Computer Networks 1

Lab 1

Network Devices

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I. Objectives:

- Get to know basic network devices
- Understand functions of network devices
- Able to connect different network devices together to form a simple network

II. Content

1. Get to know network devices:

- ✔ Network Interface Card (NIC)
- ✔ Cables
- ✔ Hub
- ✔ Switches
- ✔ Routers
- ✔ Access Points
- ✔ Modems

2. Understanding functions of network devices

a. Network Interface Card (NIC)

* NIC functions:
  - Transmission and Reception of data over a network.
  - Encapsulation and decapsulation of data into frames.
  - Error detection and correction during data transfer.
  - Flow control to manage data speed.
  - Handling MAC addressing to direct data to the correct device.
  - Supporting both half-duplex and full-duplex communication modes.
  - Buffering to smooth out data traffic and prevent loss.
  - Interrupt handling to notify the CPU of network events.
  - Power management and features like Wake-on-LAN.
  - Protocol offloading to relieve the CPU from intensive network tasks.

* Code of NIC processors:
* Check NIC of a computer, what is its MAC address? 00-E0-4C-73-B8-B7

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Ethernet adapter Ethernet 3:

   Connection-specific DNS Suffix  . : hcmut.edu.vn
   Description . . . . . . . . . . . : Realtek USB GbE Family Controller
   Physical Address. . . . . . . . . : 00-E0-4C-73-B8-B7
   DHCP Enabled. . . . . . . . . . . : Yes
   Autoconfiguration Enabled . . . . : Yes
   Link-local IPv6 Address . . . . . : fe80::e065:6c83:8763:2750%48(Preferred)
   IPv4 Address. . . . . . . . . . . : 10.28.129.244(Preferred)
   Subnet Mask . . . . . . . . . . . : 255.255.254.0
   Lease Obtained. . . . . . . . . . : Saturday, October 5, 2024 2:12:58 PM
   Lease Expires . . . . . . . . . . : Saturday, October 5, 2024 11:39:12 PM
   Default Gateway . . . . . . . . . : 10.28.128.1
   DHCP Server . . . . . . . . . . . : 10.28.128.1
   DHCPv6 IAID . . . . . . . . . . . : 805363788
   DHCPv6 Client DUID. . . . . . . . : 00-01-00-01-2A-FB-A7-E9-00-6F-00-08-09-93
   DNS Servers . . . . . . . . . . . : 8.8.4.4
                                       8.8.8.8
   NetBIOS over Tcpip. . . . . . . . : Enabled
```

* Cable to connect NIC to a network:
Type: Cat5
Standard: RJ-45

b. Hubs

***** Roles of hub in a network:

- Central Connection Point: Connects multiple devices in a LAN.
- Broadcasting Data: Transmits data to all connected devices.
- Signal Repeater: Amplifies signals to extend the network range.
- Shared Bandwidth: All devices share the same bandwidth.
- Half-Duplex Communication: Allows only one direction of communication at a time.
- Simple, Cost-Effective Solution: For basic, small-scale networks.

* Main characteristics:

- A hub is a Layer 1 device that regenerates signals out all ports other than the ingress port. All ports on a hub belong to the same collision domain. Hubs use CSMA/CD to detect collisions on the network

* Weakness of hub:

- **No Intelligent Traffic Management:** Hubs operate purely at the physical layer and lack the capability to filter or route data. They broadcast incoming data to all connected devices, leading to unnecessary network congestion.
- **Increased Network Collisons:** Because hubs use a half-duplex communication method, multiple devices attempting to send data simultaneously can cause collisions. This can significantly degrade network performance, especially as the number of connected devices increases.
- **Shared Bandwidth:** All devices connected to a hub share the same bandwidth. For example, if a hub has a 100 Mbps bandwidth, all devices must share this capacity, leading to reduced speed and performance as more devices are added.
- **Limited Distance:** While hubs can amplify signals, they still have limitations in terms of the distance over which they can effectively transmit data. Typically, the maximum distance for Ethernet cables is around 100 meters, after which signal degradation can occur.
- **No Security Features:** Data transmitted through a hub is visible to all connected devices, making it easy for unauthorized users to intercept data. Hubs do not provide any security measures to prevent data snooping or unauthorized access.

- **Lack of Support for Advanced Protocols:** Hubs do not support advanced networking protocols and features such as spanning tree protocol (STP), which is essential for preventing loops in switched networks.

c. Switches

*Roles of Switches in a Network:

- Connect multiple devices within a Local Area Network (LAN).
- Receive and forward data packets to intended recipients based on MAC addresses.
- Reduce unnecessary traffic and collisions.
- Facilitate communication between devices.
- Improve bandwidth utilization.
- Allow for the creation of Virtual LANs (VLANs) for better network management.

*Main Characteristics of Switches:

- Operate at the Data Link Layer (Layer 2) of the OSI model.
- Utilize MAC address tables to learn device addresses.
- Support full-duplex communication (simultaneous data transmission and reception).
- Offer multiple ports for device connectivity.
- Manage traffic efficiently.
- Support advanced features like Quality of Service (QoS) and VLANs.

*Differences Between Hubs and Switches:

- Hubs broadcast data to all devices; switches forward data only to intended recipients.
- Hubs operate at Layer 1; switches operate at Layer 2.
- Switches reduce collisions and improve efficiency compared to hubs.
- Switches support full-duplex communication; hubs do not.
- Switches offer advanced features (VLANs, QoS) while hubs do not.

*Weaknesses of Switches:

- Can experience broadcast storms if misconfigured.
- Vulnerable to MAC address flooding attacks.
- Unmanaged switches lack advanced management and security features.
- Generally more expensive than hubs.
- Limited in scalability compared to higher-end network devices.

*Switch Ports:

- Physical connections allowing devices to connect to the network.
- Each port connects a single device (computer, printer, etc.).
- Range from 5 to 48 or more ports on a switch.
- Operate at varying speeds (10/100/1000 Mbps or even 10 Gbps).
- Managed switches provide configuration options for security and traffic management.
- Some ports support Power over Ethernet (PoE) for powering devices through the network cable.

d. Routers

*Roles of Routers in a Network:

- Connect multiple networks (e.g., LANs and WANs).
- Route data packets between different networks based on IP addresses.
- Enable communication between devices on different subnets.
- Provide network address translation (NAT) for IP address management.
- Facilitate internet access for connected devices.

*Main Characteristics of Routers:

- Operate at the Network Layer (Layer 3) of the OSI model.
- Use routing tables to determine the best path for data transmission.
- Support various protocols (e.g., TCP/IP, BGP, OSPF).
- Offer features like firewall protection and VPN support.
- Can have both wired and wireless connectivity options.

*Differences Between Routers and Switches:

- Routers connect different networks; switches connect devices within a single network.
- Routers operate at Layer 3; switches operate at Layer 2.
- Routers use IP addresses for routing; switches use MAC addresses for forwarding.
- Routers typically include additional features like NAT and firewalls; switches primarily manage local traffic.
- Routers are generally more complex and expensive than switches.

*Router Ports:

- Provide physical connections for devices to access the network.
- Include WAN ports for connecting to external networks (e.g., internet).
- Include LAN ports for connecting local devices (computers, printers).
- Some routers feature USB ports for connecting storage devices or printers.
- Can support Ethernet (RJ45) connections and sometimes fiber optic connections.

d. Access Points

*****Roles of Access Points:

- Extend a wired network by adding wireless connectivity.
- Allow wireless devices to connect to a wired network.
- Facilitate communication between wireless devices within the network.
- Provide internet access to mobile devices (smartphones, tablets, laptops).
- Support roaming, enabling users to move freely within the coverage area without losing connection.

*Main Characteristics of Access Points:

- Operate at the Data Link Layer (Layer 2) of the OSI model.
- Support various wireless standards (e.g., 802.11a/b/g/n/ac/ax).
- Can function in different modes (e.g., access point mode, repeater mode, client mode).
- Often feature multiple antennas for improved signal strength and coverage.
- Allow for network security protocols (e.g., WPA2, WPA3) to protect wireless communications.

*Access Point’s Interfaces:

- Ethernet Ports: Typically include one or more ports for connecting to the wired network.
- Wireless Interfaces: Allow devices to connect wirelessly using various Wi-Fi standards.
- Management Interfaces: Often provide web-based or command-line interfaces for configuration and management.
- Power Input: May use standard power adapters or Power over Ethernet (PoE) for power supply.
- LED Indicators: Display status information (e.g., power, connectivity, activity).

*Compare Access Points and Other Networking Devices:

- Access Points vs. Routers:

- Access points extend wired networks with wireless connectivity; routers connect different networks and route data between them.
- Routers have built-in NAT and firewall features; access points primarily focus on wireless communication.

-Access Points vs. Hubs:

- Access points provide wireless connectivity; hubs connect devices using wired connections and broadcast data to all ports.
- Hubs operate at Layer 1; access points operate at Layer 2.

-Access Points vs. Network Interface Cards (NICs):

- Access points allow multiple devices to connect wirelessly to a network; NICs enable a single device to connect to a network (wired or wireless).
- NICs are installed in devices (computers, printers), while access points are standalone devices that serve as connection points for multiple devices.

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: crossover 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