1.2- Classify how applications, devices, and protocols relate to the OSI model layers
Description of applications, devices and protocols relates to the OSI Model

- MAC address
- IP address
- EUI-64
- Frames
- Packets
- Switch
- Router
- Multilayer switch
- Encryption devices
- Cable
- NIC
- Bridge
MAC Address

• Also known as hardware address or ethernet address

• A Media Access Control (MAC) Address is assigned a unique number by the manufacturer to each device capable of network connectivity.

• MAC Addresses are in a 48-bit hexadecimal format such as 00:2f:21:c1:11:0a.

• They are used to uniquely identify a device on a network, and for other functions such as for being authenticated by a DHCP server.

• MAC addresses are used in the data-link layer of the OSI model
IP Address

- IP address stands for **Internet Protocol Address**

- A unique string of numbers separated by dots that identifies each computer on a network.

- The format of an IPv4 address is a 32-bit numeric address written as four numbers separated by dots.

- Each number can be zero to 255. For example, 1.160.10.240 could be an IP address.

- IP addresses are part of the Network Layer in the OSI model.
IP Address (cont)

An IPv4 address (dotted-decimal notation)

172 . 16 . 254 . 1

10101100 . 00010000 . 11111110 . 00000001

One byte = Eight bits

Thirty-two bits ( 4 * 8 ), or 4 bytes
IP Address (cont)

- Version
- IHL
- TOS
- Identification
- Time to Live
- Protocol
- Total Length
- Flags
- Fragment Offset
- Header Checksum
- Source Address
- Destination Address

4 Bytes
4 Bytes
4 Bytes
4 Bytes
EUI-64

• Extended Unique Identifier (EUI), allows a host to assign itself a unique 64-Bit IP Version 6 interface identifier (EUI-64).

• The IPv6 EUI-64 format address is obtained through the 48-bit MAC address. The Mac address is first separated into two 24-bits, with one being OUI (Organizationally Unique Identifier) and the other being NIC specific.

• The 16-bit 0xFFFE is then inserted between these two 24-bits to form the 64-bit EUI address.

• IEEE has chosen FFFE as a reserved value which can only appear in EUI-64 generated from the an EUI-48 MAC address.
EUI-64

Here is an example
Frames

- A frame is a unit of data transmission

- Frames are part of the Data Link Layer of the OSI model

- A frame is made up of two parts
  - Header: Contains data used for addressing and error correction
  - Packet: Data being transmitted
Frames

Figure 2-16 Inside the NIC
Inside a frame

• Frames are made up of fields that contain information
• Frames contain the recipient’s MAC address, the sender’s MAC address, the data itself, and a cyclic redundancy check (CRC) for error checking

| Recipient’s MAC address | Sender’s MAC address | Data | CRC |

Figure 1.2.1 Generic frame
Frame as a canister

Figure 1.2.2 Frame as a canister
Frame Size

•Different networks use different sizes of frames

•Many frames hold about 1500 bytes of data

•The sending software breaks up large amounts of data into smaller chunks

•The receiving station must then put the chunks back together in the proper order
Processing Frames

• All devices on the network see the frame, but only the device that it is addressed to will process it

• Every frame is received by every NIC

• The MAC address is used to decide if the frame belongs to a given device
• Since the cable is shared, only one system may speak at a time

• Processes are used to keep two NICs from talking at the same time
Figure 1.2.3  Incoming frame!

1. The recipient address matches neither of these computers, so they will not process the frame.

2. The recipient address matches this computer’s address, so this computer will process the frame.
Getting To Know You

• Usually two devices have talked before, so the destination MAC address is already known

• If the MAC address is not known, a broadcast message is sent over the network

  • The destination device will respond by sending its MAC address

• A MAC broadcast address is FF-FF-FF-FF-FF
Figure 1.2.4 Building the frame

NIC receives the command to send data and starts to make the frame.
Figure 1.2.4 Adding the data and CRC to the frame
NIC sends the frame when no one else is using the wire.

Figure 1.2.5 Sending the frame
The frame has the MAC address for this NIC.

Figure 1.2.6  Reading an incoming frame
After the frame is received

- The receiving station checks the CRC value in the frame
- If the value matches what it should, then the NIC sends the data portion to the network operating system for processing
- If the value does not match, the frame has errors and must be resent
Packets

- **Packet** is a unit of data transmission used in routing data across a network.

- Packets are part of the Network Layer of the OSI model.

- A packet is made up of two parts:
  - **Header**: Contains data used for validation and routed.
  - **Packet**: Data being transmitted.
Cabling

• Most networks use a cable, like this one, as a physical channel to move the bits of data

Unshielded Twisted Pair (UTP) cable

Figure 1.2.7 UTP cabling
Network Interface Cards (NICs) are installed in PCs. Network cables attach to the NICs.
NIC to Hub Connections

• Cables run from the NIC in the PC to a jack on the wall
• Cables run through the walls to the closet where they connect to a hub

Figure 1.2.9 NIC with cable connecting the PC to the wall jack
The NIC

• Each system must have a unique identifier
• Media Access Control (MAC) address
  • A unique address burned into a ROM chip on the network card
  • Each MAC address is 12 hex characters or 48 bits in length

MAC address printed on surface of chip – and burned inside the chip.

Figure 1.2.10  MAC address
Applications, Devices, and Protocols

Hub

A **hub** is a device used to connect multiple ethernet devices together to act as a network.

Any signal or data inputted into one port of the hub is repeated and transmitted to all the other ports.

The hub operates on in the Physical Layer of the OSI model.

Hubs are not commonly used and have been largely replaced by Switches and Routers.
A **switch** is a device used to connect multiple Ethernet devices together to act as a network.

Unlike hubs, switches only transmit a received message to the intended device.

The hub operates in the Datalink Layer of the OSI model.

Switches replaced hubs in most networks because they are more efficient and more secure.
A router is used to connect different networks or data lines.

A router reads the address information from a packet to determine its final destination. It uses stored information called a routing table to ensure it gets to the right location.

The hub operates on in the Internet Layer of the OSI model.

Routers make up the backbone of the internet since they primarily connect two networks together.
A Multilayer switch is a switch that performs additional functions in higher OSI layers.

Many multilayer switches perform operations in the internet later of the OSI model.

Even though they operate on the same OSI layer as routers, they are used to connect devices not networks together.
Bridge

Typical Bridge