IEEE802 Standard and Ethernet

1. The OSI model and the TCP/IP protocol suite

Please refer to the Textbook and corresponding slides for the details of OSI and TCP/IP reference model.

2. IEEE802 reference model

In 1980, IEEE (Institute of Electrical and Electronics Engineers) established an 802 LAN standard committee to work on the local area network standardization. The IEEE 802 reference model only defines two layers: physical and data link. All upper layers are consistent with the OSI model. See Figure 1-3:

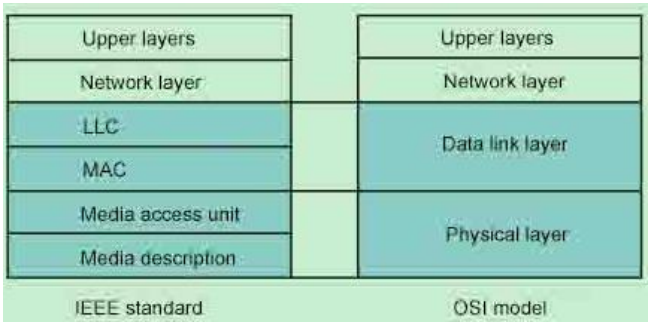

Figure 1-3 IEEE TCP/IP and OSI reference model

In the OSI model, the physical layer is to offer a physical connection to upper layer and transmits bits in a transparent way. In IEEE802 LAN reference model, the physical layer is divided into two sub-layers,

a. The bottom sub-layer is media description
b. The upper sub-layer is media access unit (MAU)

Physical media can be various, like UTP or Coax. The main function of MAU contains information of coding, transmission and media handling.

In the OSI model, the data link layer is to exchange frames through the physical layer to provide a reliable link for the upper layer. In IEEE802 LAN reference model, the data link layer is divided into two sub-layers,

a. The bottom sub-layer is MAC
b. The upper sub-layer is LLC

The LLC sub-layer offers efficient data transmission, flow control and error control. The MAC sub-layer ensures consistency of physical function and logical function. MAC sublayer also receives frames from the LLC sub-layer and sends them to the physical layer for encoding.

3. Ethernet physical address

Each host in Ethernet has a network interface card (NIC) which offers a physical address of 6 bytes, e.g., 44-45-53-54-00-00. In the IEEE802 standard Ethernet, this address is called “MAC address”. MAC address of each NIC is globally unique. Some bits of MAC address have special meanings, as shown in Figure 1-4:

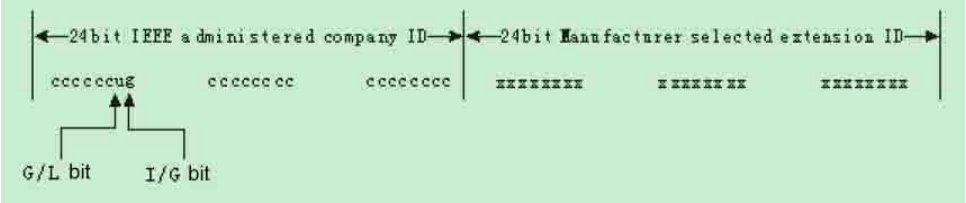

Figure 1-4 Ethernet MAC address

I/G bit represents Individual/Group. When it is 0, such address represents a single host address (*unicast*). When it is 1, the address filed represents a group address (*multicast*).

G/L bit represents Global/Local, when it is 1, it represents global management which ensures the address is unique globally. When it is 0, it represents local management that the users can assign address freely.

Ethernet MAC address can be divided into three types: unicast address, broadcast address and multicast address. Unicast address is one-to-one, which is the MAC address of a specific host. Broadcast address is one-to-all and all bits are 1s, specifying that the data frame is sent to all hosts. Multicast address is one-to-many, indicating that the data frame is sent to a group of hosts.

4. Ethernet access mode

Please refer to the Textbook and corresponding slides for the details of CSMA/CD.

5. Ethernet frame format

(1) MAC frame format

There are two standards of Ethernet MAC frame, one is DIX Ethernet V2 standard and the other one is IEEE802.3 standard. But they can exist in the same Ethernet. Both of the frame formats have seven fields: preamble, start of frame delimiter, destination address, source address, length or type, data and CRC. See Figure 1-5:

Preamble (7 bytes)	Start Frame Delimiter (1 byte)	Destination Address (6 bytes)	Source Address (6 bytes)	Length or type (2 bytes)	Data	CRC (4 bytes)

Figure1-5 Ethernet frame format

We can distinguish the type of frames by the length/type field. If the value of length/type is larger than1536, the frame is a DIX Ethernet V2 frame. If the value of length or type field is less than or equal to 1536, the frame is an IEEE802.3 frame. For DIX Ethernet V2, the value of length or type field is the type of upper protocol. And for IEEE802.3, the upper protocol must be LLC and the value of length or type field means the length of data.

In Ethernet MAC frame format, the meaning of each field is as follow:

a. Preamble: This field contains 7 bytes of alternating 0s and 1s, which notifies the receiver of the incoming frame and enables it to synchronize its input timing.
b. Start frame delimiter (SFD): This field (1 byte: 10101011) signals the beginning of the frame. The SFD warns the station or stations that this is the last chance for synchronization. The last 2 bits is 11 and alerts the receiver that the next field is the destination address.
c. Destination address: This field has 6 bytes and contains the physical address of destination station or stations to receive the frame.

d. Source address: This field is 6 bytes and contains the physical address of the sender.
e. Length or type: If the value of this field is less than or equal to 1518, it defines the length of the data. If the value of this field is greater than 1536, then it defines type of the data.
f. Data. This field carries data encapsulated from the upper-layer protocols. It is a minimum of 46 and a maximum of 1500 bytes.
g. CRC. The last field contains error detection information, using CRC-32. It detects all contents except for preamble, SFD and CRC.

(2) LLC frame format

DSAP	SSAP	Control	LLC data

Figure 1-6 LLC Format

LLC uses DSAP (destination service access point) and SSAP (source service access point) to identify user entities of receiver and sender. The first bit of DSAP is used to specify the type of frame: 0 for individual address and 1 for group address. The first bit of SSAP is used to specify type of frame, 0 for command frame and 1 for response frame.

LLC defines three frames: information frame (I-frame), supervisory frame (S-frame) and unnumbered frame (U-frame). The type of frame can be identified by the field of control. The length of control field is 2 bytes for I-frame and S-frame and 1 byte for U-frame.

Figure 1-7 shows comparison of three types.

1 bit	7 bits	1 bit	7 bits
0	N(S)	P/F	N(R)

I-frame control segment

1 bit	1 bit	2 bits	4 bits	1 bit	7 bits
1	0	SS	X	P/F	N(R)

S-frame control segment

1	1	M	M	P/F	M	M	M

U-frame control segment

Figure 1-7 Control fields of three types of LLC

1. N(S): send number
2. N(R): received number
3. SS: supervisory function bit, 00 means ready to receive (RR); 10 means not ready to receive(RNR); 01 means reject to receive (REJ)
4. M: modify function bit
5. X: save, set to be 0
6. P/F: Poll/Final bit. Ask LLC PDU to transmit/ respond LLC PDU transmission.

(3) Relationship between LLC-PDU and neighbor layer PDU

IEEE802 standard has detailed definitions for LLC and MAC frame format. Figure 1-8 shows relationship among network layer PDU, LLC sub-layer PDU and MAC sub-layer PDU.

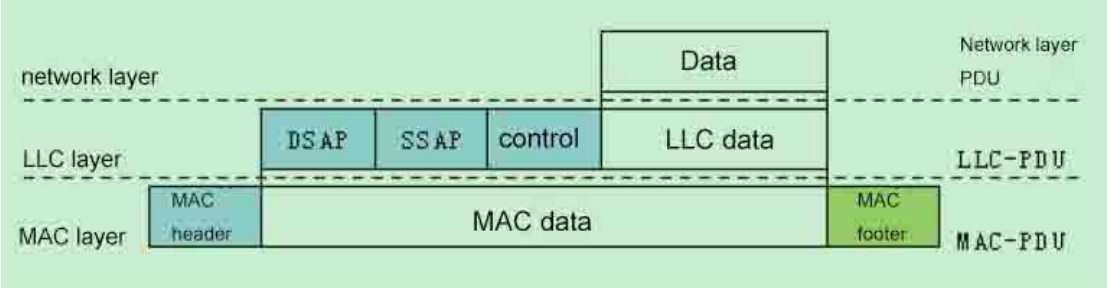

Figure 1-8 Encapsulation of LLC PDU

LLC frame has no relation with medium, while MAC frame is affected by the type of medium access. Different LANs have different MAC formats.

(4) LLC address and MAC address

There are source MAC address and destination MAC address in MAC frame header. Both of them are 6 bytes. DSAP and SSAP are LLC address in LLC header. DSAP and SSAP are logical addresses, which represent different access service point in data link layer. LLC address and MAC address are different concepts. In LAN, hosts which have many service access points can use the same link. Thus, to some extent, LLC sub-layer has some functions of OSI network layer.