Unicast, Multicast, and Broadcast

Communication is the process of sharing or exchanging information between two or more devices that are connected with each other across a network. There are three types of communication: one to one, one to many, and one to all. In computer networks, these types of communication are known as unicast, multicast, and broadcast, respectively.

Unicast Communications:

In unicast communications, a device communicates or shares data with only one device at a time. In computer networks, when a device wants to send data to another specific device, it uses the **Destination MAC Address,** right. So, when sending data or stream of packets, the **destination MAC address** is checked if the **Least Significant Bit (LSB)** of in the **first octet** is 0. If yes, then it's unicast. The data packet is sent to all devices in the collision domain, but **only intended recipient processes it.**

So, above we have two confusing terms which is **Least Significant Bit (LSB) of the first octet is 0 and the other one in Collision Domain.**

Lease Significant Bit (LSB) of the first octet is 0:

An octet is just group of 8 bits (or 1 byte). In a MAC address (used in Ethernet), we represent it as 6 groups of two hexadecimal numbers separated by colons. For example:

MAC Address: **01:23:45:67:89:AB**

Here, In this MAC address, each group like 01, 23, 45, etc. is an octet, and the entire MAC address has 6 octets.

What is the "First Octet"?

The **first octet** is the first group in the MAC address. In the above example, 01 is the first octet. This is the part we examine to determine whether the frame is **unicast** or **multicast**.

Least Significant Bit (LSB) of the First Octet

The **Least Significant Bit (LSB)** is the rightmost bit in a binary number. For the first octet, we convert the hexadecimal value to binary to check this bit.

Example:

1. **First Octet**: 01 (hexadecimal)
    - Binary equivalent of 01 is 00000001.
    - The **last bit** (LSB) is 1.
2. **First Octet**: 02 (hexadecimal)
    - Binary equivalent of 02 is 00000010.
    - The **last bit** (LSB) is 0.

How Does This Relate to Unicast or Multicast?

- If the LSB in the first octet is **0**, the frame is **unicast**.
    - Example: 02:23:45:67:89:AB (first octet 02 → binary 00000010, LSB = 0 → **unicast**)
- If the LSB in the first octet is **1**, the frame is **multicast**.
    - Example: 01:23:45:67:89:AB (first octet 01 → binary 00000001, LSB = 1 → **multicast**)

Why Does This Matter?

The LSB of the first octet acts as a flag that tells devices whether a frame is meant for:

- A **single device** (unicast)

- A **group of devices** (multicast)

Simplified Analogy:
Think of it like the **area code** in a phone number:

- If the area code starts with 0, it's a **personal call** (unicast).
- If the area code starts with 1, it's a **group call** (multicast).

Collision Domain:

A **collision domain** is a part of a computer network where data packets can "collide" with each other when two or more devices try to send data at the same time. This happens because all devices in the same collision domain share the same communication channel.
In simple terms:

- Think of a collision domain as a single road.
- If multiple cars (data) try to enter the road at the same time, they might crash (collide).
- After a collision, everyone must stop and retry (just like data packets need to be resent).

Where Do Collisions Happen?
Collisions mainly occur in older network setups, like those using hubs, or in half-duplex Ethernet communication where devices can't send and receive data at the same time.
Example:
Imagine you're in a group call (collision domain), but only one person can talk at a time. If two people start talking simultaneously, they interrupt each other (a collision). Both need to stop and try again.

How Does It Work?

1. **Shared Communication Channel**: In a collision domain, all devices share the same bandwidth.
2. **Collision Detection**: Ethernet uses a protocol called **CSMA/CD (Carrier Sense Multiple Access with Collision Detection)** to manage collisions:
    - Devices "listen" to the network.
    - If the network is free, they send data.
    - If a collision happens, they stop, wait a random amount of time, and then try again.

Collision Domains in Network Devices

- **Hubs**:
    - All ports of a hub share the same collision domain.
    - More devices → More collisions → Slower performance.
    - Example: A hub is like a single lane road; traffic jams are common.
- **Switches**:
    - Each port of a switch creates its own collision domain.
    - No collisions between devices connected to different ports.
    - Example: A switch is like a multi-lane highway; each car (device) has its own lane, so no collisions.
- **Routers**:
    - Routers separate collision domains across different networks.

Why Do Collision Domains Matter?
The size of a collision domain affects network performance:

- **Larger collision domains** (like hubs) mean more devices are competing for the same bandwidth, leading to more collisions.
- **Smaller collision domains** (like switches) reduce competition, improve speed, and minimize collisions.

Multi-cast Communications:

In a multi-cast communications, a data packet or data frame is sent to multiple devices but not all, over the network. As we already know, if the **LSB in the first octet** of the **destination MAC address** is set to 1, then this marks the frame as multicast. Devices decides to accept or ignore the frame based on a list of configured multicast addresses.

Example:
Imagine streaming a live sports match. Only people who have subscribed to that match (configured multicast addresses) will be able to view it, even though it is broadcasted to many.

Broadcast Communications:

- A broadcast is like announcing on a loudspeaker in a public square—**everyone hears it**. The destination MAC address is set to **all F's (FF:FF:FF:FF:FF:FF)**, indicating it's a broadcast.
    - Every device receives and processes the frame.

Example:
In a classroom, a teacher says, “Does anyone know whose book this is?” Everyone in the room hears the question, and anyone who recognizes the book can respond.

Why Use These Types of Transmissions?

1. **Unicast**: For private communication between two devices (e.g., sending files, web browsing).
2. **Multicast**: For sending data to a group (e.g., video conferencing, online gaming).
3. **Broadcast**: For sending messages to all devices on a LAN (e.g., finding other devices or services on the network like printers).