



Data Link Layer

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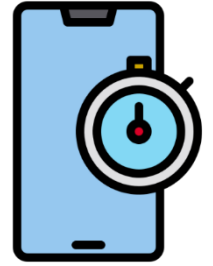
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Naryn, 11:06am, Sept 26, 2022



Lessons learnt last time



- Purpose of the Physical Layer: Describe the purpose and functions of the physical layer in the network
- Physical Layer Characteristics: Describe characteristics of the physical layer
- Copper Cabling: Identify the basic characteristics of copper cabling
- UTP Cabling: Explain how UTP cable is used in Ethernet networks
- Fiber-Optic Cabling: Describe fiber optic cabling and its main advantages over other media
- Wireless Media: Connect devices using wired and wireless media

What we gonna discuss today?



- Purpose of the Data Link Layer: Describe the purpose and function of the data link layer in preparing communication for transmission on specific media
- Topologies: Compare the characteristics of media access control methods on WAN and LAN topologies
- Data Link Frame: Describe the characteristics and functions of the data link frame

Purpose of the Data Link Layer

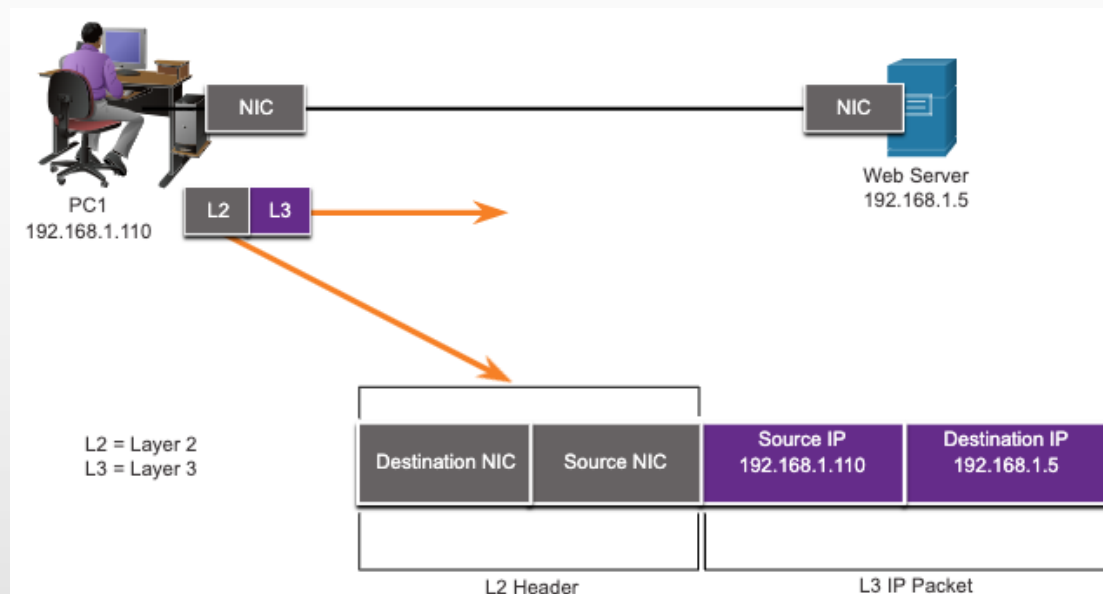
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- Purpose of the Data Link Layer

Purpose of the Data Link Layer

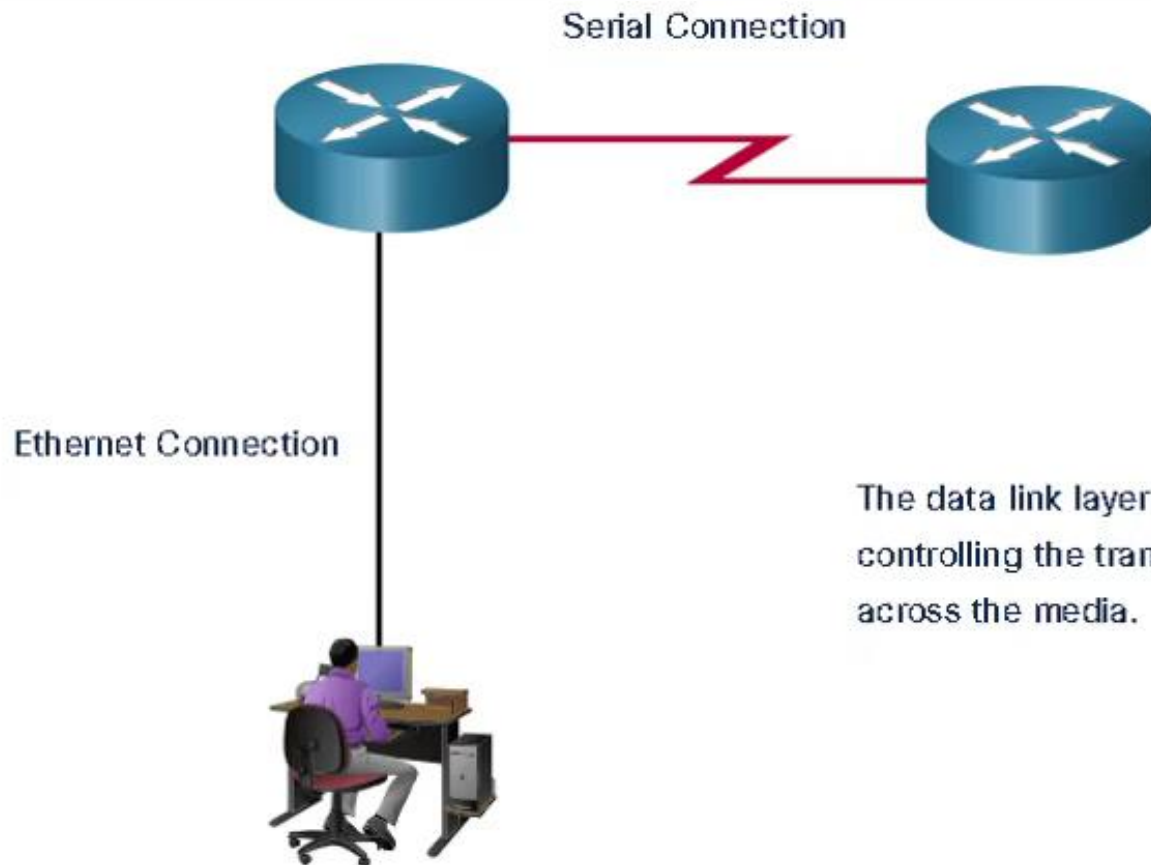
- The Data Link Layer

- The Data Link layer is responsible for communications between end-device network interface cards
- It allows upper layer protocols to access the physical layer media and encapsulates Layer 3 packets (IPv4 and IPv6) into Layer 2 Frames
- It also performs error detection and rejects corrupts frames



Purpose of the Data Link Layer

- The Data Link Layer (cont.)



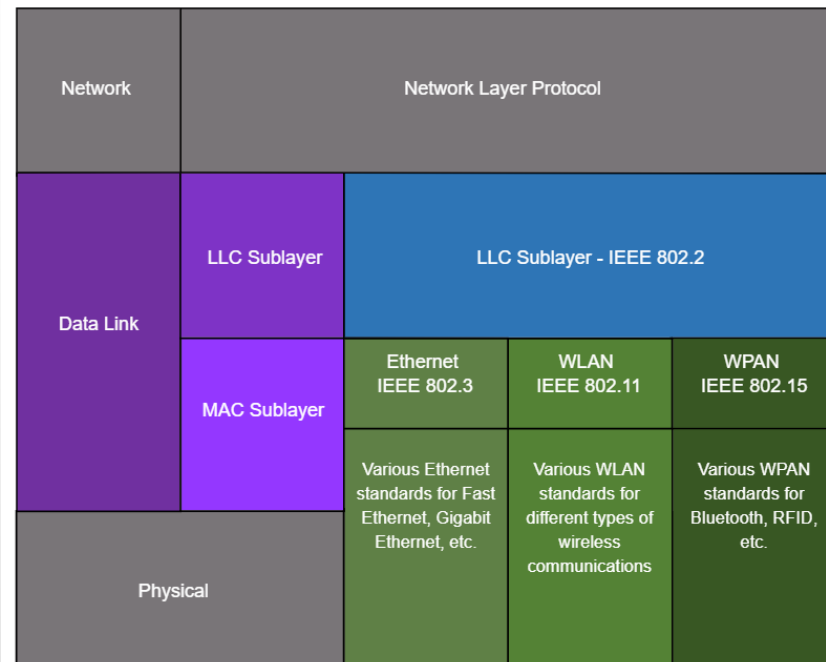
The data link layer is responsible for controlling the transfer of frames across the media.

Purpose of the Data Link Layer

- IEEE 802 LAN/MAN Data Link Sublayers
 - IEEE 802 LAN/MAN standards are specific to the type of network (Ethernet, WLAN, WPAN, etc.)
 - The **Data Link Layer** consists of two sublayers: **Logical Link Control (LLC)** and **Media Access Control (MAC)**

°The LLC sublayer communicates between the networking software at the upper layers and the device hardware at the lower layers

°The MAC sublayer is responsible for data encapsulation and media access control



Purpose of the Data Link Layer



- Providing Access to Media
 - Packets exchanged between nodes may experience numerous data link layers and media transitions
 - At each hop along the path, a router performs four basic Layer 2 functions:
 - Accepts a frame from the network medium
 - De-encapsulates the frame to expose the encapsulated packet
 - Re-encapsulates the packet into a new frame
 - Forwards the new frame on the medium of the next network segment

Purpose of the Data Link Layer

- Data Link Layer Standards

- Data link layer protocols are defined by engineering organizations:

- Institute for Electrical and Electronic Engineers (IEEE)
 - International Telecommunications Union (ITU)
 - International Organizations for Standardization (ISO)
 - American National Standards Institute (ANSI)



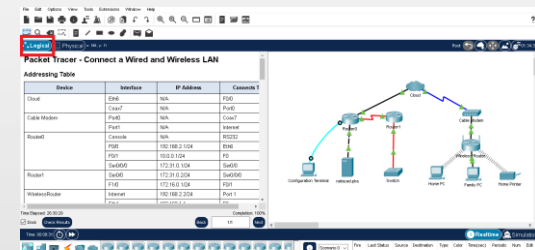
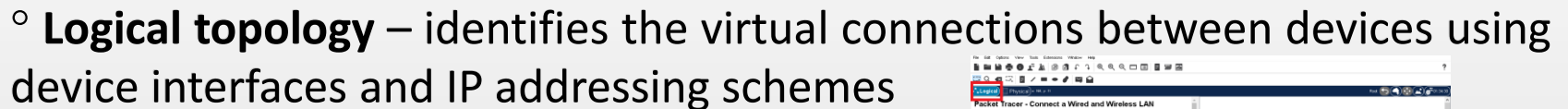
Topologies



- Topologies

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- The topology of a network is the arrangement and relationship of the network devices and the interconnections between them
- There are two types of topologies used when describing networks:
 - **Physical topology** – shows physical connections and how devices are interconnected



Topologies

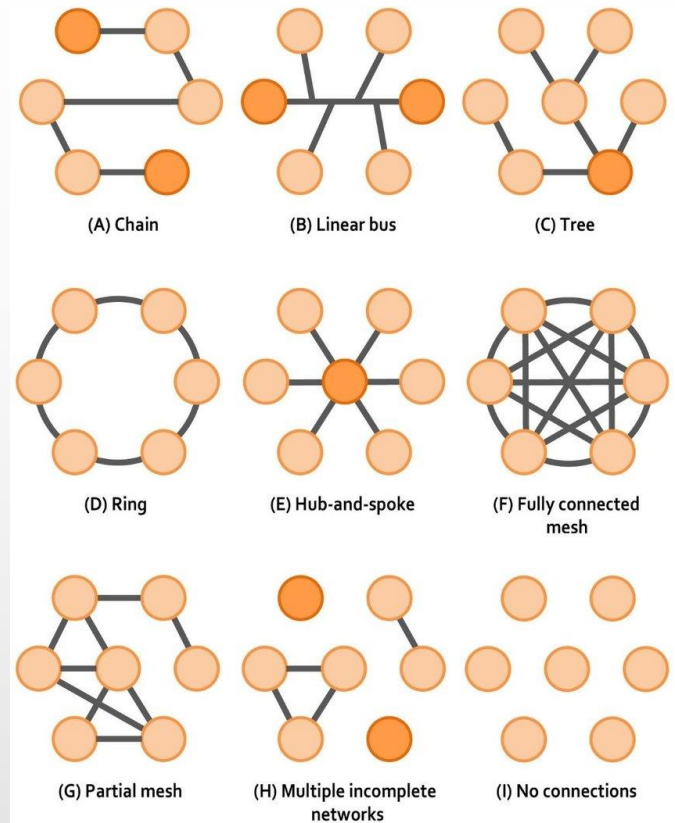
- WAN Topologies

- There are three common physical WAN topologies:

- **Point-to-point** – the simplest and most common WAN topology. Consists of a permanent link between two endpoints

- **Hub and spoke** – similar to a star topology where a central site interconnects branch sites through point-to-point links

- **Mesh** – provides high availability but requires every end system to be connected to every other end system



Topologies

- Point-to-Point WAN Topology

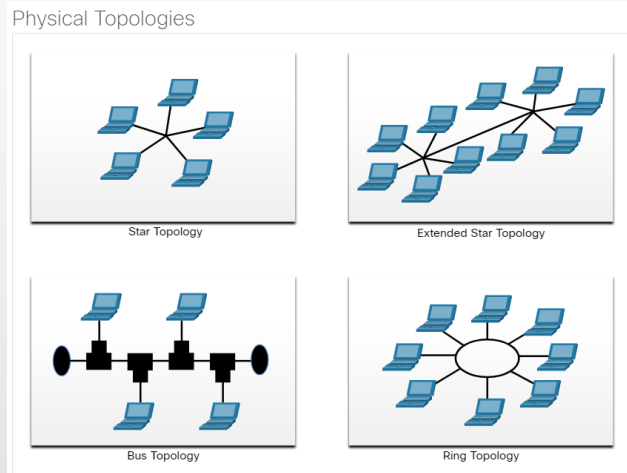
- Physical point-to-point topologies directly connect two nodes
- The nodes may not share the media with other hosts
- Because all frames on the media can only travel to or from the two nodes, Point-to-Point WAN protocols can be very simple



Topologies

- LAN Topologies

- End devices on LANs are typically interconnected using a star or extended star topology. Star and extended star topologies are easy to install, very scalable and easy to troubleshoot.
- Early Ethernet and Legacy Token Ring technologies provide two additional topologies:
 - **Bus:** All end systems chained together and terminated on each end
 - **Ring:** Each end system is connected to its respective neighbors to form a ring



Topologies

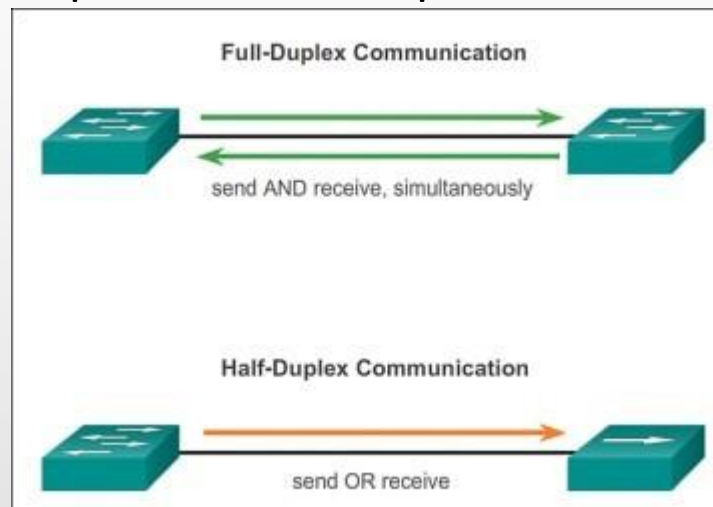
- Half and Full Duplex Communication

- Half-duplex communication

- Only allows one device to send **OR** receive at a time on a shared medium
 - Used on WLANs and legacy bus topologies with Ethernet hubs

- Full-duplex communication

- Allows both devices to simultaneously transmit and receive on a shared medium
 - Ethernet switches operate in full-duplex mode

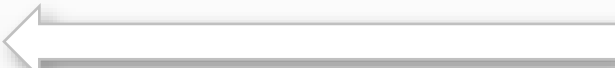



Topologies



- Access Control Methods

- **Contention-based access:** All nodes operating in half-duplex, competing for use of the medium. Examples are:

- Carrier sense multiple access with collision detection (**CSMA/CD**) as used on legacy bus-topology **Ethernet** 

- Carrier sense multiple access with collision avoidance (**CSMA/CA**) as used on **Wireless LANs** 

- Controlled access

- Deterministic access where each node has its own time on the medium

- Used on legacy networks such as Token Ring and ARCNET

Topologies



- Contention-Based Access – CSMA/CD

- CSMA/CD

- Used by legacy Ethernet LANs
 - Operates in half-duplex mode where only one device sends or receives at a time
 - Uses a collision detection process to govern when a device can send and what happens if multiple devices send at the same time

- CSMA/CD collision detection process

- Devices transmitting simultaneously will result in a signal collision on the shared media
 - Devices detect the collision
 - Devices wait a random period of time and retransmit data

Topologies



- Contention-Based Access – CSMA/CA

- CSMA/CA

- Used by IEEE 802.11 WLANs

- Operates in half-duplex mode where only one device sends or receives at a time

- Uses a collision avoidance process to govern when a device can send and what happens if multiple devices send at the same time

- CSMA/CA collision avoidance process:

- When transmitting, devices also include the time duration needed for the transmission

- Other devices on the shared medium receive the time duration information and know how long the medium will be unavailable

Data Link Frame



- Data Link Frame

Data Link Frame



- The Frame

- Data is encapsulated by the data link layer with a header and a trailer to form a frame. A data link frame has three parts:

- Header

- Data

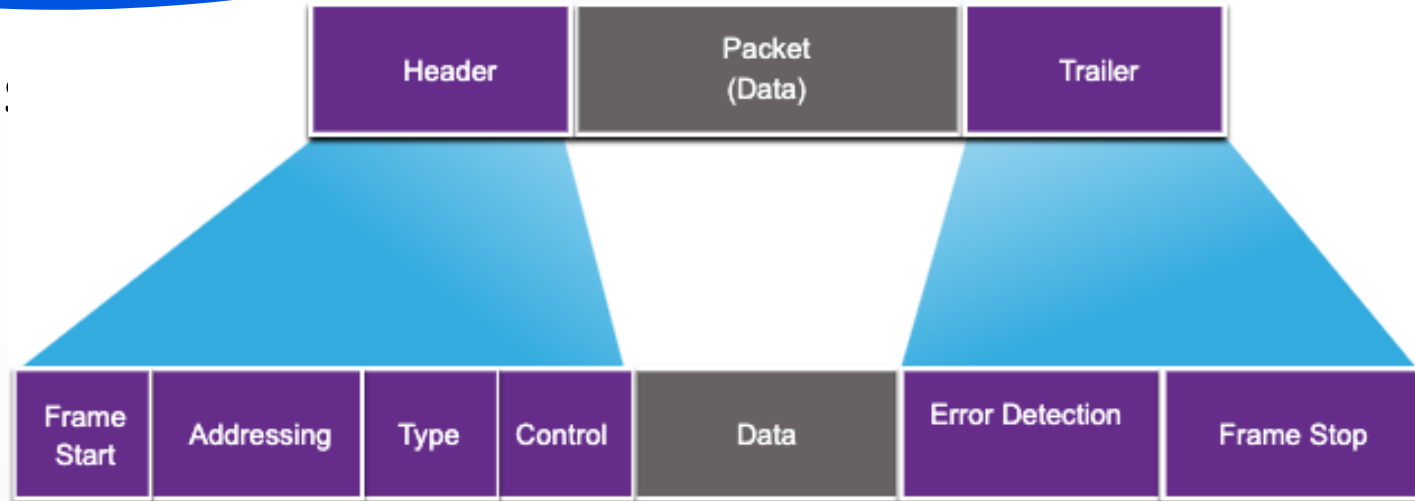
- Trailer

- **The fields of the header and trailer vary according to data link layer protocol**

- The amount of control information carried with in the frame varies according to access control information and logical topology

Data Link Frame

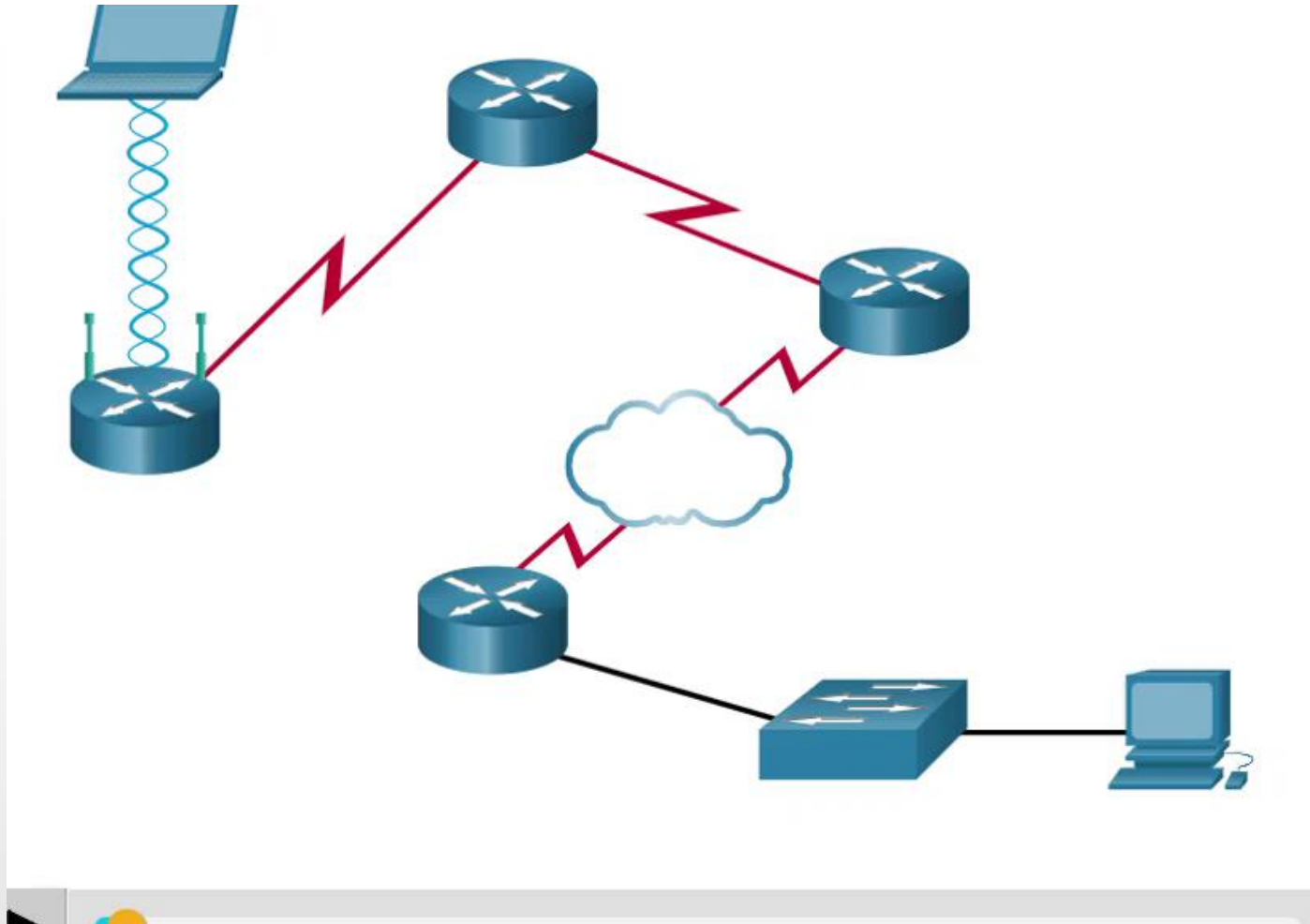
- Frame Fields



Field	Description
Frame Start and Stop	Identifies beginning and end of frame
Addressing	Indicates source and destination nodes
Type	Identifies encapsulated Layer 3 protocol
Control	Identifies flow control services
Data	Contains the frame payload
Error Detection	Used for determine transmission errors

Data Link Frame

- Data Link Frame

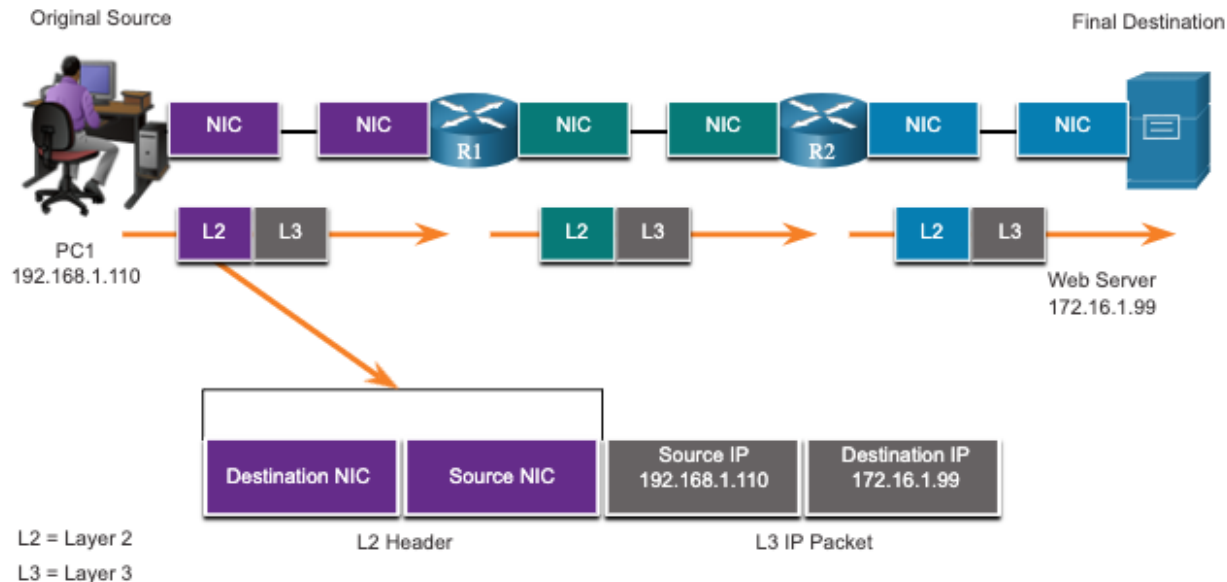


- Point-to-Point Protocol (PPP)

- High-Level Data Link Control (HDLC)

Data Link Frame

- Media Access Control (MAC address or Layer 2 addresses or physical address or hardware address)
 - Also referred to as a physical address
 - Contained in the frame header
 - Used only for local delivery of a frame on the link
 - Updated by each device that forwards the frame



Data Link Frame



- LAN and WAN Frames

- The logical topology and physical media determine the data link protocol used:

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

- Each protocol performs media access control for specified logical topologies

Do you have any
questions or
comments?



An abstract graphic consisting of multiple concentric, overlapping circular bands in shades of blue and grey, creating a sense of depth and motion. The bands are composed of various widths and segments, some solid and some with internal patterns, arranged in a way that suggests a spiral or a dynamic circular structure.

Thank you
for your attention !

In this presentation:

- Some icons were downloaded from flaticon.com and iconscout.com