Topic 4B: Compare Networking Hardware

Network Interface Cards:

A **Network Interface Card (NIC)** is a hardware component that allows a computer to connect to a network. It establishes Ethernet communications using either **electrical signals** over copper cables or **light pulses** over fiber optic cables. NICs are essential for enabling devices to communicate within a network. Most modern PC motherboards come with a built-in NIC that supports **1000BASE-T Ethernet**, which operates at **1 Gbps** over copper twisted-pair cables. For specialized needs, you can install an adapter card to support other Ethernet types, like fiber optics, or to add multiple ports for increased network capabilities. For example, A NIC with four 1000BASE-T ports can bond these ports to create a link speed of 4 Gbps, improving data transfer rates for demanding applications.

NICs convert electrical or light signals into digital data that the computer can process. To manage this communication, the Ethernet standard defines:

1. **Framing**: Breaking data into consistent units called **frames**.
2. **Addressing**: Ensuring each frame is sent to the correct destination using a **Media Access Control (MAC) address**.

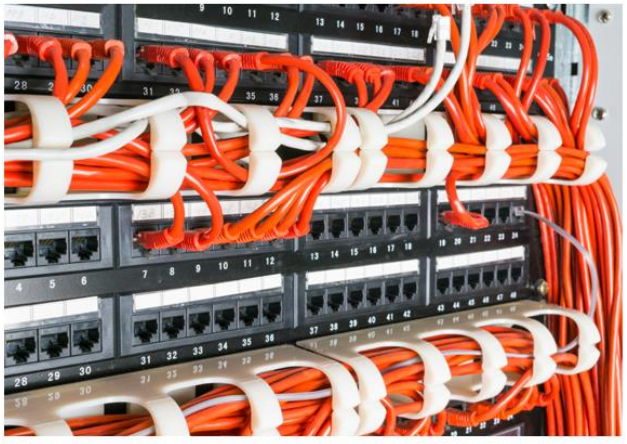
MAC Address

- A **MAC address** is a unique hardware identifier for a NIC port, ensuring data is sent and received correctly within a local network.
- **Structure**:
    - A MAC address is **48 bits** (6 bytes) long.
    - Represented in **hexadecimal format** (base-16) with 12 digits, e.g., 00:60:8C:12:3A:BC.
    - Digits may be separated by colons (:), hyphens (-), or written without separators.

Example:

- 00:60:8C:12:3A:BC = A MAC address in colon-separated format.
- Each pair of hex digits (e.g., 00, 60, 8C) represents one byte of the address.

Patch Panels:



A **patch panel** is an essential component of structured cabling systems in office networks. It acts as a centralized hub, making it easier to manage and organize network connections. Patch panels are commonly used in environments where cables run through walls to connect computers, printers, and other devices to a network.

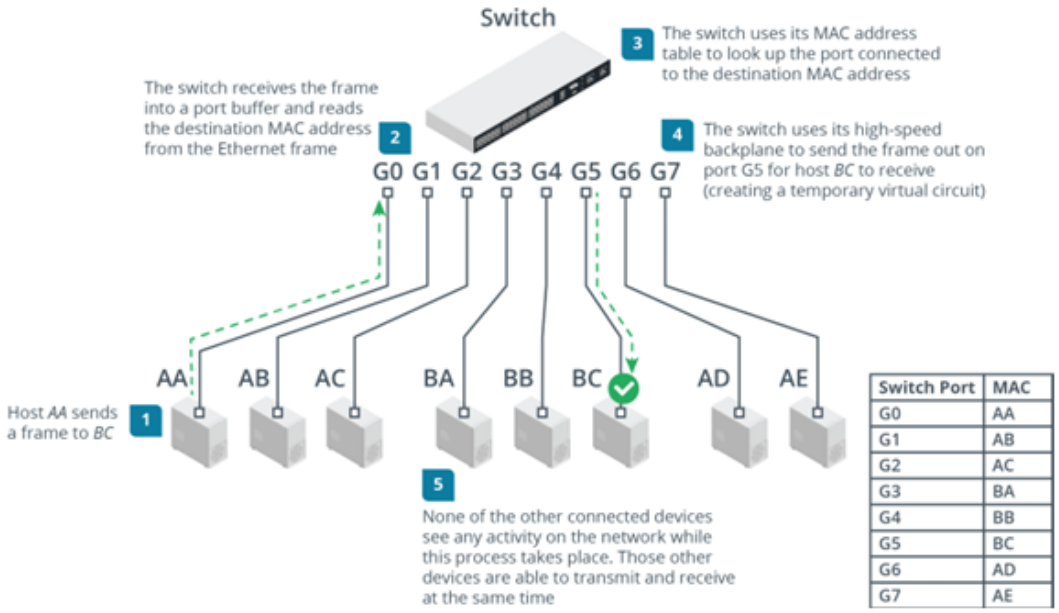
For example, Computers and devices are connected to wall ports using Ethernet cables. These wall ports are linked to the patch panel through cables that run behind the walls. At the back of the patch panel, these cables are terminated on **Insulation Displacement Connector (IDC) punchdown blocks**, which securely hold the wires. A proper labeling system is crucial for identifying which patch panel port corresponds to which wall port. Without clear labels, troubleshooting or reconfiguring connections becomes time-consuming and error-prone.

Hubs:

A **hub** is an outdated network device used to connect multiple computers in a **star topology**. It was commonly used in older Ethernet networks such as **10BASE-T** and **100BASE-T**, but has largely been replaced by modern switches due to its limitations. A hub typically has **4 to 48 ports**, with each computer or device connected to one port using Ethernet cables. When a device sends data, the hub **repeats** the transmission to all other ports.

All devices connected to a hub are part of the same **collision domain**, meaning that when one device sends data, all others receive it. Each device checks the data frame to see if the **MAC address** matches its own and ignores the frame if it doesn't. Devices can only send or receive data at one time, not both. If two devices try to send data simultaneously, a **collision** occurs, causing both devices to stop, wait for a random time, and then resend.

Switches:



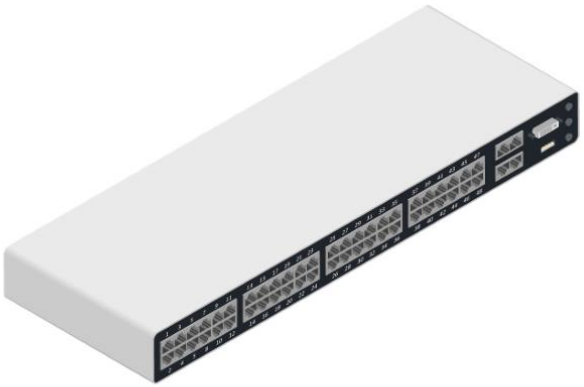
Switch operation. (Image © 123RF.com.)

To solve the issue of collisions in networks, **Ethernet switches** replaced hubs by creating separate collision domains for each connected device. Unlike hubs, switches can decode Ethernet frames to identify source and destination **MAC addresses**, tracking which devices are connected to each port. This allows the switch to forward data intelligently to the correct port instead of broadcasting it to all ports. With **full-duplex communication**, devices can send and receive data simultaneously at maximum speed, eliminating contention and improving performance. If the destination MAC address is unknown, the switch temporarily floods the frame to all ports until the address is learned. These features make switches the foundation of modern office networks.

Unmanaged and managed switches:

Unmanaged switches are simple plug-and-play devices that require no configuration. They automatically establish Ethernet connectivity between connected devices and are typically used in small networks. For example, many **SOHO routers** provided by ISPs have unmanaged four-port or eight port switches built in, allowing devices to connect easily. These switches are limited in functionality and may not support advanced features or higher speeds like **1 Gbps** on older models. On some older SOHO routers, the LAN interfaces are implemented as a hub. These do not support 1 Gbps operation.

Larger workgroups and corporate networks require additional functionality in their switches. Switches designed for larger LANs are **managed switches**. They can be configured by an administrator through a **web interface** or **command-line interface** to enable features like traffic management, security settings, and VLANs (Virtual LANs). Managed switches are commonly rack-mounted, with 24 or 48 ports for connecting devices like PCs, servers, and printers. For even larger setups, **modular switches** are used, allowing hundreds of ports to be provisioned through a single appliance by interconnecting multiple switch units. This flexibility and advanced functionality make managed switches ideal for corporate and enterprise networks.



A workgroup switch. (Image © 123RF.com.)

Modular chassis allows provisioning multiple access switches. (Image © 123RF.com.)

Power Over Ethernet:

Power over Ethernet (PoE) allows both power and data to be transmitted through a single Ethernet cable, eliminating the need for separate power adapters for devices like **VoIP phones**, **cameras**, or **wireless access points**. PoE makes installations cleaner, more efficient, and easier to manage.

PoE Standards

1. **802.3af**:
    - Supplies up to **13 W** of usable power to connected devices.
    - Total power delivery: **15.4 W** at 48V, but voltage drops over long cables.
2. **802.3at (PoE+)**:
    - Supplies up to **25 W** of usable power.
    - Higher current capacity (600mA) for devices with greater energy needs.
3. **802.3bt (PoE++ or 4PPoE)**:
    - **Type 3**: Supplies up to **51 W**.
    - **Type 4**: Supplies up to **73 W**, suitable for power-hungry devices.

How PoE Works

- A **PoE-enabled switch**, known as **endspan Power Sourcing Equipment (PSE)**, detects whether a connected device is PoE-capable.
- If the device supports PoE:
    - The switch supplies power at the required voltage and current.
- If the device is not PoE-compatible:
    - The switch does not send power, ensuring the device is not damaged.

If the switch does not support PoE, a **PoE injector** (or **midspan device**) can be used. It connects between the switch and the powered device to inject power into the cable. However, the total cable length from the switch to the device cannot exceed **100 meters**.

Some Questions:

1. **True or false? A MAC address identifies the network to which a NIC is attached.**
   Answer: **False**. A **MAC address** is a unique hardware identifier for a network interface card (NIC) port. It does not provide information about the network or its address.

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2. **A workstation must be provisioned with a 4 Gbps network link. Is it possible to specify a single NIC to meet this requirement?**
   Answer: **Yes**. A **single NIC** with **four 1 Gbps Ethernet ports** can be used. These ports can be **bonded** together to create a **4 Gbps link**.

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3. **You are completing a network installation as part of a team. Another group has cabled wall ports to a patch panel. Is any additional infrastructure required?**
   Answer: **Yes**. The **patch panel** only terminates the cables. To connect the segments, you need to install a **network switch** and use **RJ45 patch cords** to connect the switch to the patch panel.

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4. **You are planning to install a network of wireless access points with power supplied over data cabling. Each access point requires a 20W power supply. What version of PoE must the switch support to fulfill this requirement?**
   Answer: The switch must support **PoE+ (802.3at)** or **PoE++ (802.3bt)** to supply **20W** of power to each access point.