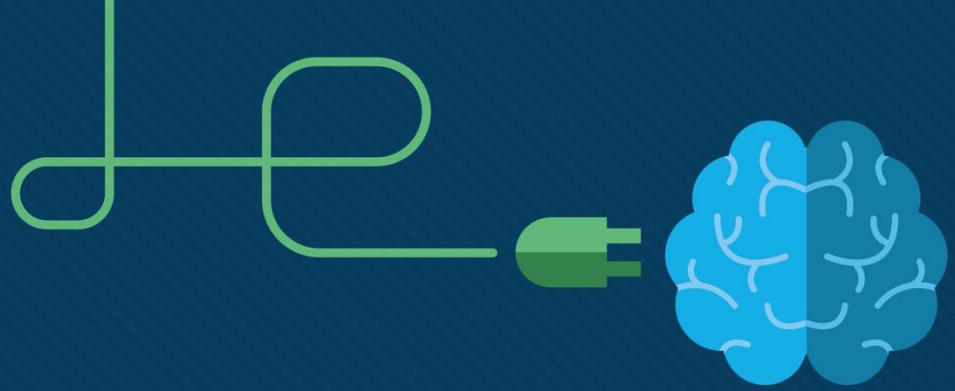
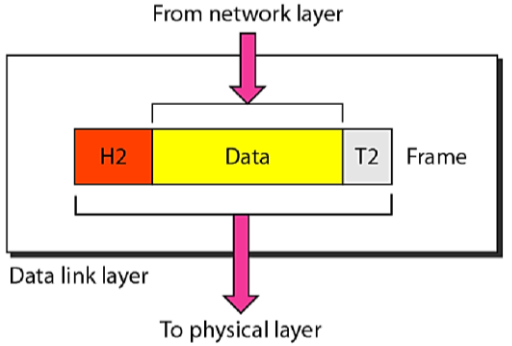


# Module 4: Data Link Layer

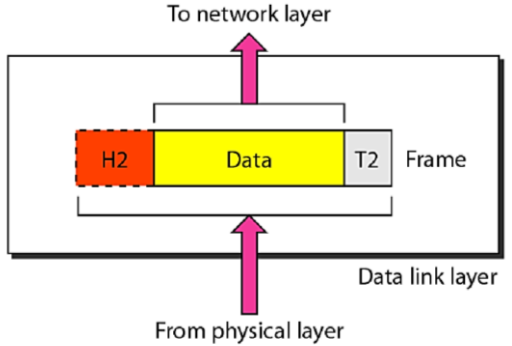
Introduction to Networks v7.0
(ITN)

# The Data Link Layer

- The Data Link layer is responsible for communications between end-device network interface cards (NIC).
- This layer deals with frames.
- This is the only layer that contains a tail to separate frames from each other.
- It allows upper layer protocols to access the physical layer media and encapsulates Layer 3 packets (IP) into Layer 2 Frames.
- It also performs error detection and rejects corrupts frames.




**Data link layer at the source side**




**Data link layer at the destination side**

# 4.1 Data Link Layer Connecting Devices

# Bridges

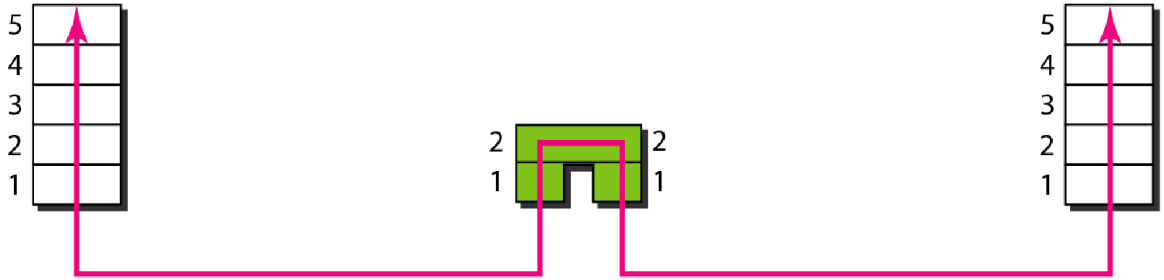
## 1-Bridges

- Acts on the **data link** layer (**MAC address level**).
- Used to **divide** (segment) the LAN into smaller LANs segments, or to connect LANs that use identical physical and data link layers protocol.


- Each LAN segment is a separate **collision domain.**
- Bridge does not send the received frame to all other interfaces like hubs and repeaters, but it performs **filtering.**
- A bridge has a table used in filtering decisions.

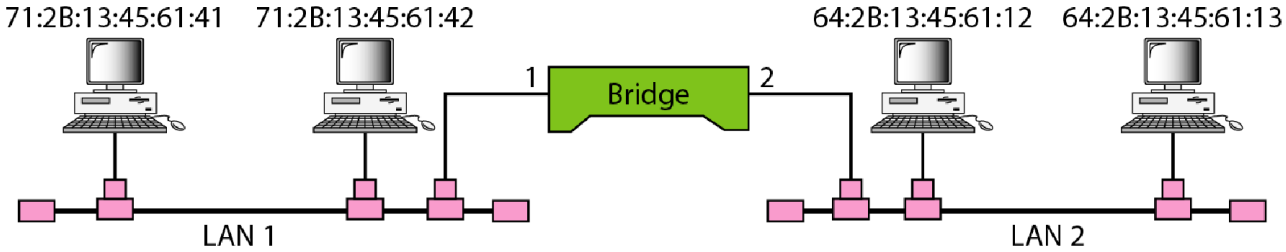
# Bridges (contd.)

## A bridge connecting two LANs




| Address | Port |
|---|---|
| 71:2B:13:45:61:41 | 1 |
| 71:2B:13:45:61:42 | 1 |
| 64:2B:13:45:61:12 | 2 |
| 64:2B:13:45:61:13 | 2 |

Bridge Table



# Switches

## 2-Switches

- Operates at data link layer (deals with frames)
- Usually used to connect individual computers **not** LANs like bridge.
- Allows more than one device connected to the switch directly to transmit simultaneously.

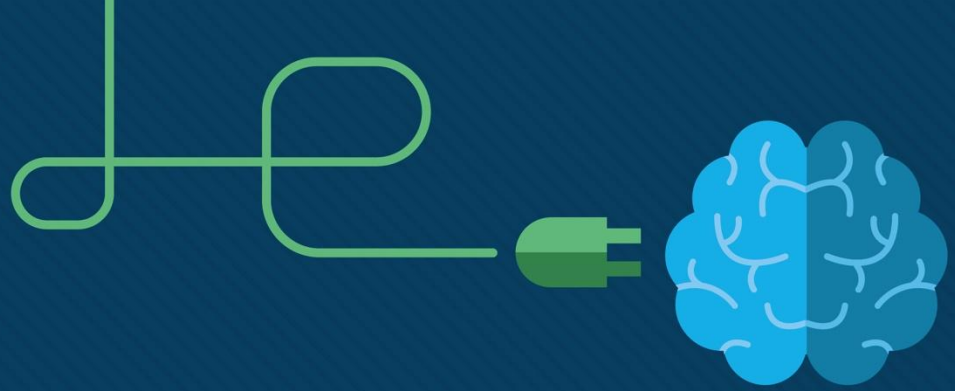

- Can operates in **Full-duplex** mode (can send and receive frames at the same time over the same interface).
- Performs MAC address recognition and frame forwarding in **hardware.**

# Switches (contd.)

## Types of Switching techniques

Switches can use different forwarding techniques: **store-and-forward** switching method and **cut-through** switching method.

| Store-and-Forward Switching | Cut-through Switching |
|---|---|
| The switching device waits to receive the entire frame before forwarding the data packet. | The switching device forwards the data packet as soon as the destination address is received. |
| It supports error checking | There is no error-checking technique. |
| Frames are stored in the buffer memory of the switching device. | Frames are not stored in the switching device. |
| It has a high latency rate | It has a low latency rate |
| It is more secure | It is less secure |
| It has networks with more storage requirements. | It has less storage requirement. |
| Example: Telecommunication networks or transmission across networks requiring high mobility. | Example: Communication via fiber channel and low latency transmission for SCSI transmission. |



# 4.2 Ethernet Frame

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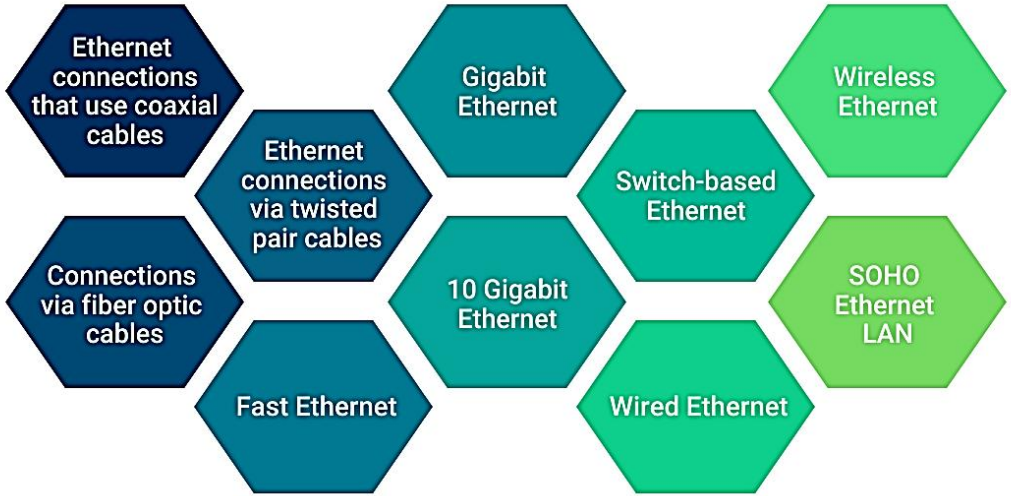
(ITN)

# What is Ethernet

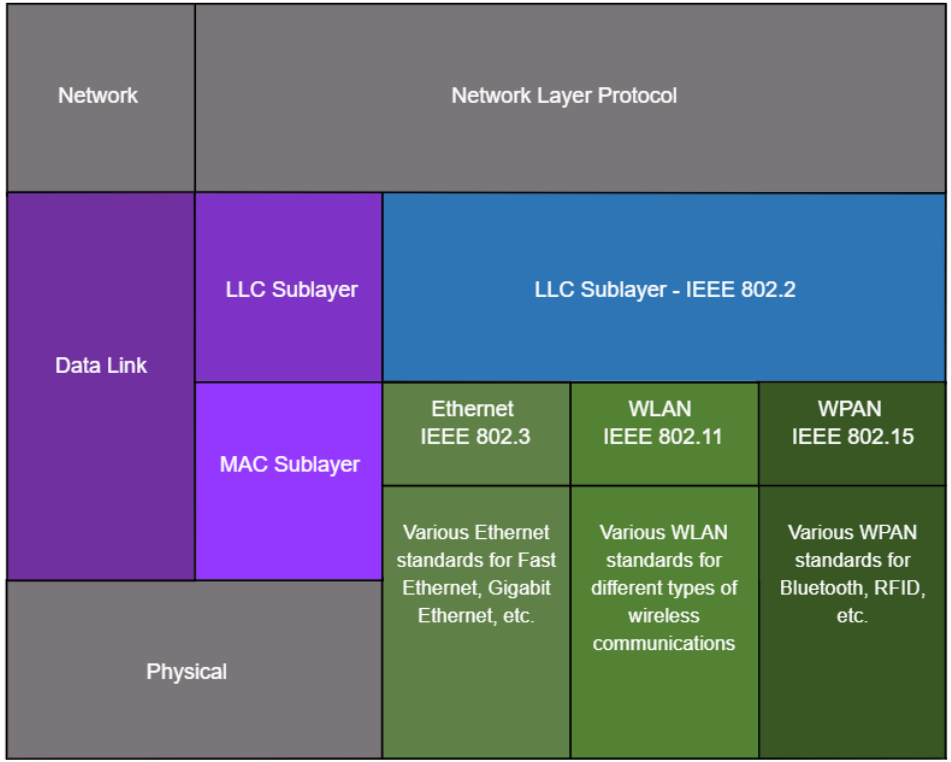
- **Ethernet is a networking technology that includes the protocol, port, cable, and computer chip needed to plug a desktop or laptop into a local area network (LAN) via coaxial or fiber optic cables.**
- **There are 10 Types of Ethernet, The key types of Ethernet connectivity are as follows:**



# Data Link Sublayers

- The data link layer is divided into two sublayers:

1. Logical Link Control (LLC) sublayer provides the logic for the data link. Thus, it controls the synchronization, flow control, and error checking functions of the data link layer.
2. Media Access Control (MAC) sublayer provides control for accessing the transmission medium.




- Ethernet operates in the MAC sublayer and the physical layer.
- It is a family of networking technologies defined in the IEEE 802.2, 802.3, 802.11 and 802.15 standards.

# 4.3 Ethernet MAC Address

# MAC Address and Hexadecimal

- An Ethernet MAC address consists of a **48-bit binary value**, expressed using **12 hexadecimal values** or **6 bytes**.

- Every byte (or 2-hexadigits) is separated by (**:**) or(**-**) as shown:

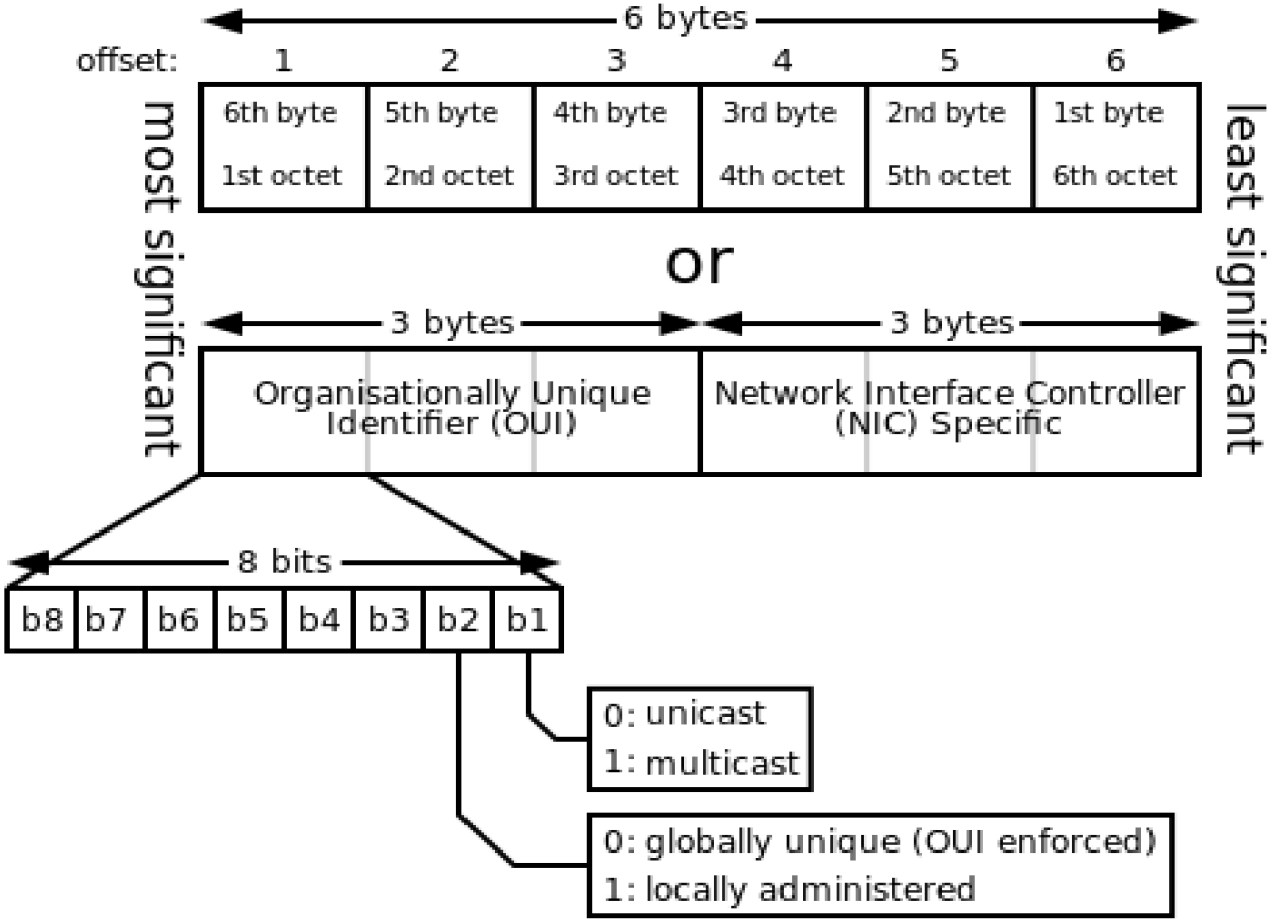
**07:01:02:01:2C:4B**

**07-01-02-01-2C-4B**

- Hexadecimal numbers are often represented by the value preceded by **0x** (e.g., 0x73) or followed H(e.g., 73H) to distinguish between decimal and hexadecimal values in documentation.

- An example of a MAC- 48 address would be: "**00-08-74-4C-7F-1D**". If you cross-reference the first three octets with IEEE's OUI assignments, you can see that this MAC address came from Dell Computer Corp. The last three octets represent the serial number assigned to the adapter by the manufacturer.

# Structure of MAC address



Ethernet MAC Addresses

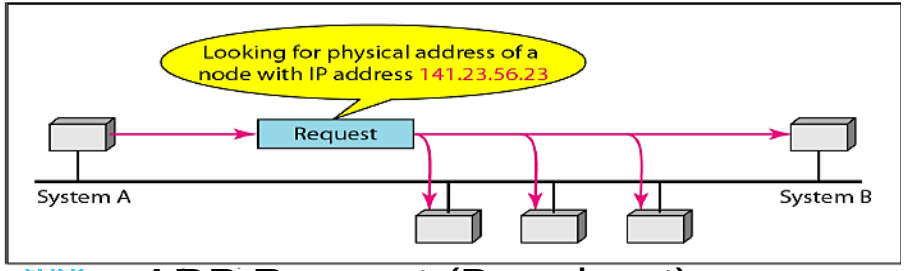
# Switch Fundamentals

A Layer 2 Ethernet switch uses MAC addresses to make forwarding decisions. It is completely unaware of the data (protocol) being carried in the data portion of the frame known as **Address Resolution Protocol (ARP)** with the following steps:

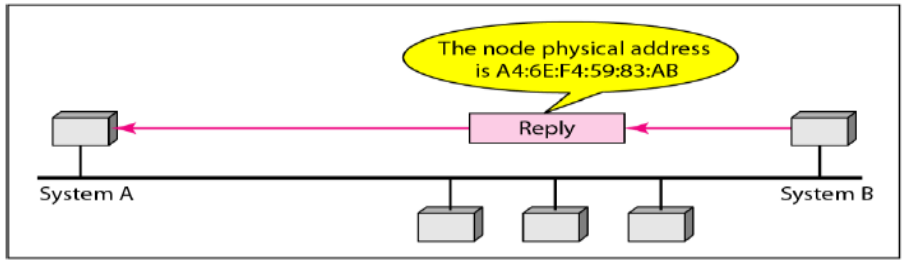
1. First the switch send a broadcast message:

   **FF-FF-FF-FF-FF-FF** to get all connected NICs
2. ARP Maps IP addresses to MAC addresses
3. ARP Request is a broadcast, but ARP reply is Unicast.
4. ARP tables contain the MAC and IP addresses of other devices on the network
5. Finally when a device want to connect to the other the connection will happen depending on ARP table saved in the switch cash

| IP → | MAC |
|---|---|
| 192.168.0.1 | 0C:3D:66:9F:00:2E |
| 192.168.0.2 | 1F:32:09:EF:40:DD |




ARP Request (Broadcast)



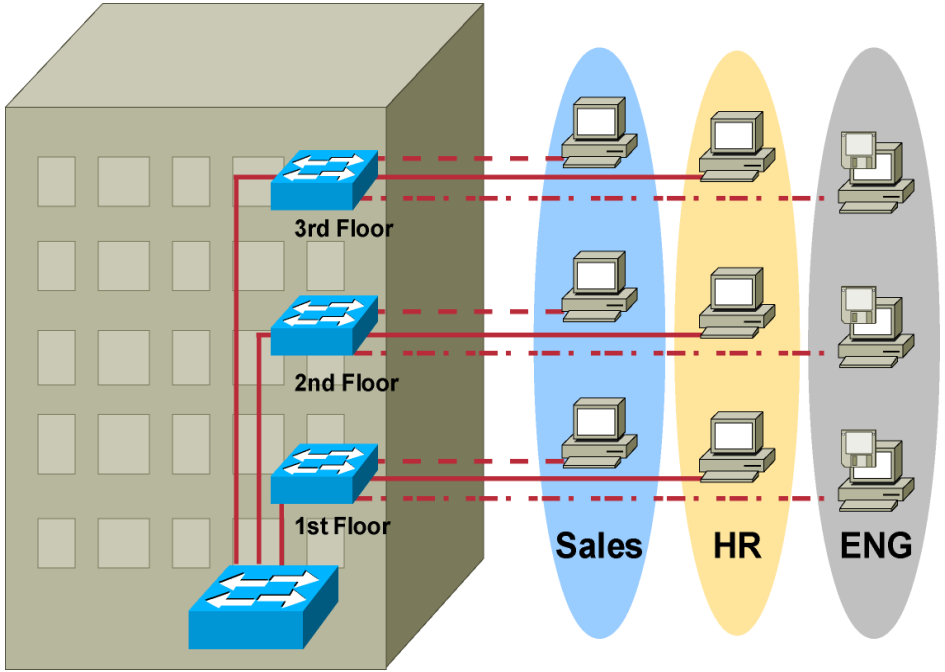

ARP Reply (Unicast)

# 4.4 VLAN

# VLAN

- A **VLAN (Virtual Local Area Network)** is a logical network divides a physical network into multiple segments. VLANs can be used to isolate traffic between different departments, user groups, or devices. This can improve security, performance, and manageability.
- VLAN confine broadcasts, so introducing better broadcast control.
- VLAN can span multiple switches (no physical boundaries), VLAN can group users based on their business requirements (business departments) independent of any physical locations
- But using VLANs will cause the following:
  - It will not simplify the network.
  - It will not eliminate the need of L3 routing

# VLAN




- Segmentation
- Flexibility
- Security

A VLAN = A Broadcast Domain = Logical Network (Subnet)

# Deploying VLANs

- The number of VLANS will be dependent on network requirement.
- VLANs could be implemented using two basic methods:

1) **Local VLANs:** Created based on geographic or physical locations rather than the job functions of the users on the end devices

2) **End to End VLAN:** Called Campus-wide VLAN, they are designed regarding their function (same VLAN are distributed on among different switch blocks)