OSI Data Link Layer

Network Fundamentals – Chapter 7

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Objectives

- Explain the role of Data Link layer protocols in data transmission and describe how the Data Link layer prepares data for transmission on network media.

- Describe the different types of MAC methods.

- Identify several common logical network topologies and describe how the logical topology determines the media access control method for that network.

- Describe the Layer 2 frame structure and identify generic fields.

- Explain the role of key frame header and trailer fields.

2

Data Link Layer

- Data Link layer provides a means for exchanging data over a common local media

- PDU is the Frame

- Nodes – devices connected to the network

- Media – carries the signal
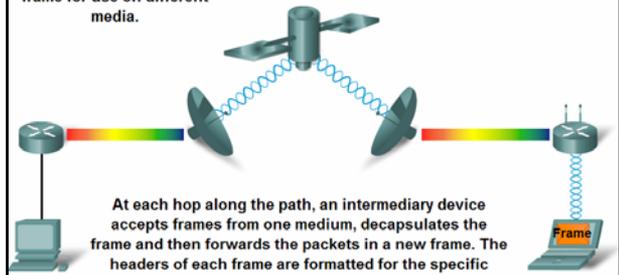
- Physical network segment

7 Application
6 Presentation
5 Session
4 Transport
3 Network
2 Data Link
1 Physical
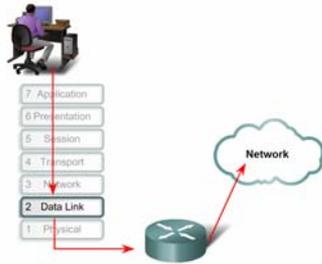
Network

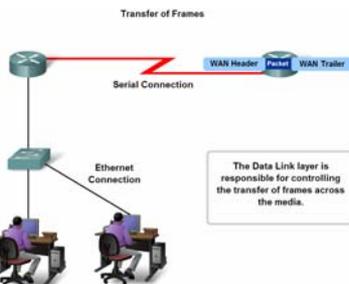The Data Link layer prepares network data for the physical network.

Data Link Layer Protocols

Data link layer protocols govern how to format a frame for use on different media.

Different protocols may be in use for different media.

At each hop along the path, an intermediary device accepts frames from one medium, decapsulates the frame and then forwards the packets in a new frame. The headers of each frame are formatted for the specific medium that it will cross.

Frame

4

- Layer 2 protocols specify:
  1. encapsulation of a packet into a frame
 2. the techniques for getting the encapsulated packet on and off each medium.

Transfer of Frames

WAN Header | Packet | WAN Trailer
Serial Connection

Ethernet Connection

The Data Link layer is responsible for controlling the transfer of frames across the media.

- MAC

  Media Access Control

5

Data Link Layer PDU – the Frame

Header			Packet	Trailer	
Frame start	Addressing	Type	DATA	Error detection	Frame stop

- 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)

6

Data Link Layer Frame – Error Detection

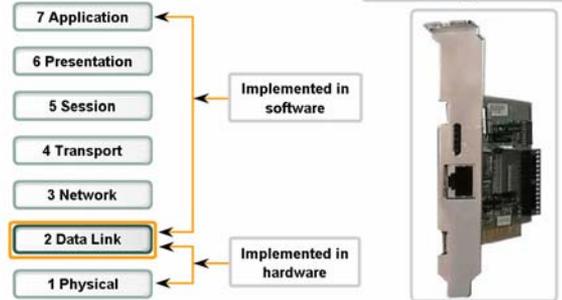| Header | | | Packet | Trailer | |
| Frame start | Addressing | Type | DATA | FCS | Frame stop |
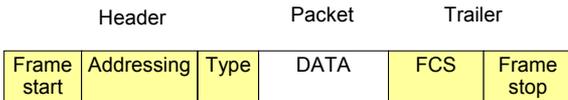
- Frame Check Sequence (FCS)
- Checks for bit-errors during transmission
- A logical summary of the contents of the frame is carried out - known as the cyclic redundancy check (CRC) value
- What happens to error frames depends on the data link protocol

7

Network Interface Card (NIC)

The Data Link layer links the software and hardware layers.

Physical devices devoted to the Data Link layer have both hardware and software components.

7 Application

6 Presentation

5 Session

4 Transport

3 Network

2 Data Link

1 Physical

Implemented in software

Implemented in hardware

PC NIC

Data Link Sublayers

The data link layer is divided into two sublayers:

- Logical Link Control (LLC)
    Frames the Network layer packet
    Identifies the Network layer protocol
- Media Access Control (MAC)
    Addresses the frame
    Marks the beginning and ending of the frame

- Physical Layer
    Encodes the bits

9

Data Link Layer Open Standards

Institute of Electrical and Electronic Engineers (IEEE)
        802.3 (LLC)
        802.3 (Ethernet)
        802.5 (Token Ring)
        802.11 (Wireless LAN)
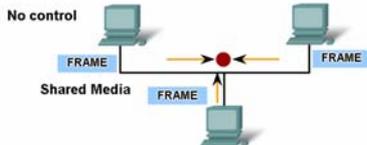
International Telecommunications Union (ITU)
        Q922 (Frame Relay Standard)
        Q921 (ISDN Data Link Standard)
        HDLC (High Level Data Link Control

10

Media Access Control Techniques

No control at all would result in many collisions. Collisions cause corrupted frames that must be resent.
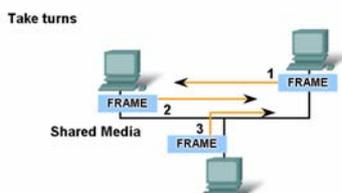
No control

FRAME

FRAME

Shared Media

FRAME

Controlled access
Methods that enforce a high degree of control prevent collisions, but the process has high overhead.

Contention-based access
Methods that enforce a low degree of control have low overhead, but there are more frequent collisions.

Take turns

FRAME

1

FRAME

2

3

Shared Media

FRAME

There are two basic media access control methods for shared media:

- Controlled - Each node has its own time to use the medium. Deterministic. Not necessarily efficient.
- Contention-based - All nodes compete for the use of the medium. Non-deterministic. Carrier Sense Multiple Access (CSMA) process. Data collisions may occur.
    - CSMA/Collision Detection (CSMA/CD)
        traditional Ethernet method.
    - CSMA/Collision Avoidance (CSMA/CA).
        used by 802.11 wireless networks

12

Non-shared Media Access Point-to-point links

- Full Duplex – nodes can transmit and receive at the same time

- Half Duplex – nodes can both transmit and receive, but not at the same time


Full-duplex
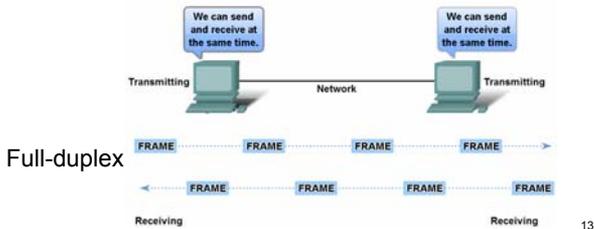
Logical and Physical Topology

- The topology of a network is the arrangement or relationship of the network devices and the interconnections between them.

- Topology can be viewed at the physical level and the logical level.

- The physical topology is how the media is used to interconnect the devices.

- A logical topology is the way a network transfers frames from one node to the next.

- A network's physical topology is not necessarily the same as it's logical topology

Common Logical Topologies
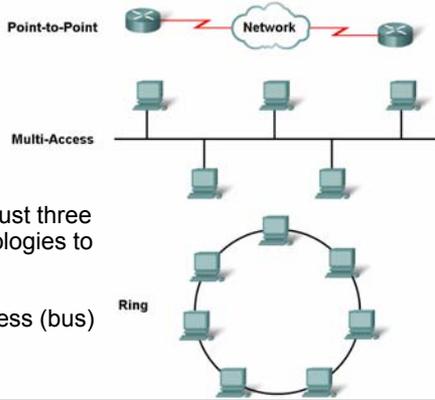
There are just three logical topologies to consider:
- P2P
- Multi-Access (bus)
- Ring

Logical Point-to-Point Networks - Virtual Circuit

- A virtual circuit is a logical connection created within a network between two network devices.

- May be permanent or temporary

Logical Multi Access Topology

- Data from only one node can be placed on the medium at any one time.

- Every node sees all the frames that are on the medium, but only the node to which the frame is addressed processes the contents of the frame.

- Media access control methods include:

    CSMA/CD

    CSMA/CA

    Token passing
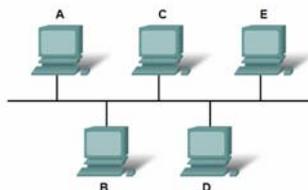
Logical Ring Topology

- Typical Media Access Control method for a logical ring is Token Passing

- A special frame called a token is passed around the ring

- When a node has the token, it has permission to put data on the media

- Deterministic

Data Link Addressing

- A.k.a. physical addressing.
- Data Link layer address is only used for local delivery. Addresses at this layer have no meaning beyond the local network.
- Physical address is not changed when the device is moved to another network.
- Point-to-point topologies do not need physical addresses.
- Multi-access and ring topologies do need physical addresses.

19

Data Link Protocols

- Data link protocols that will be covered in CCNA courses include:
  - Ethernet
  - Point-to-Point Protocol (PPP)
  - High-Level Data Link Control (HDLC)
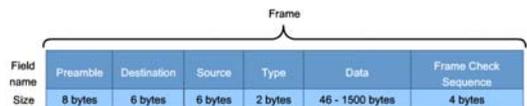 - Frame Relay
  - Asynchronous Transfer Mode (ATM)

20

Ethernet

- Ethernet is a family of networking technologies that are defined in the IEEE 802.2 and 802.3 standards.
- Ethernet standards define both the Layer 2 protocols and the Layer 1 technologies.
- Ethernet is the most widely used LAN technology and supports data bandwidths of 10, 100, 1000, or 10,000 Mbps.
- An Ethernet MAC address is 48 bits and represented in hexadecimal format.
- Ethernet II is the Ethernet frame format used in TCP/IP networks.

21

Ethernet Frame

Field name	Preamble	Destination	Source	Type	Data	Frame Check Sequence
Size	8 bytes	6 bytes	6 bytes	2 bytes	46 - 1500 bytes	4 bytes

- Preamble – used for synchronization
- Destination and Source addresses – 48-bit MAC addresses
- Type – upper layer protocol type
- Data or payload – Layer 3 PDU
- Frame Check Sequence – check for bit errors

22

Summary

In this chapter, you learned 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, including addressing, QoS, type of protocol, and Frame Check Sequence.

23