Chapter 7 OSI Data Link Layer

Learning Objectives

Upon completion of this chapter, you will be able to:

- Explain the role of Data Link layer protocols in data transmission.
- Describe how the Data Link layer prepares data for transmission on network media.
- Describe the different types of media access control methods.
- Identify several common logical network topologies and describe how the logical topology determines the media access control method for that network.
- Explain the purpose of encapsulating packets into frames to facilitate media access.
- Describe the Layer 2 frame structure and identify generic fields.
    - Explain the role of key frame header and trailer fields.

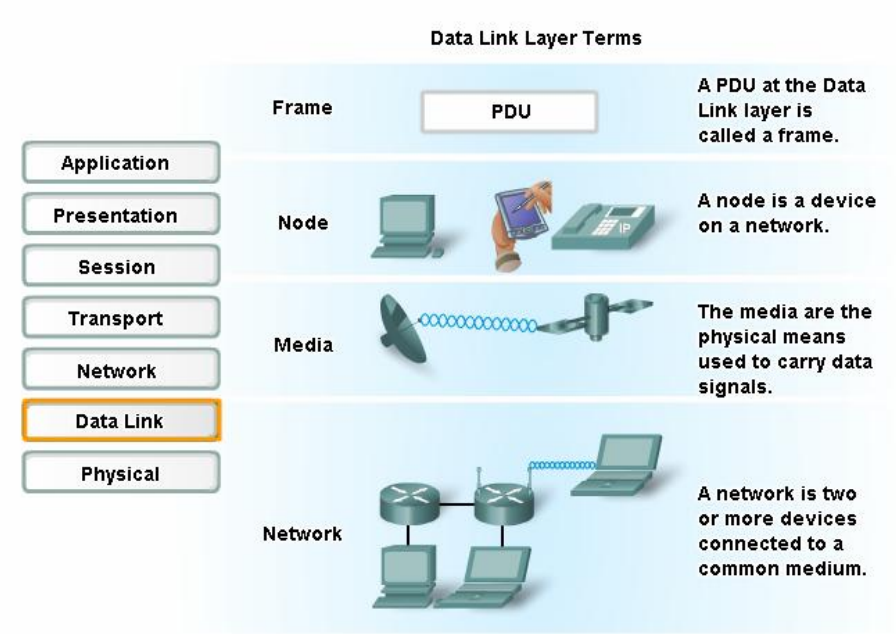


Figure 1.

7.1 Data Link Layer – Accessing the Media

7.1.1 Data Link layer – Supporting & Connecting to Upper Layer Services

The Data Link layer performs two basic services:

- Allows the upper layers to access the media using techniques such as framing

- Controls how data is placed onto the media and is received from the media using techniques such as media access control and error detection as with each of the OSI layers, there are terms specific to this layer:
- Frame - The Data Link layer PDU
- Node - The Layer 2 notation for network devices connected to a common medium

The Data Link layer is responsible for the exchange of frames between nodes over the media of a physical network.

- Logical networks are defined at the Network layer by the arrangement of the hierarchical addressing scheme.
- Physical networks represent the interconnection of devices on a common media. Sometimes, a physical network is also referred to as a network segment.

Upper Layer Access to Media

Figure 2 shows each link between devices uses a different medium. Between the PC and the router may be an Ethernet link. The routers are connected through a satellite link, and the laptop is connected through a wireless link to the last router. In this example, as an IP packet travels from the PC to the laptop, it will be encapsulated into Ethernet frame, decapsulated, processed, and then encapsulated into a new data link frame to cross the satellite link. For the final link, the packet will use a wireless data link frame from the router to the laptop.

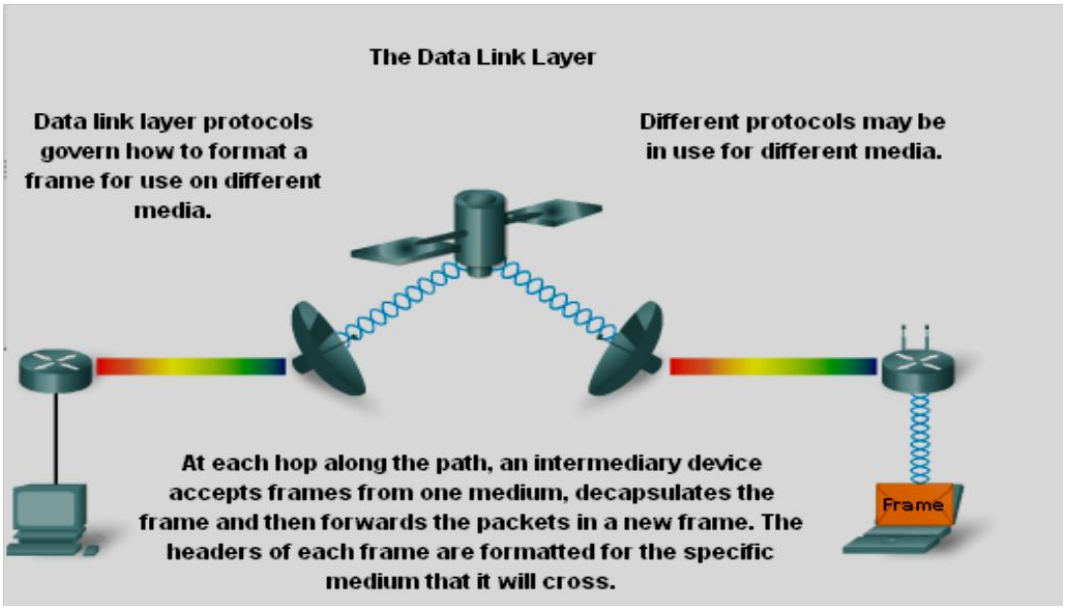


Figure 2.

7.1.2 Data Link Layer - Controlling Transfer across Local Media

Layer 2 protocols specify the encapsulation of a packet into a frame and the techniques for getting the encapsulated packet on and off each medium. For the data to be transferred across a number of different media, different media access control methods may be required during the course of a single communication.

Data Link layer protocols require control information to enable the protocols to function. Control information may tell:

• Which nodes are in communication with each other?

• When communication between individual nodes begins and when it ends?

• Which errors occurred while the nodes communicated?

• Which nodes will communicate next?

The Data Link layer prepares a packet for transport across the local media by encapsulating it with a header and a trailer to create a frame.

- **Data** - The packet from the Network layer
- **Header** - Contains control information, such addressing, and is located at the beginning of the PDU
- **Trailer** - Contains control information added to the end of the PDU

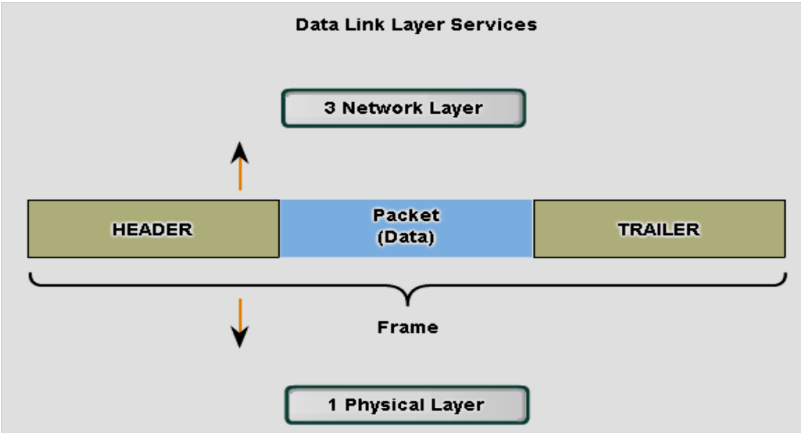
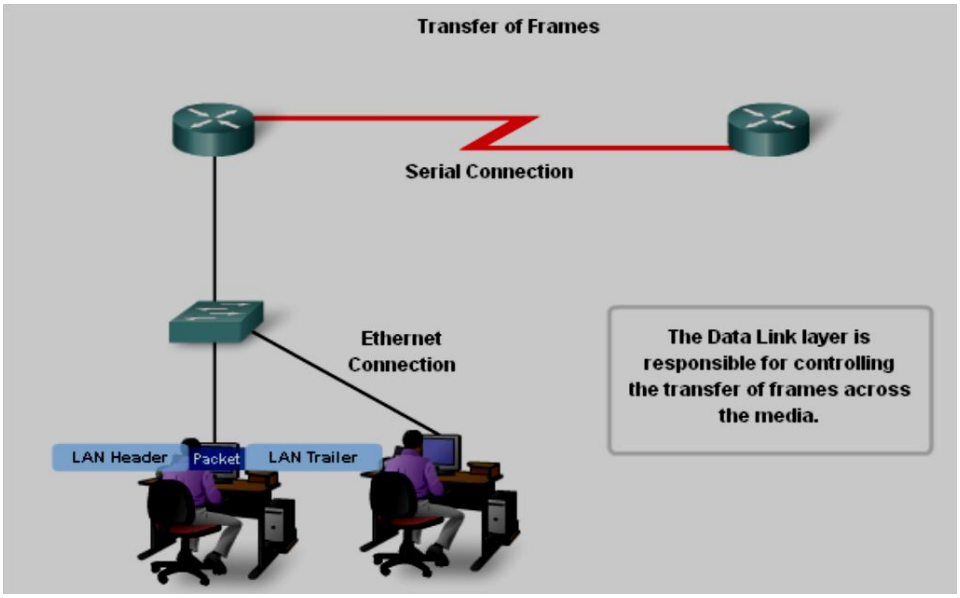


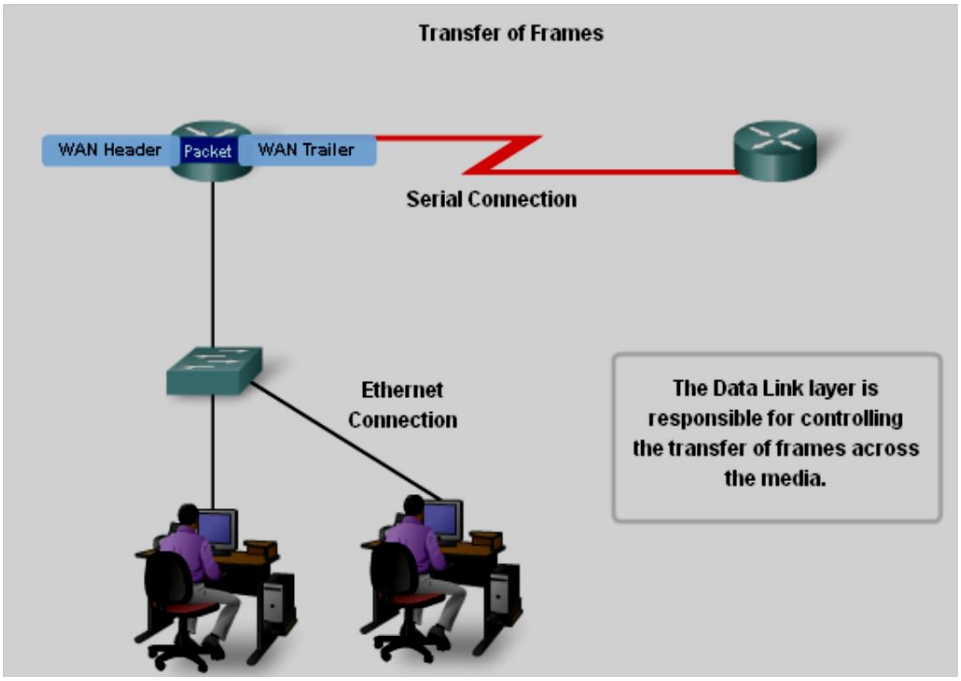
Figure 3.

A node that is an end device uses an adapter to make the connection to the network. For example, to connect to a LAN, the device would use the appropriate Network Interface Card (NIC) to connect to the LAN media. The adapter manages the framing and media access

control. At intermediary devices such as a router, where the media type could change for each connected network, different physical interfaces on the router are used to encapsulate the packet into the appropriate frame, and a suitable media access control method is used to access each link. The router in the figure has an Ethernet interface to connect to the LAN and a serial interface to connect to the WAN. As the router processes frames, it will use Data Link layer services to receive the frame from one medium, decapsulate it to the Layer 3 PDU, re-encapsulate the PDU into a new frame, and place the frame on the medium of the next link of the network as shown in Figure 4(a-b).



(a)



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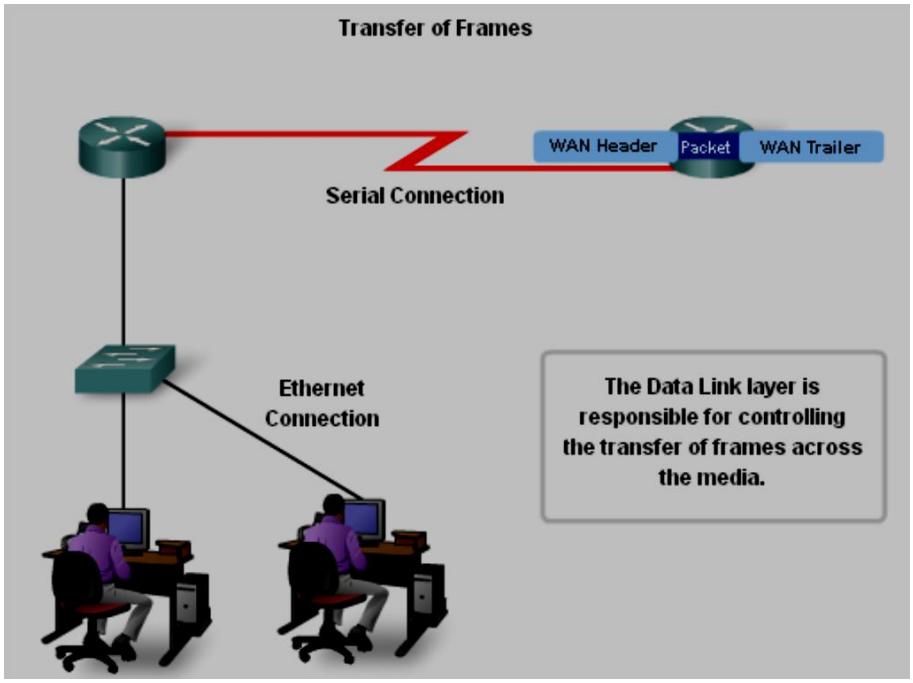

(c)

Figure 4: Frames Transfer.

7.1.3 Data Link Layer – Creating a Frame

Formatting Data for Transmission

When data travels on the media, it is converted into a stream of bits, or 1s and 0s. If a node is receiving long streams of bits, how does it determine where a frame starts and stops or which bits represent the address? Framing breaks the stream into groups, with control information inserted in the header and trailer as values in different fields. This format gives the physical signals a structure that can be received by nodes and decoded into packets at the destination.

Typical field types include:

• Start and stop indicator fields - The beginning and end limits of the frame

• Naming or addressing fields

• Type field - The type of PDU contained in the frame

• Quality - control fields

• A data field -The frame payload (Network layer packet)

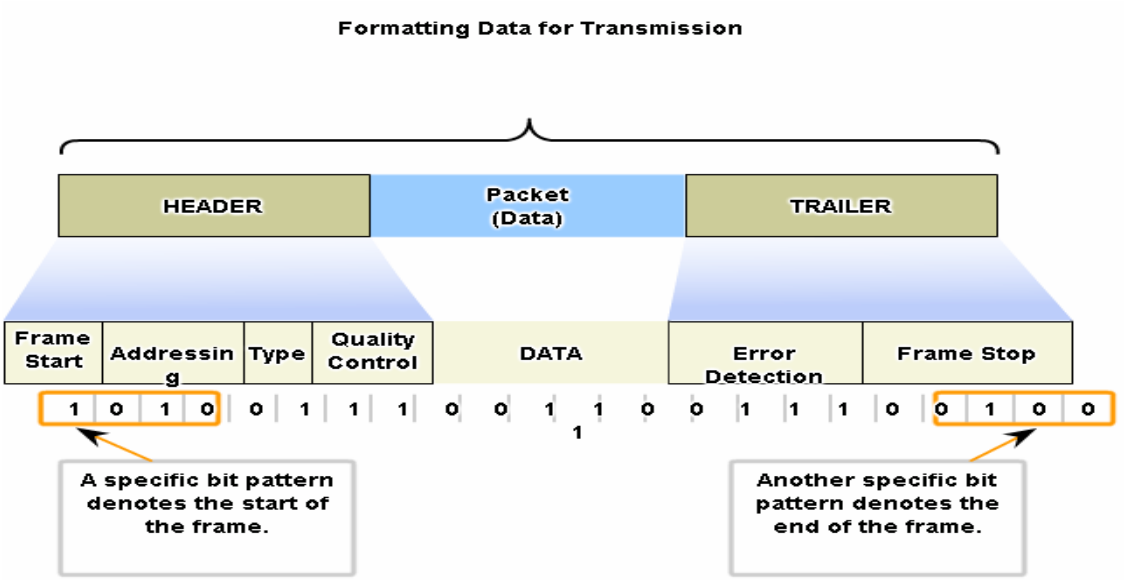

Figure 5: Formatting data for transmission.

7.1.4 Data Link Layer – Connecting Upper Layer Services to the Media

The Data Link layer exists as a connecting layer between the software processes of the layers above it and the Physical layer below it. As such, it prepares the Network layer packets for transmission across some form of media, be it copper, fiber, or the atmosphere.

In many cases, the Data Link layer is embodied as a physical entity, such as an Ethernet network interface card (NIC), which inserts into the system bus of a computer and makes the connection between running software processes on the computer and physical media.

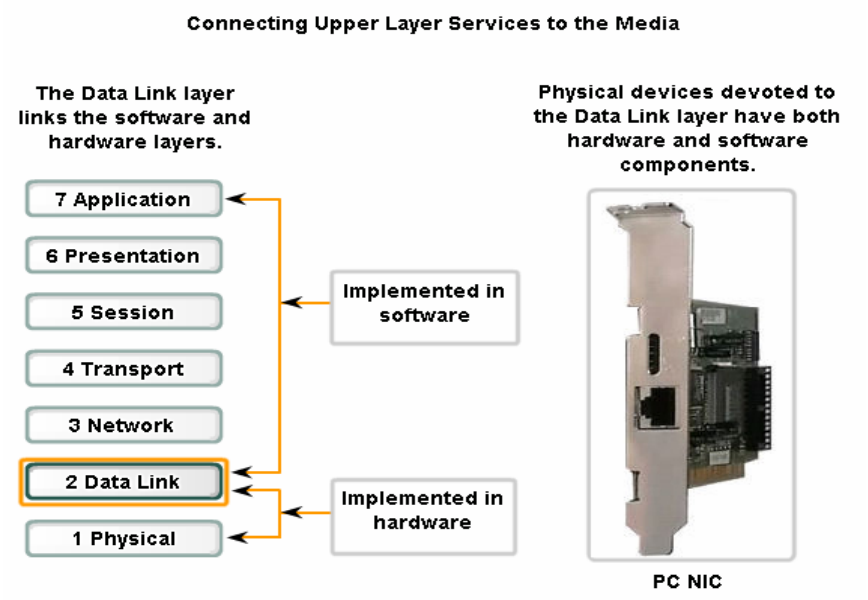

Figure 6: Connecting upper layer services to the media.