10. LAN Frame Types

Standard LANs admit several frame formats. For the IPX™ protocol, the formats described in this section are all supported. The discussion here covers the three most common standard media: CSMA/CD, token ring, and FDDI.

Each standard medium has a default frame type, employed when the end user does not make an explicit choice. The default frame formats with NetWare® 4 software are (respectively) Ethernet 802.2 for CSMA/CD, Token Ring (without SNAP), and FDDI (without SNAP).

The subsections that follow illustrate the IPX encodings for the data-link header of each frame type. First, however, there is a discussion of address representation.

10.1. Universal Address Representation

The node number portion of IPX addresses is represented using the *Universal Address Representation* defined in Reference [IEEE91]. This is sometimes called the *canonical form* of the six-byte IEEE MAC address. Figure 10-1 illustrates the representation.

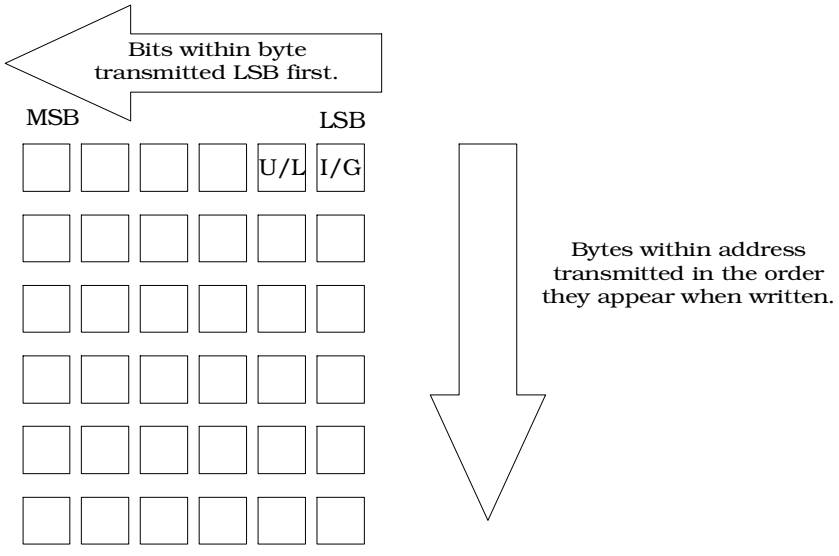

Figure 10-1: Universal Address Representation

The six-byte address is typically written in hyphenated hexadecimal notation; for example, AC-DE-48-00-00-80.

The least significant bit (LSB) of the first byte is called the *Individual/Group Address Bit* (I/G). When I/G is set to one, it indicates a broadcast or multicast address. Otherwise, the address belongs to an individual station.

The next bit of the first byte is called the *Universally or Locally Administered Address Bit* (U/L). When U/L is set to one, the address is assigned locally as part of LAN

operation. Otherwise (the common case)

- The first three bytes are an *Organizationally Unique Identifier* assigned by IEEE, typically to an equipment vendor.
- The remaining three bytes are assigned by that vendor.

In the example of AC-DE-48-00-00-80, the I/G bit and the U/L bit are both zero. They are the two adjacent low-order zero bits of the "C".

As Figure 10-1 shows, bits within a byte are transmitted on a LAN with the least significant bit (LSB) first, and the bytes themselves are transmitted in the order they appear when written. In the example of AC-DE-48-00-00-80, the order of transmission on the wire is

Byte:	0xAC	0xDE	0x48	0x00	0x00	0x80
Time ⇨	0011 0101	0111 1011	0001 0010	0000 0000	0000 0000	0000 0001

⇧
First bit transmitted; also the I/G bit.

Figure 10-2: Standard Transmission of Universal Address

The discussion so far describes the standard view seen by the network layer and above, as well as by the IEEE 802.2 Logical Link Control (LLC) layer. LLC fits above different MAC media (CSMA/CD, token ring, FDDI), and is common for all the media. In the diagrams of the subsections to follow, the boundary between the MAC header and the LLC header is a double line (for those frame types using LLC). This boundary is the start of the MAC Information field. The MAC Information field extends to the end of the packet, up to but not including the frame check sequence. The other parts of the frame (before and after MAC Information) are called *MAC-specific* fields.

Notwithstanding the discussion so far, addresses in the MAC layer must be in the orientation required by the physical medium. In fact, different MACs differ in the bit order within a byte when actually transmitting on the wire (or fiber, as the case might be).

For CSMA/CD, transmission is LSB-first for the entire packet: the MAC-specific fields and the MAC Information field. An address' bit order on the wire is as shown in Figure 10-2 for both

- MAC Information; including the Node Number field in IPX addresses, and
- The MAC-specific fields; for example, the MAC Destination Address and Source Address fields in the subsections that follow.

For token ring and FDDI, by contrast,

- The MAC Information field is transmitted with the most significant bit (MSB) first, while
- The LAN MAC Destination Address and Source Address fields are still transmitted with the I/G bit first, as in Figure 10-2, but
- The MAC-specific fields are specified according to bit transmission order without indicating which is MSB or LSB

Note: Most implementations store nonaddress MAC-specific fields in memory with the first-transmitted bit as MSB. Therefore, from a software view, the entire packet is transmitted MSB first.

When viewed on a token ring or FDDI LAN, the Node Number field in IPX addresses actually appear on the wire as in Figure 10-3, as does, in fact, the entire IPX header and IPX Data.

Byte:	0xAC	0xDE	0x48	0x00	0x00	0x80
Time ⇨	1010 1100	1101 1110	0100 1000	0000 0000	0000 0000	1000 0000

⇧
First bit transmitted.

Figure 10-3: Addresses within Token Ring MAC Information

All effects of the differences of bit transmission order are contained in the MAC layer, below LLC. As viewed by the common, media-independent, LLC layer and above, the MAC Information arrives arranged in memory at the destination with the same bit orientation as it originated at the source. So, there is no problem with MAC Information.

However, in mapping to the physical medium, token ring and FDDI MAC implementations reverse the bit order of the MAC Destination Address and Source Address fields, so that each MAC address byte is transmitted in the MAC header as the mirror image of the same byte in an IPX Node Number of the same packet.

Note: This "mirror image" issue is a perennial source of compatibility problems. Different system designs differ in how and when bytes are reversed. Problems arise when, for example, software considers an address to be in the universal address representation when it is, in fact, the mirror image. When troubleshooting compatibility problems arise, implementors should keep in mind how (a) their system's internal design and (b) their diagnostic tools deal with the issue.

10.2. Ethernet 802.2

In Ethernet 802.2 packets, the Frame Length field contains a value less than or equal to 1500. The DSAP and SSAP values illustrated in the diagram indicate that the frame contains an IPX packet.

Ethernet 802.2

	Number of Bytes	Value
Destination Address	6	
Source Address	6	
Frame Length	2	less than or equal to 1500
DSAP	1	0xE0
SSAP	1	0xE0
Control	1	0x03

10.3. Ethernet SNAP

In Ethernet SNAP packets, the Frame Length field contains a value less than or equal to 1500. The DSAP and SSAP values illustrated in the diagram indicate SNAP encapsulation. The Protocol Identification value illustrated in the diagram indicates that the frame contains an IPX packet.

Ethernet SNAP

	Number of Bytes	Value
Destination Address	6	
Source Address	6	
Frame Length	2	less than or equal to 1500
DSAP	1	0xAA
SSAP	1	0xAA
Control	1	0x03
Protocol Identification	5	0x0000008137

10.4. Ethernet Raw 802.3

This is a historical frame format, supported for backward compatibility with certain installed systems. In Ethernet Raw 802.3 packets, the Frame Length field contains a value less than or equal to 1500. The IPX header immediately following the Frame Length field starts with 0xFFFF in the Checksum field. This frame format cannot be used with IPX checksums.

Ethernet Raw 802.3

	Number of Bytes	Value
Destination Address	6	
Source Address	6	
Frame Length	2	less than or equal to 1500

10.5. Ethernet II

The Frame Type value illustrated in the diagram indicates that the frame contains an IPX packet. Note that the Frame Type value is greater than 1500, to discriminate the packet from previously described frame formats.

Ethernet II

	Number of Bytes	Value
Destination Address	6	
Source Address	6	
Frame Type	2	0x8137

10.6. Token Ring

In token ring packets, the DSAP and SSAP values illustrated in the diagram indicate that the frame contains an IPX packet. Presence of the Route fields indicates the use of source route bridging.

Token Ring	Number of Bytes	Value
Access Control	1	
Frame Control	1	
Destination Address	6	
Source Address	6	
Route Control Broadcast / Length	1	
Route Control Direction	1	
Route Designator 1	2	
... ...	2	
Route Designator n	2	
DSAP	1	0xE0
SSAP	1	0xE0
Control	1	0x03

10.7. Token Ring SNAP

In token ring SNAP packets, the DSAP and SSAP values illustrated in the diagram indicate SNAP encapsulation. The Protocol Identification value illustrated in the diagram indicates that the frame contains an IPX packet. Presence of the Route fields indicates the use of source route bridging.

Token Ring SNAP	Number of Bytes	Value
Access Control	1	
Frame Control	1	
Destination Address	6	
Source Address	6	
Route Control Broadcast / Length	1	
Route Control Direction	1	
Route Designator 1	2	
... ...	2	
Route Designator n	2	
DSAP	1	0xAA
SSAP	1	0xAA
Control	1	0x03
Protocol Identification	5	0x0000008137

10.8. FDDI

In FDDI packets, the DSAP and SSAP values illustrated in the diagram indicate that the frame contains an IPX packet. Presence of the Route fields indicates the use of source route bridging.

FDDI

	Number of Bytes	Value
FDDI Header	3	
Frame Control	1	
Destination Address	6	
Source Address	6	
Route Control Broadcast / Length	1	
Route Control Direction	1	
Route Designator 1	2	
... ...	2	
Route Designator n	2	
DSAP	1	0xE0
SSAP	1	0xE0
Control	1	0x03

10.9. FDDI SNAP

In FDDI SNAP packets, the DSAP and SSAP values illustrated in the diagram indicate SNAP encapsulation. The Protocol Identification value illustrated in the diagram indicates that the frame contains an IPX packet. Presence of the Route fields indicates the use of source route bridging.

FDDI SNAP

	Number of Bytes	Value
FDDI Header	3	
Frame Control	1	
Destination Address	6	
Source Address	6	
Route Control Broadcast / Length	1	
Route Control Direction	1	
Route Designator 1	2	
... ...	2	
Route Designator n	2	
DSAP	1	0xAA
SSAP	1	0xAA
Control	1	0x03
Protocol Identification	5	0x0000008137