The Frame

This topic discusses in detail what happens to the data link frame as it moves through a network. The information appended to a frame is determined by the protocol being used.

The data link layer prepares the encapsulated data (usually an IPv4 or IPv6 packet) for transport across the local media by encapsulating it with a header and a trailer to create a frame.

The data link protocol is responsible for NIC-to-NIC communications within the same network. Although there are many different data link layer protocols that describe data link layer frames, each frame type has three basic parts: header, data and trailer

Unlike other encapsulation protocols, the data link layer appends information in the form of a trailer at the end of the frame.

All data link layer protocols encapsulate the data within the data field of the frame. However, the structure of the frame and the fields contained in the header and trailer vary according to the protocol.

There is no one frame structure that meets the needs of all data transportation across all types of media. Depending on the environment, the amount of control information needed in the frame varies to match the access control requirements of the media and logical topology. For example, a WLAN frame must include procedures for collision avoidance and therefore requires additional control information when compared to an Ethernet frame.

As shown in the figure, in a fragile environment, more controls are needed to ensure delivery. The header and trailer fields are larger as more control information is needed.

Frame Fields

Framing breaks the stream into decipherable groupings, with control information inserted in the header and trailer as values in different fields. This format gives the physical signals a structure that are by recognized by nodes and decoded into packets at the destination.

The generic frame fields are shown in the figure. Not all protocols include all these fields. The standards for a specific data link protocol define the actual frame format.

The image shows a data packet encapsulated by a data link header and a data link trailer. The data link header is broken down to for fields: Frame start, addressing, type, and control. The data link trailer is broken down to two fields: Error detection and frame stop.

Frame fields include the following:

- **Frame start and stop indicator flags** - Used to identify the beginning and end limits of the frame.
- **Addressing -** Indicates the source and destination nodes on the media.
- **Type** - Identifies the Layer 3 protocol in the data field.
- **Control** - Identifies special flow control services such as quality of service (QoS). QoS gives forwarding priority to certain types of messages. For example, voice over IP (VoIP) frames normally receive priority because they are sensitive to delay.
- **Data** - Contains the frame payload (i.e., packet header, segment header, and the data).
- **Error Detection** - Included after the data to form the trailer.

Data link layer protocols add a trailer to the end of each frame. In a process called error detection, the trailer determines if the frame arrived without error. It places a logical or mathematical summary of the bits that comprise the frame in the trailer. The data link layer adds error detection because the signals on the media could be subject to interference, distortion, or loss that would substantially change the bit values that those signals represent.

A transmitting node creates a logical summary of the contents of the frame, known as the cyclic redundancy check (CRC) value. This value is placed in the frame check sequence (FCS) field to represent the contents of the frame. In the Ethernet trailer, the FCS provides a method for the receiving node to determine whether the frame experienced transmission errors.

Layer 2 Addresses

The data link layer provides the addressing used in transporting a frame across a shared local media. Device addresses at this layer are referred to as physical addresses. Data link layer addressing is contained within the frame header and specifies the frame destination node on the local network. It is typically at the beginning of the frame, so the NIC can quickly determine if it matches its own Layer 2 address before accepting the rest of the frame. The frame header may also contain the source address of the frame.

Unlike Layer 3 logical addresses, which are hierarchical, physical addresses do not indicate on what network the device is located. Rather, the physical address is unique to the specific device. A device will still function with the same Layer 2 physical address even if the device moves to another network or subnet. Therefore, Layer 2 addresses are only used to connect devices within the same shared media, on the same IP network.

The source host encapsulates the Layer 3 IP packet in a Layer 2 frame. In the frame header, the host adds its Layer 2 address as the source and the Layer 2 address for R1 as the destination.

The data link layer address is only used for local delivery. Addresses at this layer have no meaning beyond the local network. Compare this to Layer 3, where addresses in the packet header are carried from the source host to the destination host, regardless of the number of network hops along the route.

If the data must pass onto another network segment, an intermediary device, such as a router, is necessary. The router must accept the frame based on the physical address and de-encapsulate the frame in order to examine the hierarchical address, which is the IP address. Using the IP address, the router can determine the network location of the destination device and the best path to reach it. When it knows where to forward the packet, the router then creates a new frame for the packet, and the new frame is sent on to the next network segment toward its final destination.

LAN and WAN Frames

Ethernet protocols are used by wired LANs. Wireless communications fall under WLAN (IEEE 802.11) protocols. These protocols were designed for multiaccess networks.

WANs traditionally used other types of protocols for various types of point-to-point, hub-spoke, and full-mesh topologies. Some of the common WAN protocols over the years have included:

- Point-to-Point Protocol (PPP)
- High-Level Data Link Control (HDLC)
- Frame Relay
- Asynchronous Transfer Mode (ATM)
- X.25

These Layer 2 protocols are now being replaced in the WAN by Ethernet.

In a TCP/IP network, all OSI Layer 2 protocols work with IP at OSI Layer 3. However, the Layer 2 protocol used depends on the logical topology and the physical media.

Each protocol performs media access control for specified Layer 2 logical topologies. This means that a number of different network devices can act as nodes that operate at the data link layer when implementing these protocols. These devices include the NICs on computers as well as the interfaces on routers and Layer 2 switches.

The Layer 2 protocol that is used for a particular network topology is determined by the technology used to implement that topology. The technology used is determined by the size of the network, in terms of the number of hosts and the geographic scope, and the services to be provided over the network.

A LAN typically uses a high bandwidth technology capable of supporting large numbers of hosts. The relatively small geographic area of a LAN (a single building or a multi-building campus) and its high density of users make this technology cost-effective.

However, using a high bandwidth technology is usually not cost-effective for WANs that cover large geographic areas (cities or multiple cities, for example). The cost of the long-distance physical links and the technology used to carry the signals over those distances typically results in lower bandwidth capacity.

The difference in bandwidth normally results in the use of different protocols for LANs and WANs.

Data link layer protocols include:

- Ethernet
- 802.11 Wireless
- Point-to-Point Protocol (PPP)
- High-Level Data Link Control (HDLC)
- Frame Relay