission	Broadcasts data to all ports. Causes network collisions.	Inspects data and forwards it to the correct destination port. Prevents collisions.
Duplex Mode	Half-duplex (can either transmit or receive at a time)	Full-duplex (can transmit and receive simultaneously)
OSI Model Layer	Physical Layer	Data Link Layer
Central Connection	Can be linked through a central hub	Can connect multiple systems and manage ports, configure VLANs
Data Filtering	No data filtering mechanism	Filters and forwards data based on MAC addresses
Data Transmission Type	Transmits data as bits (electrical signals)	Transmits data as frames or packets
Device Type	Passive device	Active device
Duplex Operation	Half-duplex	Can operate in half or full duplex mode
Speed	Typically 10 Mbps	Ranges from 10 Mbps to 1 Gbps

Weaknesses of Switches:

➡ They are more expensive compared to network bridges.
➡ Network connection issues are difficult to trace through switches.
➡ Handling broadcast traffic can be complex.
➡ Switches in idle mode are vulnerable to security threats, such as IP spoofing or Ethernet frame interception.
➡ Advanced design and configuration are required to manage multicast packets effectively.
➡ Although switches reduce broadcast traffic, they are not as effective as routers in controlling broadcasts.
➡ Communication between VLANs requires inter-VLAN routing, although many multi-layer switches are available today.

➡ Managing multicast traffic requires considerable configuration and proper design.

➡ They reduce the number of broadcast domains, but not as effectively as routers.

Switch ports:

d. Routers

Roles of routers in a network: A router is a networking device that forwards data packets between computer networks. It essentially acts as a "traffic director" on the internet. Data sent over the internet, such as a webpage or an email, is transmitted in the form of packets. These data packets are forwarded from one router to another through interconnected networks, until they reach their final destination.

Main Characteristics of Routers:

1. **Operates at Layer 3 (Network Layer) of the OSI Model:** Routes data based on IP addresses.
2. **Packet Forwarding:** Directs data packets between different networks, determining the best path for data to travel.
3. **Traffic Management:** Manages traffic between networks, ensuring data is routed efficiently.
4. **Interconnectivity:** Connects different networks (e.g., LAN to WAN, LAN to LAN).
5. **Security Features:** Often includes firewall, NAT (Network Address Translation), and VPN capabilities for secure data transmission.
6. **Routing Protocols:** Uses protocols like OSPF, BGP, and RIP to dynamically find the best path for data transmission.

Differences Between Routers and Switches:

Feature	**Router**	**Switch**
Primary Function	Routes data between different networks (e.g., LAN to WAN)	Connects devices within the same network (LAN)
OSI Layer	Operates at Layer 3 (Network Layer)	Operates at Layer 2 (Data Link Layer)
Data Transmission	Routes data using IP addresses	Forwards data based on MAC addresses
Broadcast Domains	Breaks up broadcast domains	Does not typically break up broadcast domains
Collision Domains	Each port on a router creates a separate collision domain	Each port on a switch creates a separate collision domain

Feature	Router	Switch
Speed	Typically slower due to more complex processing	Faster as it deals with data forwarding within a network
Security Features	Provides advanced security options like NAT, firewalls, and VPN	Basic security; can filter data based on MAC addresses
Usage	Used to connect different networks or subnets	Used to connect devices within the same network (LAN)

Router Ports:

1. **WAN Port:** Connects to an external network (e.g., the internet).
2. **LAN Ports:** Connects to local network devices (e.g., computers, switches).
3. **Console Port:** Used for router configuration and management.
4. **Optional Ports:** Can include additional interfaces like serial ports for connecting to legacy systems or other networks.

d. Access Points

Roles of Access Points:

1. **Wireless Connectivity:** Provides wireless access to a local network (LAN) for devices like laptops, smartphones, and IoT devices.
2. **Extending Network Coverage:** Expands the coverage area of a wired network by allowing wireless devices to connect.
3. **Bridging Wired and Wireless Networks:** Acts as a bridge between wired Ethernet networks and wireless devices.
4. **Managing Wireless Traffic:** Regulates and optimizes traffic between wireless devices and the network to avoid congestion.

Main Characteristics of Access Points:

1. **Operates at Layer 2 (Data Link Layer) of the OSI Model:** Manages wireless traffic and facilitates data transmission.
2. **Wireless Communication:** Utilizes Wi-Fi standards (e.g., 802.11a/b/g/n/ac/ax) to provide wireless connections.
3. **Supports Multiple Devices:** Can handle connections from multiple wireless devices simultaneously.
4. **SSID (Service Set Identifier):** Broadcasts a network name for wireless devices to connect to.

5. **Security Features:** Provides wireless security through protocols like WPA, WPA2, or WPA3 for authentication and encryption.

Access Point's Interfaces:

1. **Ethernet Port:** Connects to the wired LAN for internet and network access.
2. **Wireless Interface:** Allows wireless devices to connect using Wi-Fi standards.
3. **Power-over-Ethernet (PoE):** Some access points support PoE, enabling both data and power to be delivered through a single Ethernet cable.
4. **Console Interface:** Some access points include a console port for configuration and management.

Comparison of Access Points with Other Networking Devices:

Feature	Access Point	Router	Switch	Hub
Primary Function	Provides wireless access to a wired network	Routes data between different networks (e.g., LAN to WAN)	Connects devices within the same network (LAN)	Broadcasts data to all devices connected to it
OSI Layer	Layer 2 (Data Link Layer)	Layer 3 (Network Layer)	Layer 2 (Data Link Layer)	Layer 1 (Physical Layer)
Data Transmission	Wireless (Wi-Fi)	Routes data based on IP addresses	Forwards data based on MAC addresses	Broadcasts data indiscriminately to all connected devices
Device Type	Wireless networking device	Networking device that connects multiple networks	Networking device that connects devices within a single network	Simple device to connect multiple devices
Traffic Management	Manages wireless traffic	Manages traffic between different networks	Manages data flow within the same network	Does not manage traffic, simply broadcasts data
Security Features	Provides wireless security (WPA, WPA2, WPA3)	Offers advanced security features like NAT, VPN, and firewalls	Basic security based on MAC filtering (in managed switches)	No security features

Feature	Access Point	Router	Switch	Hub
Connectivity Type	Connects wireless devices to a wired network	Connects different networks or subnets	Connects devices within the same network	Connects devices but with no intelligence in traffic management
Speed	Varies based on Wi-Fi standards (e.g., 300 Mbps to several Gbps)	Varies based on routing capacity	Faster than a hub, ranges from 10 Mbps to 1 Gbps	Typically slower, 10 Mbps or 100 Mbps
Broadcast Control	Wireless access, does not control broadcasts across the wired network	Controls broadcast domains	Does not control broadcasts but can limit collision domains	Broadcasts data to all connected devices

e. Modern

Differentiate: Dial-up Modem, ADSL Modem, Cable Modem

1. **Dial-up Modem:**
    - **Role:** Connects a computer to the internet using a regular telephone line by converting digital data into analog signals.
    - **Characteristics:**
        - Slow connection speed (up to 56 Kbps).
        - Requires a telephone line and occupies it while connected to the internet.
        - Based on old PSTN (Public Switched Telephone Network) technology.
        - Outdated, rarely used due to slow speeds and limited bandwidth.
2. **ADSL Modem (Asymmetric Digital Subscriber Line):**
    - **Role:** Provides high-speed internet access over a telephone line without interfering with voice calls.
    - **Characteristics:**
        - Faster download speeds (up to several Mbps) compared to upload speeds.
        - Uses separate frequency bands for voice and internet, allowing simultaneous use of both.
        - Commonly used in residential areas for broadband internet.

- Requires a splitter to separate the voice and data signals.

3. **Cable Modem:**
    - **Role:** Provides internet access via cable TV networks by transmitting data through coaxial cables.
    - **Characteristics:**
        - Much faster than ADSL, with speeds ranging from several Mbps to over 1 Gbps.
        - Always-on connection, unlike dial-up.
        - Shared bandwidth in neighborhoods, meaning speeds can fluctuate during peak hours.
        - Common in urban and suburban areas.

3. Connecting network devices

Identify the type of network cable can be used for below network connections:

a) Computer and hub **Straight-through cable**

b) Computer and switch **Straight-through cable**

c) Computer and router: **Straight-through cable**

d) Computer hub and hub: **Crossover cable**

e) Hub and switch: **Crossover cable**

f) Hub and router **Straight-through cable**

g) Switch and switch **Crossover cable**

h) Switch and router **Straight-through cable**

k) Router and router **Crossover cable**