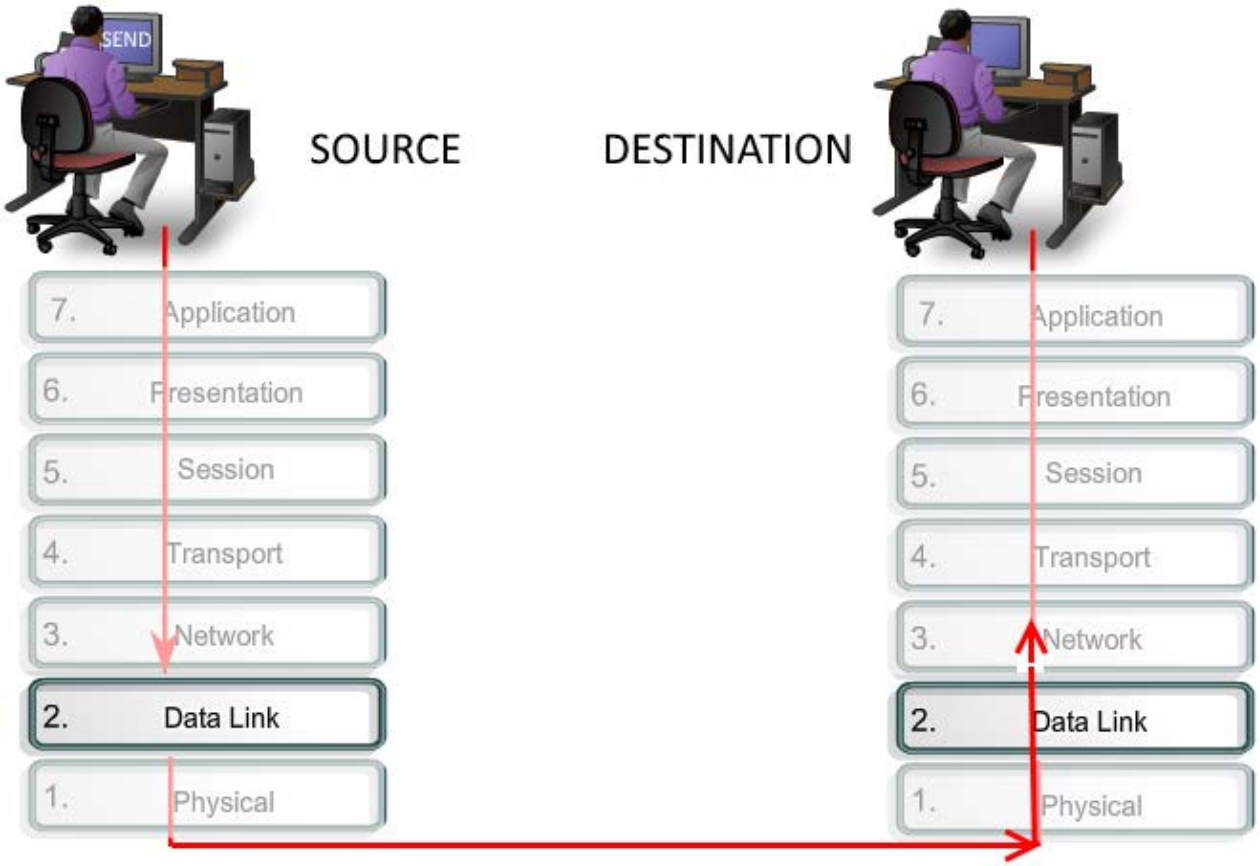
Chapter 4B: Data Link Layer Protocols

OSI Data Link Layer

The OSI has 7 layers.

The Data Link Layer is the second layer, just above the Physical Layer.



OSI Data Link Layer

- This layer is the protocol layer.
- It transfers data between adjacent network nodes.
- It is concerned with local delivery of frames between devices.
- A frame is a digital data transmission unit.

OSI Data Link Layer - Media Access Control

The Data Link Layer

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

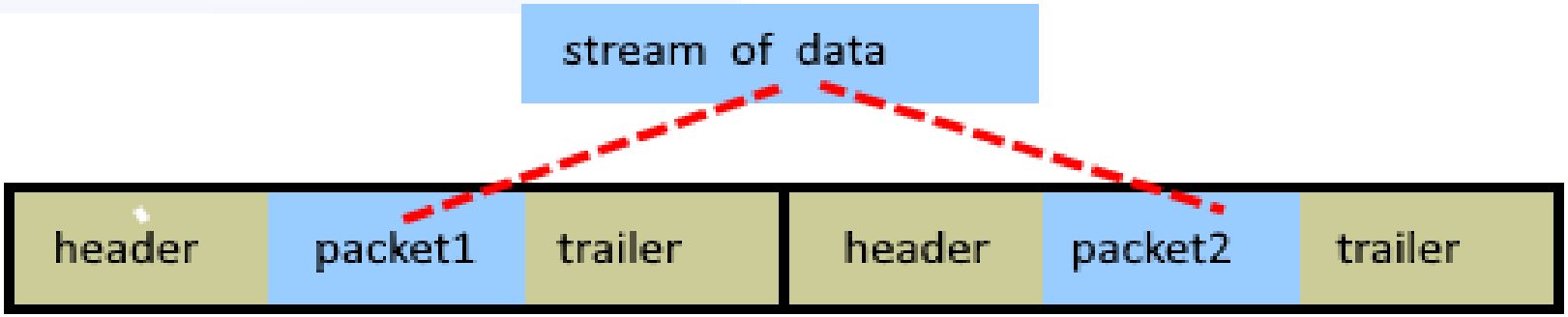
Different protocols may be in use for different media.

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.

OSI Data Link Layer
Framing

- Data are streamed from the network layer to the Data Link Layer.

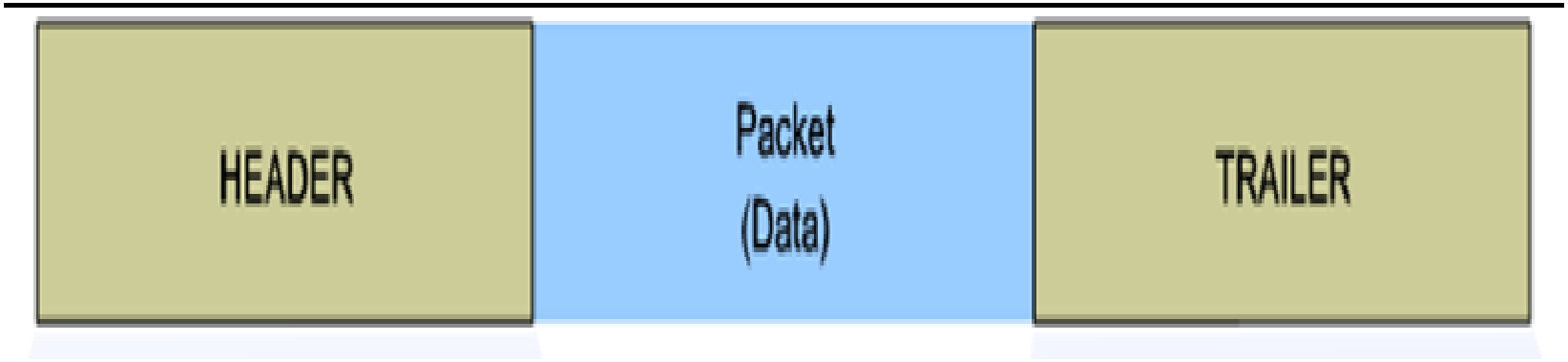
- These Data are first framed, then delivered.
- Framing is a technique performed by the Data Link layer.
- It breaks the bit stream into discrete frames.



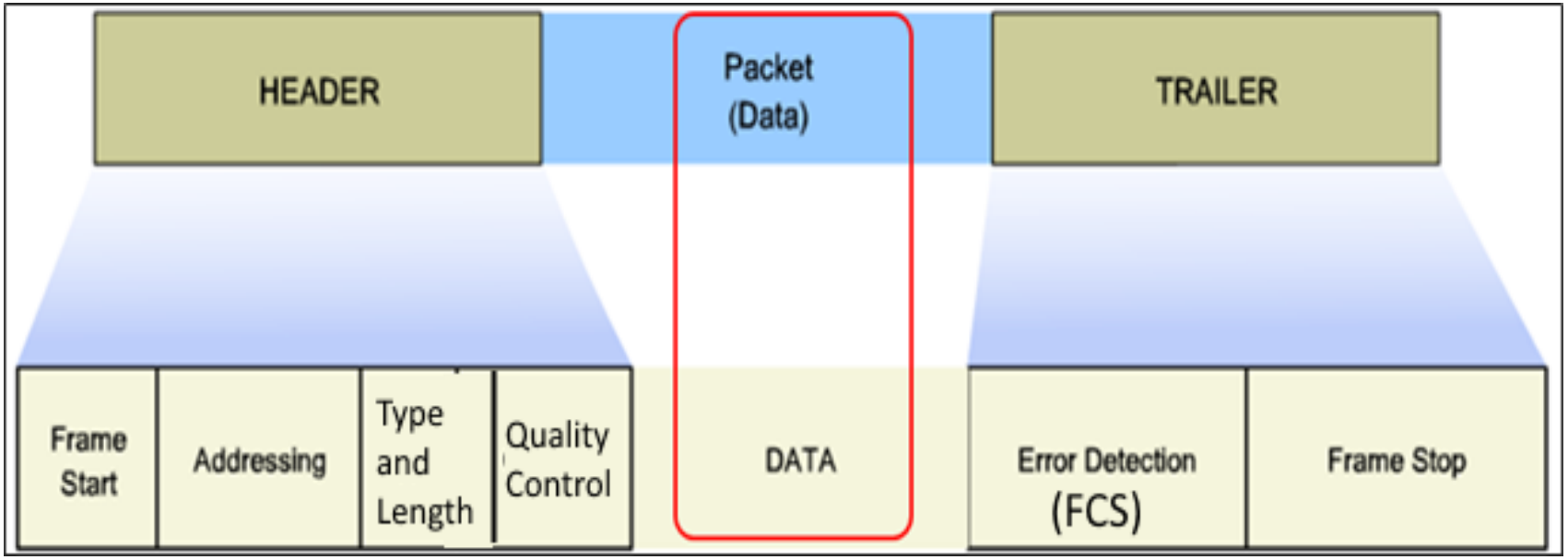
OSI Data Link Layer
A Frame

A frame comprises,

- A header
- A packet
- A trailer



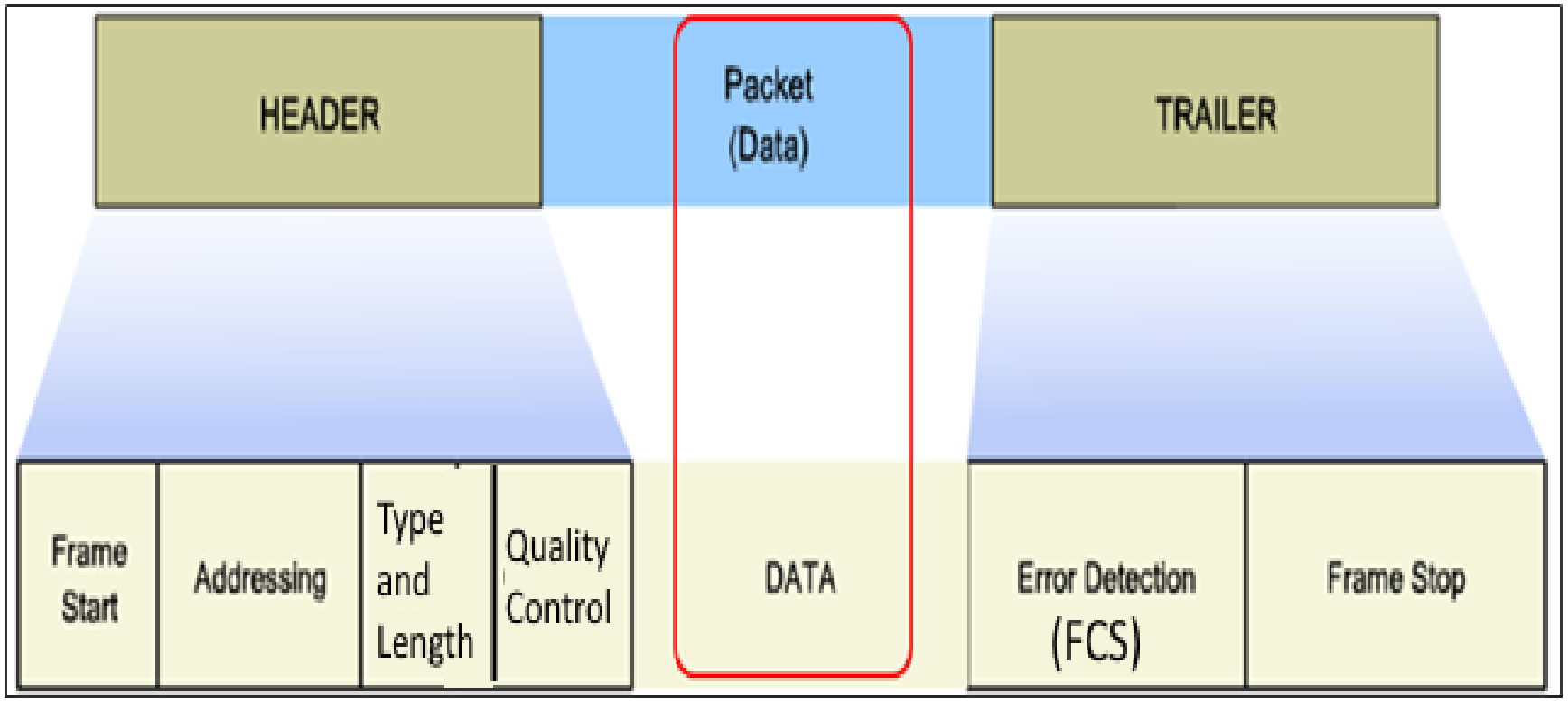
OSI Data Link Layer - The Data Link Header



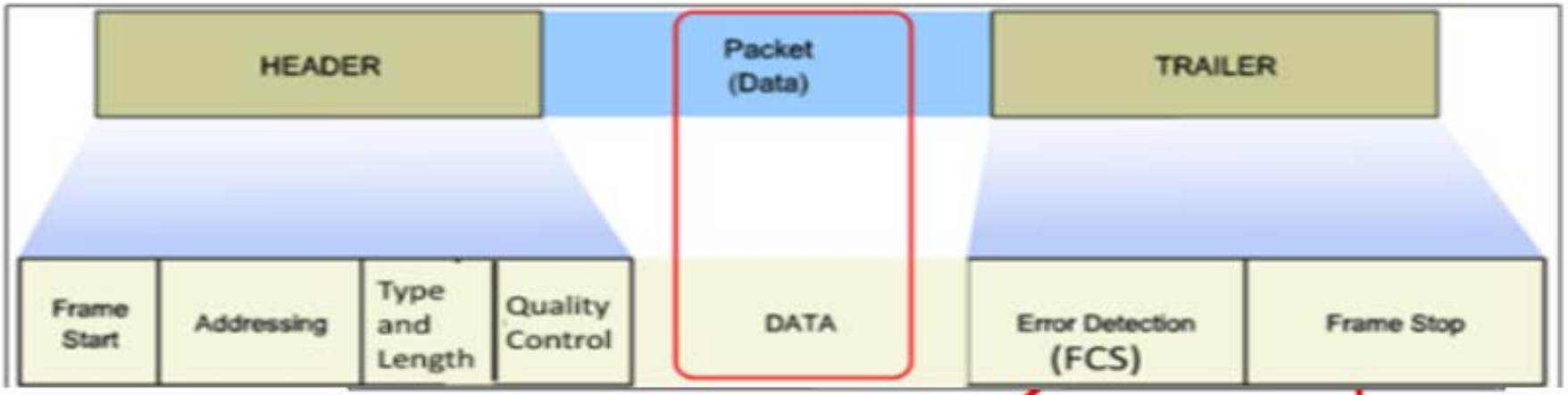
A frame consists of a header, data, and a trailer.
A header consists of a start frame, address type and control.
A trailer consists of a FCS (Frame Check Sequence) and stop frame.

OSI Data Link Layer
A Frame

The packet contains the actual data to be sent.



OSI Data Link Layer
The Trailer



Frame Check Sequence (FCS)

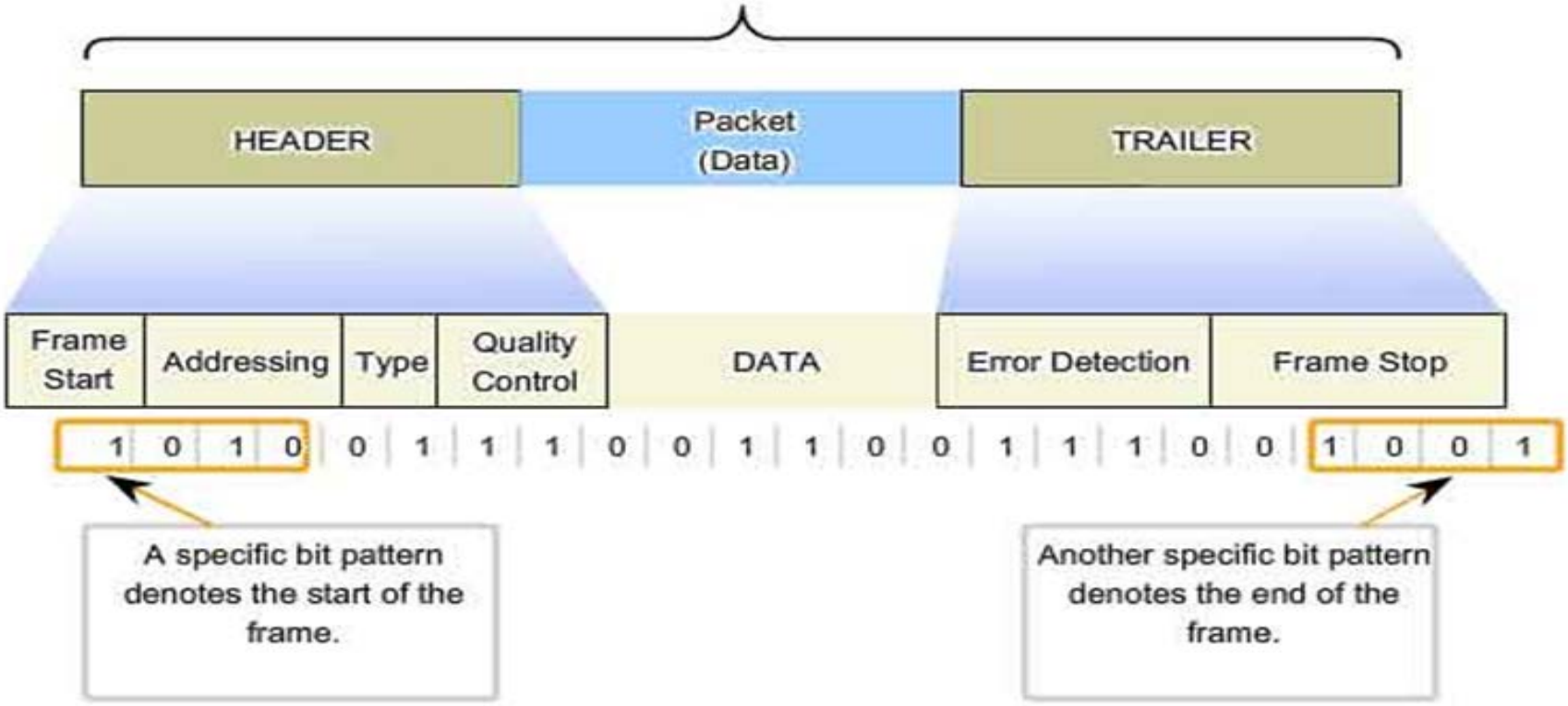
This field is used for error checking. The source calculates a number based on the frame's data and places that number in the FCS field. The destination then recalculates the data to see if the FCS matches. If they don't match, the destination deletes the frame.

Stop Frame

This field, also called the Frame Trailer, is an optional field that is used when the length of the frame is not specified in the Type/Length field. It indicates the end of the frame when transmitted.

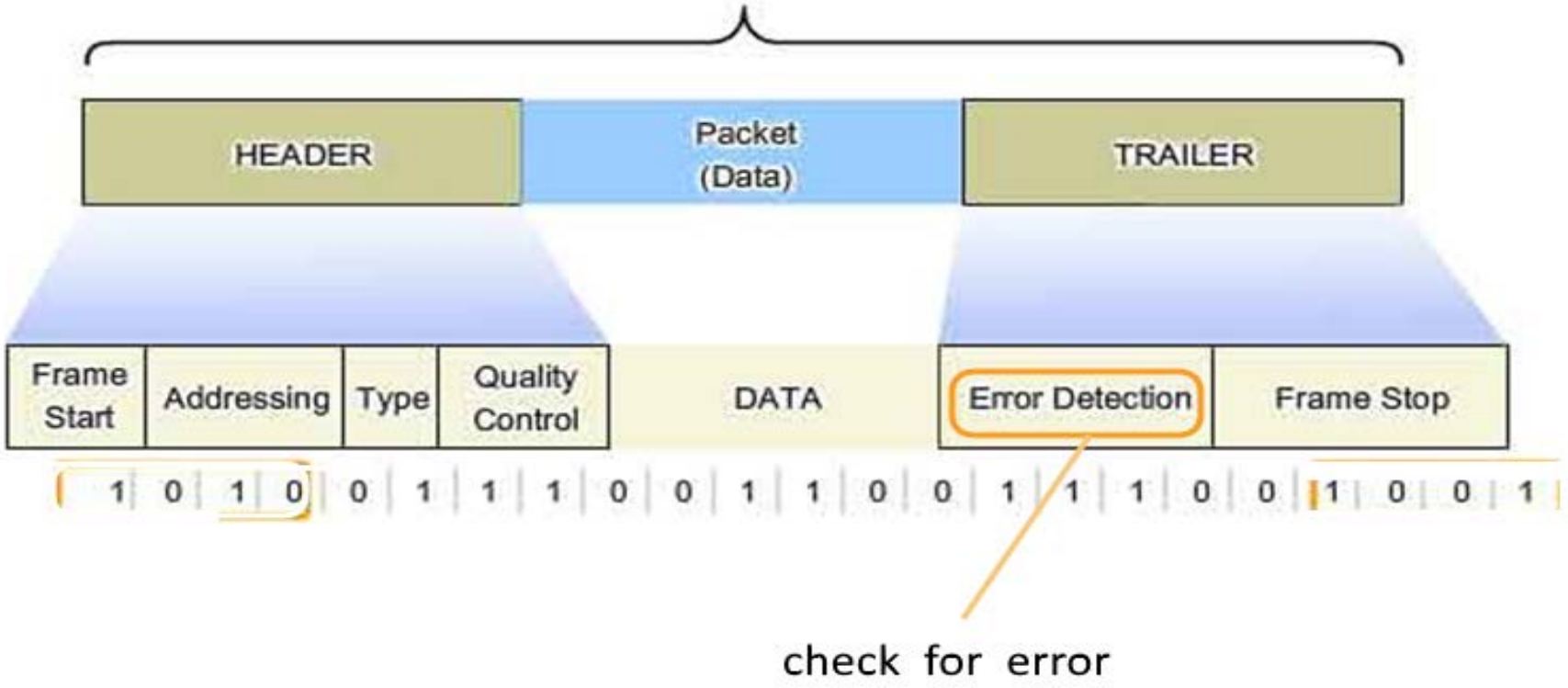
OSI Data Link Layer –
Formatting Data for Transmission

- The frame header and trailer must be of a fixed format.
- The header signals start of a packet.
- The trailers signals the end of a packet.

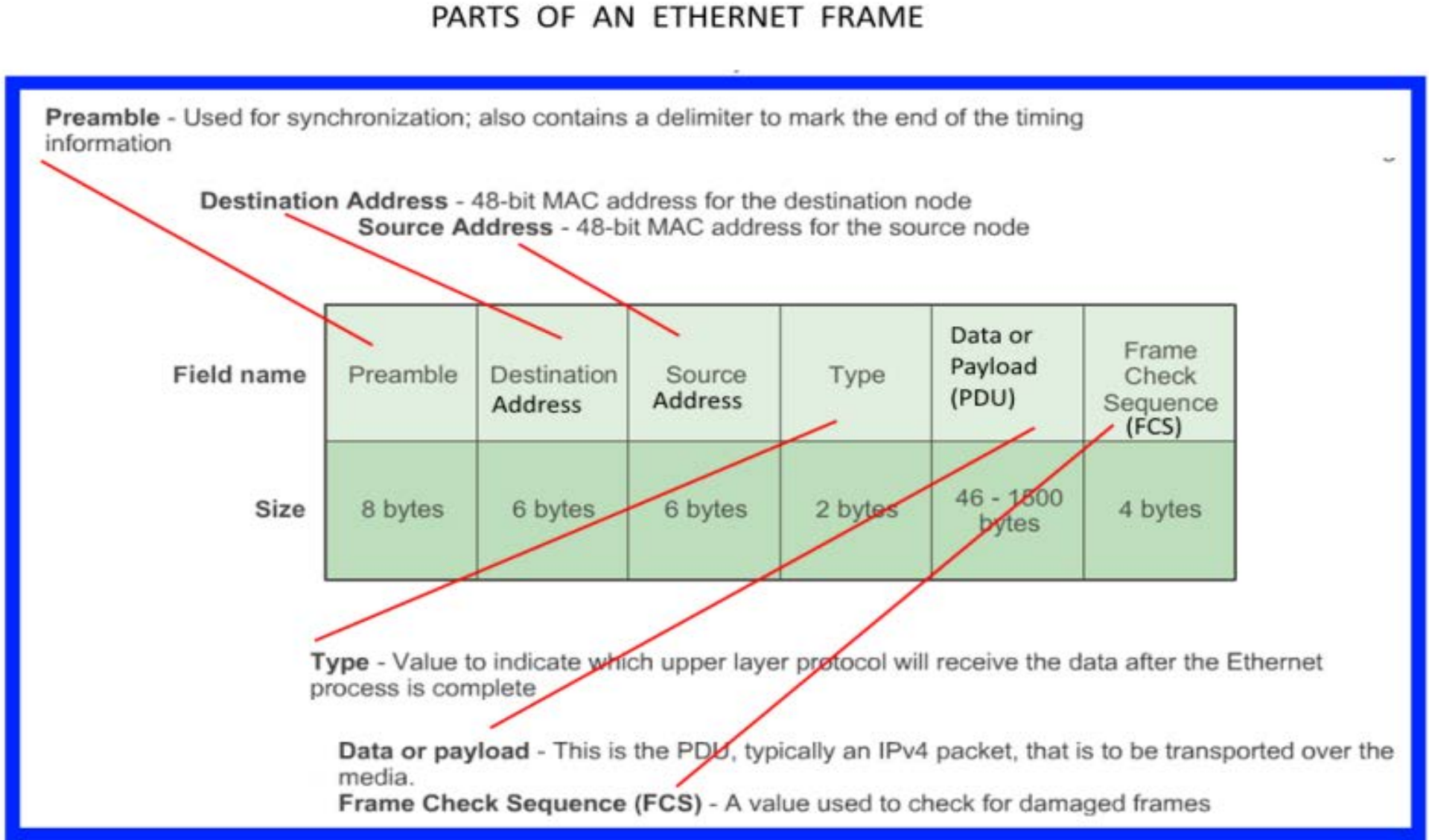


OSI Data Link Layer
Formatting Data for Transmission

- Error Detection is done. If error is detected, the frame will not be transmitted.



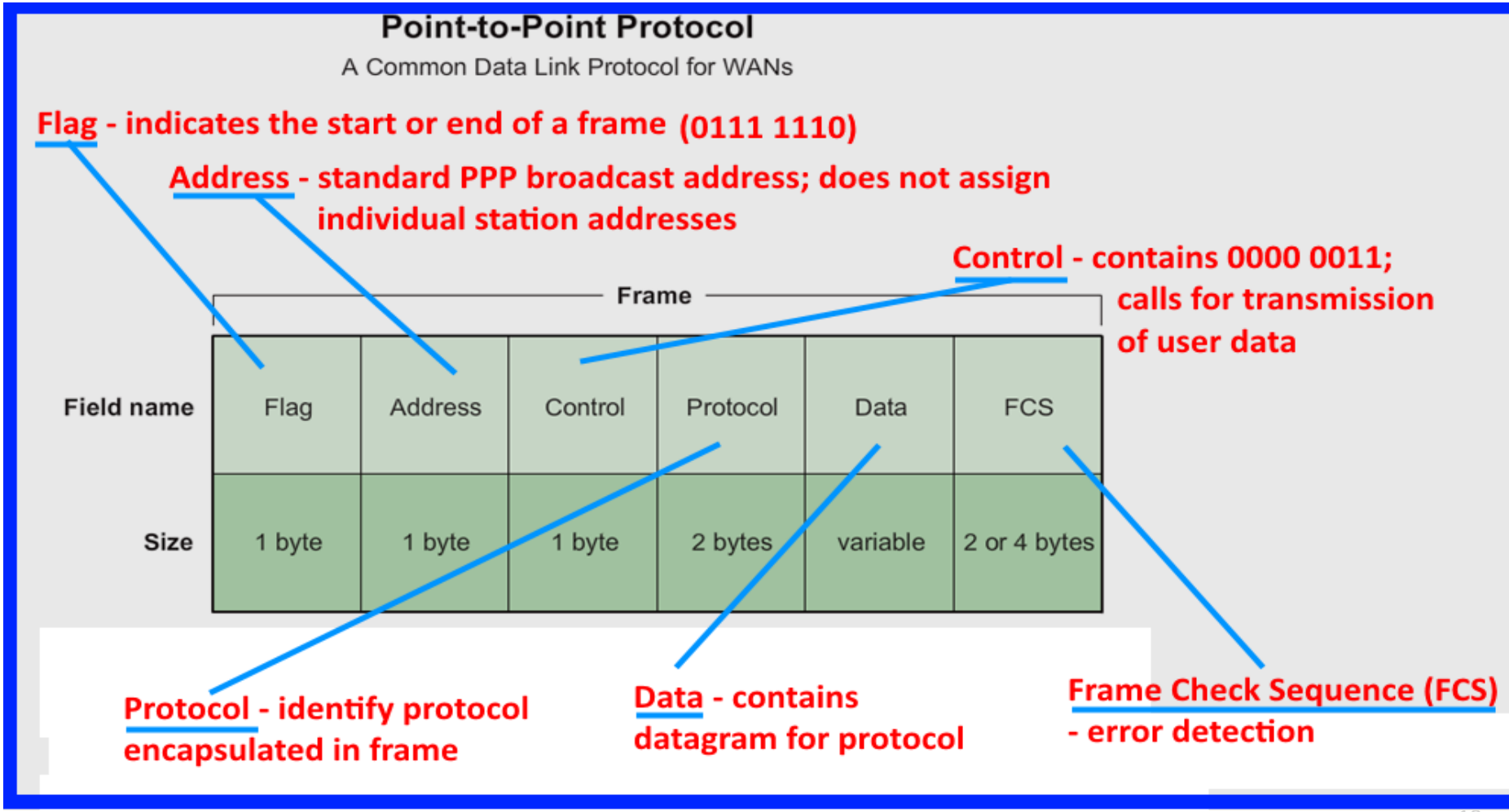
OSI Data Link Layer
Ethernet Frame, used for LANs



OSI Data Link Layer –

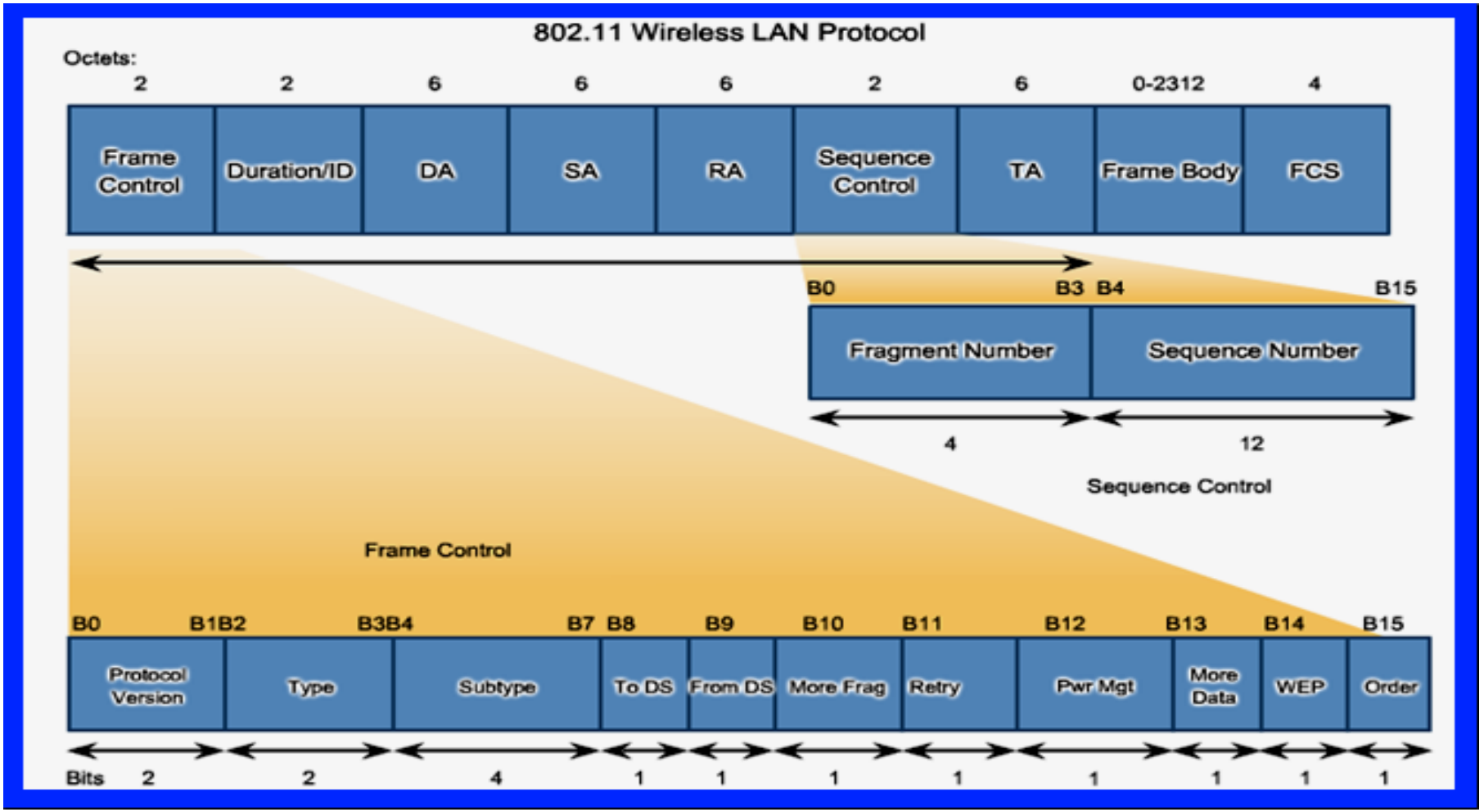
Point-to-Point Protocol (PPP) Frame, used for WANs

The PPP frame has 6 fields.
Each field contains bytes of information.

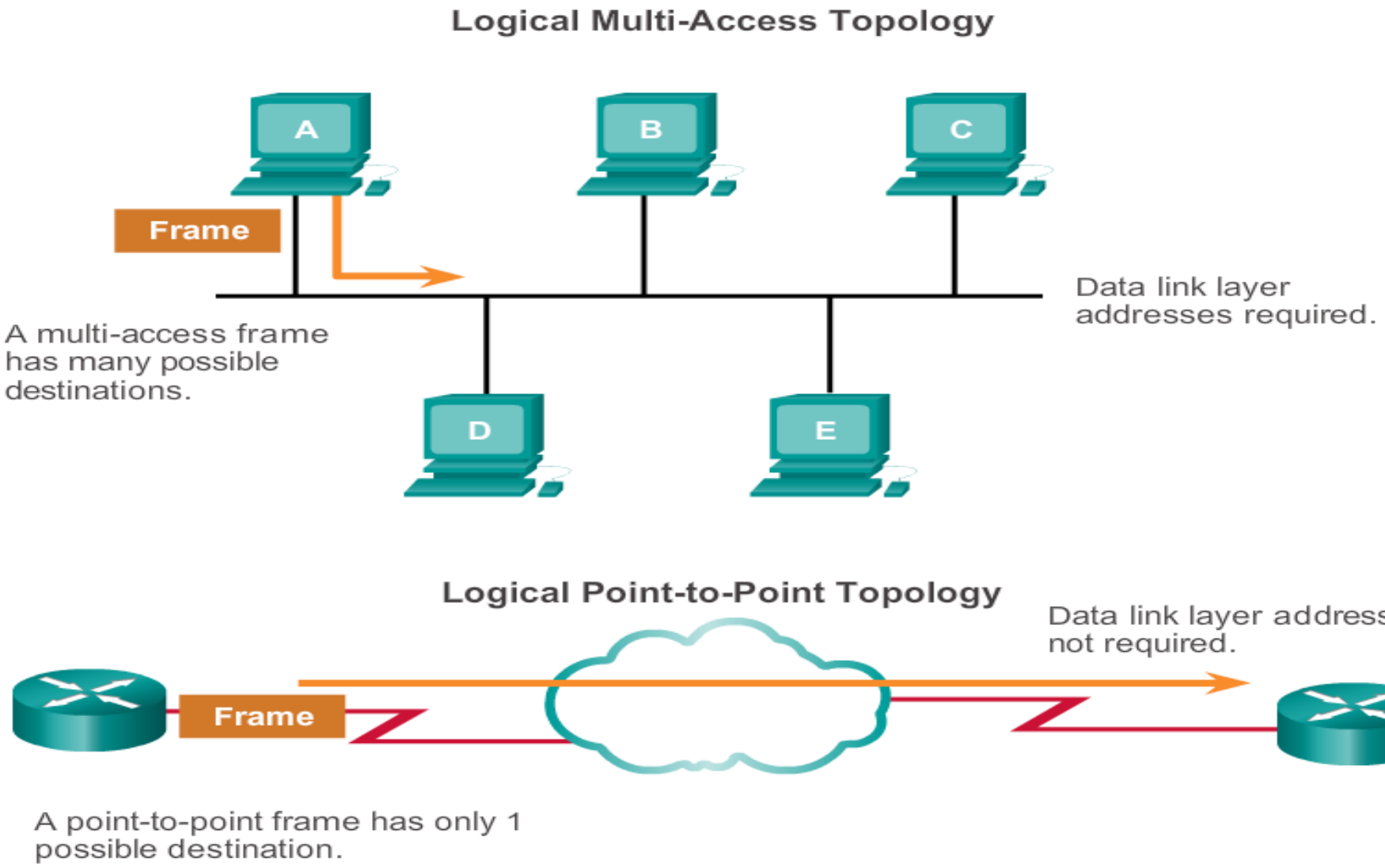


OSI Data Link Layer –
802.11 Wireless Frame

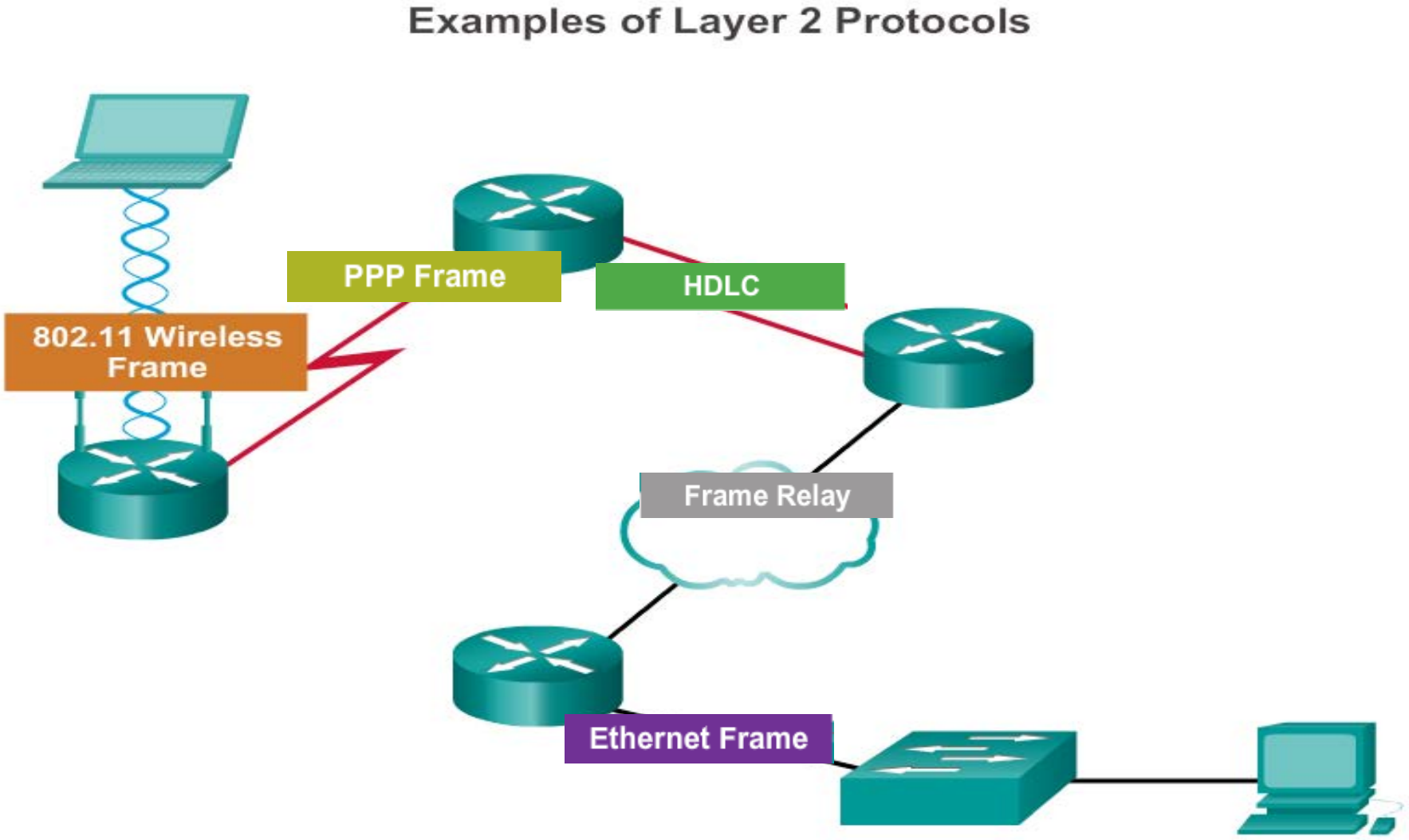
The frame for wireless transmission is more complex, with many fields.



OSI Data Link Layer –
Layer 2 Address



OSI Data Link Layer - LAN and WAN Frames



OSI Data Link Layer –
Data Link Layer Standards

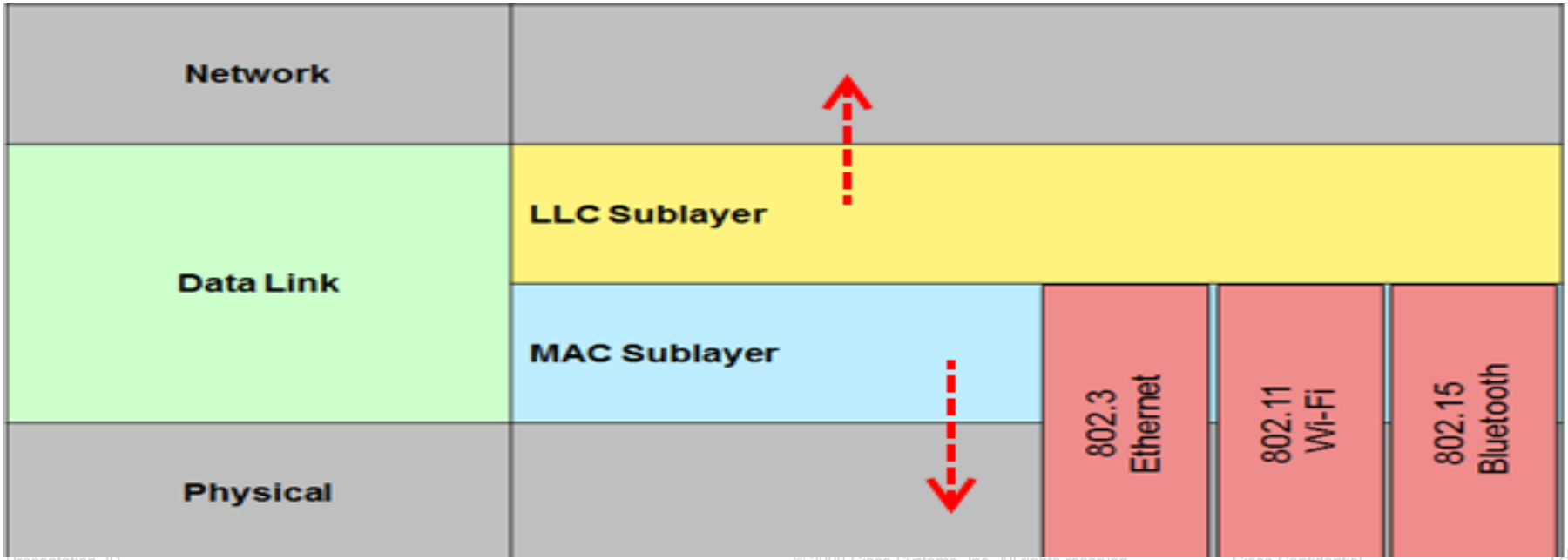
Transmission of data must follow some standards so that all hardware can communicate

Standard organization	Networking Standards
IEEE	• 802.2: Logical Link Control (LLC) • 802.3: Ethernet • 802.4: Token bus • 802.5: Token passing • 802.11: Wireless LAN (WLAN) & Mesh (Wi-Fi certification) • 802.15: Bluetooth • 802.16: WiMax
ITU-T	• G.992: ADSL • G.8100 - G.8199: MPLS over Transport aspects • Q.921: ISDN • Q.922: Frame Relay
ISO	• HDLC (High Level Data Link Control) • ISO 9314: FDDI Media Access Control (MAC)
ANSI	• X3T9.5 and X3T12: Fiber Distributed Data Interface (FDDI)

OSI Data Link Layer
Data Link Sublayers

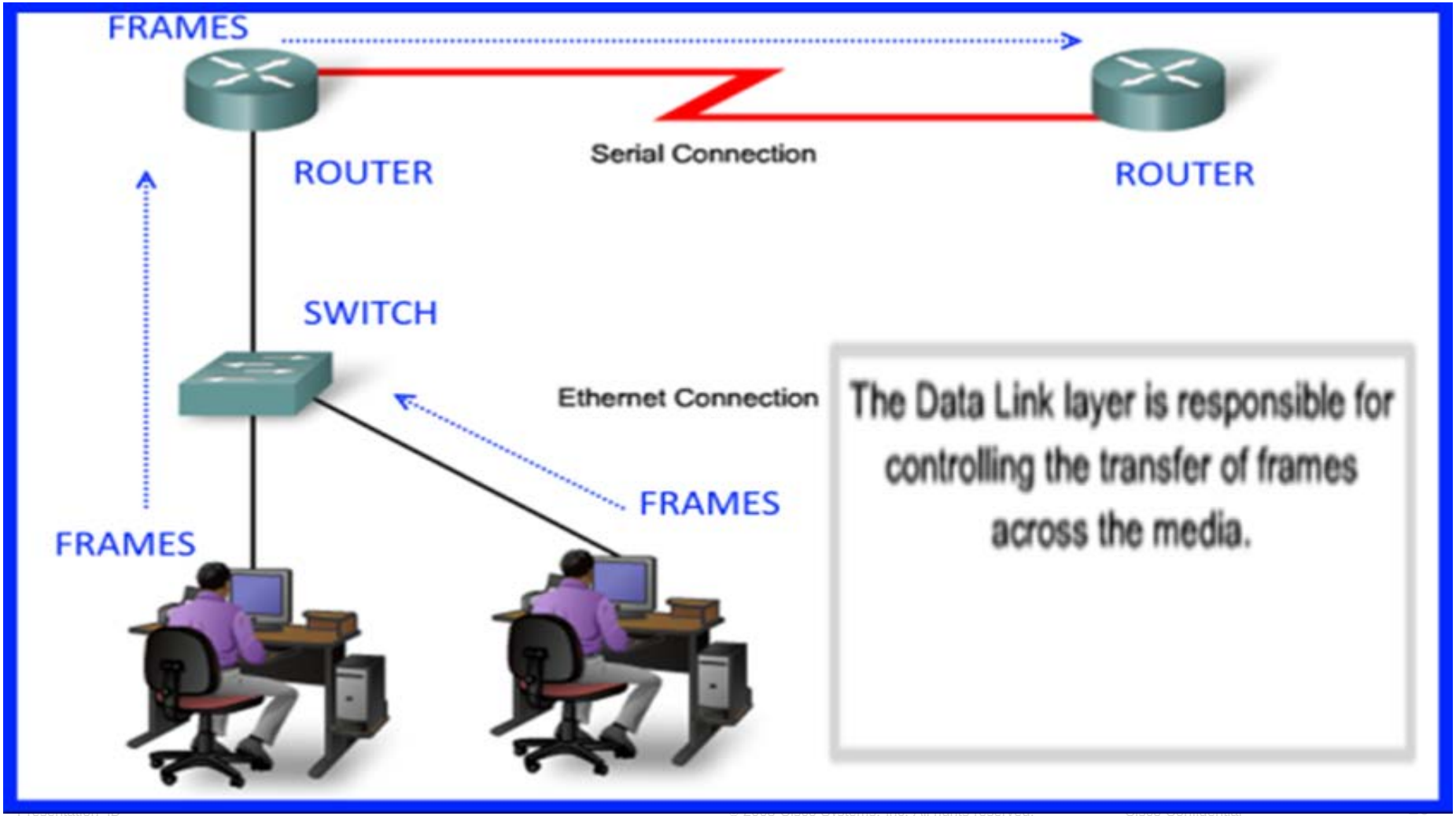
This layer has 2 sub-layers:

- LLC (Logical Link Control) Layer interacts with Network Layer
- MAC (Media Access Control) Layer interacts with Physical Layer



OSI Data Link Layer –
Media Access Control (MAC) Sublayer

Data Link Layer controls the transfer of frames.



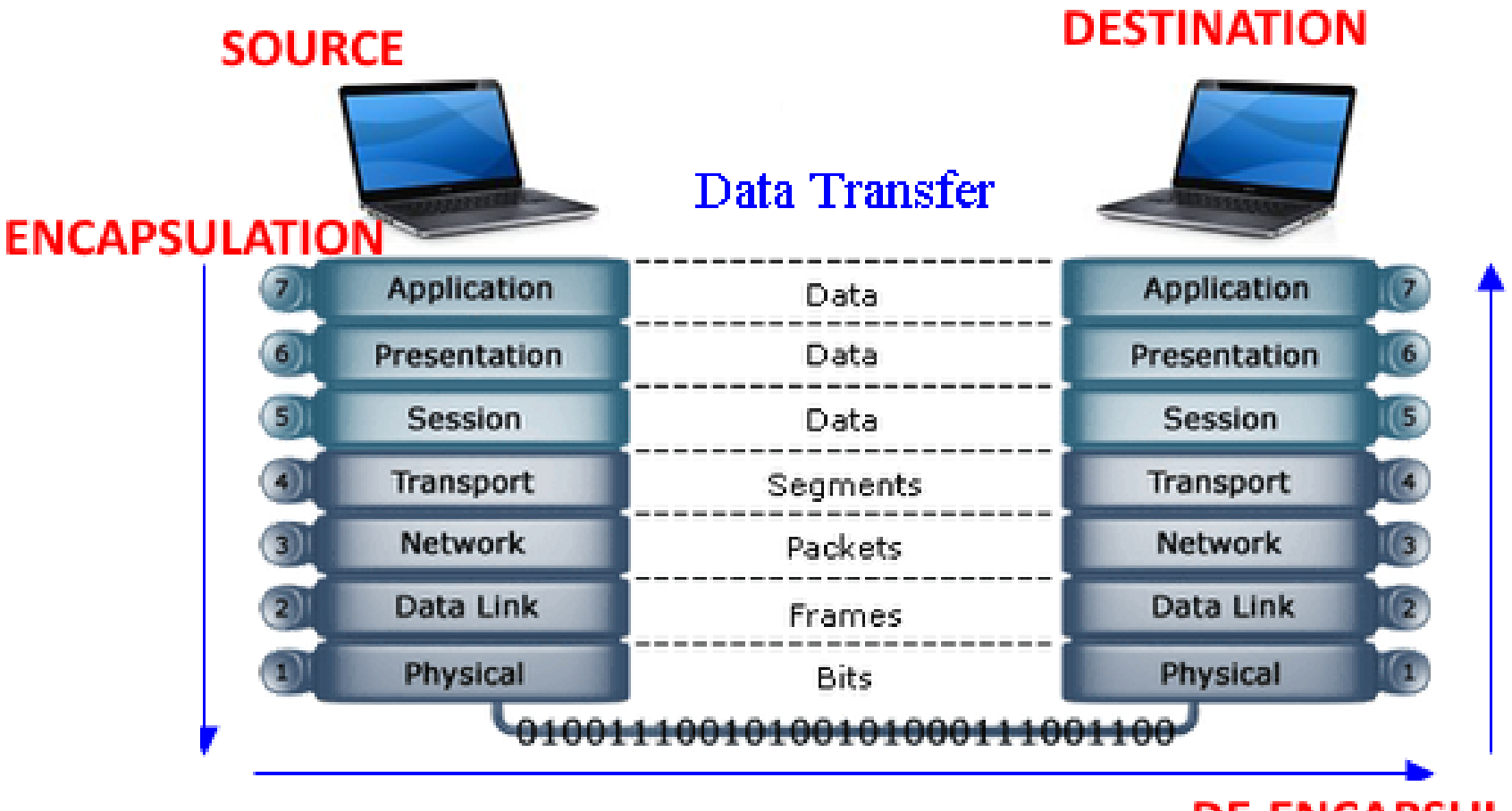
OSI Data Link Layer –

Summary of data transfer

Data from a source go through the 7 layers (7 to 1) during encapsulation.

Bits sent from one source goes through the 7 layers (1 to 7) during de-encapsulation.

Device at destination receives data sent.



OSI Data Link Layer
Topology

OSI Data Link Layer
Topology

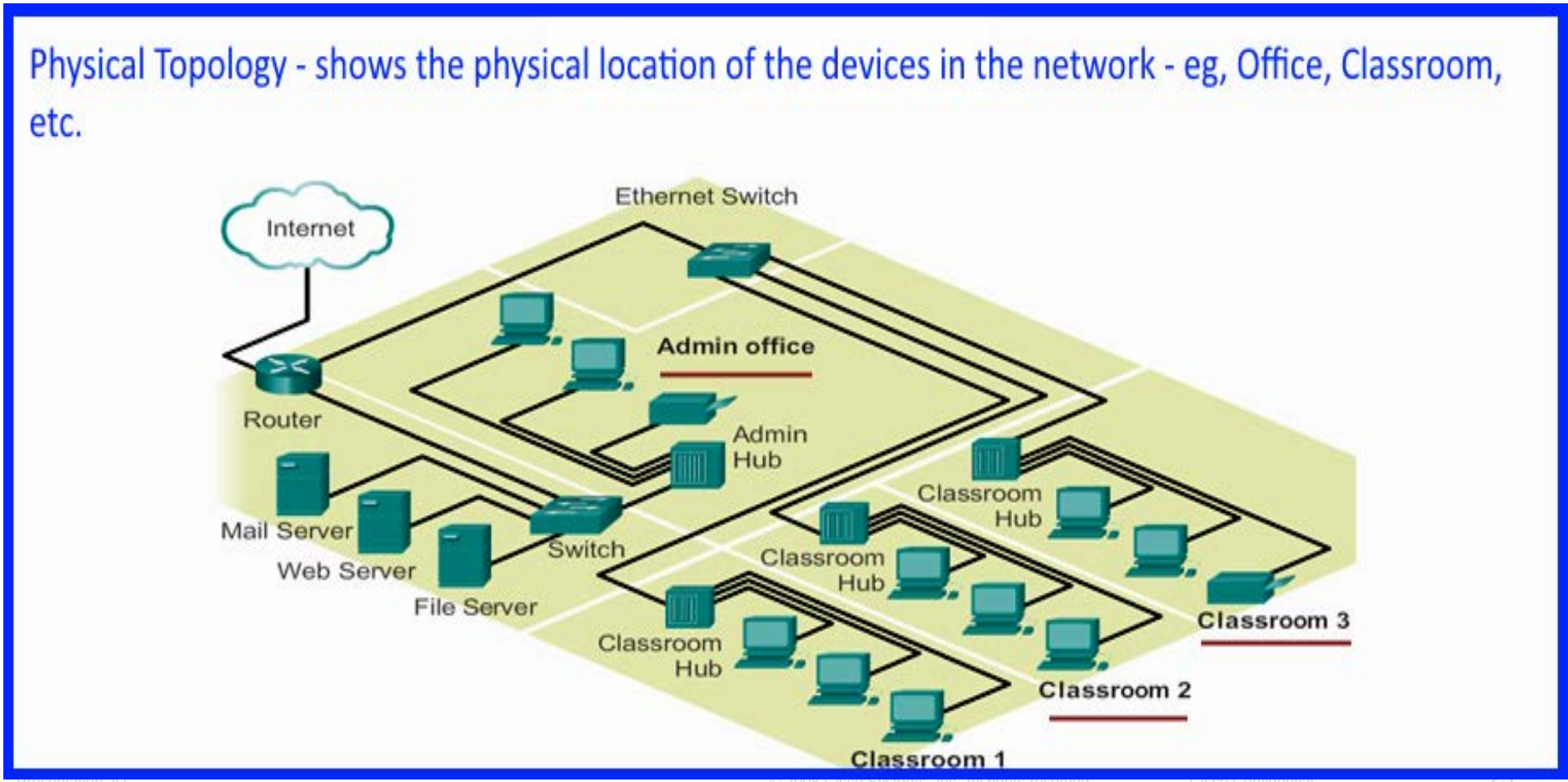
Topology is the way in which constituent parts are interrelated or arranged.

There are two types of network topology:

- Physical
- Logical

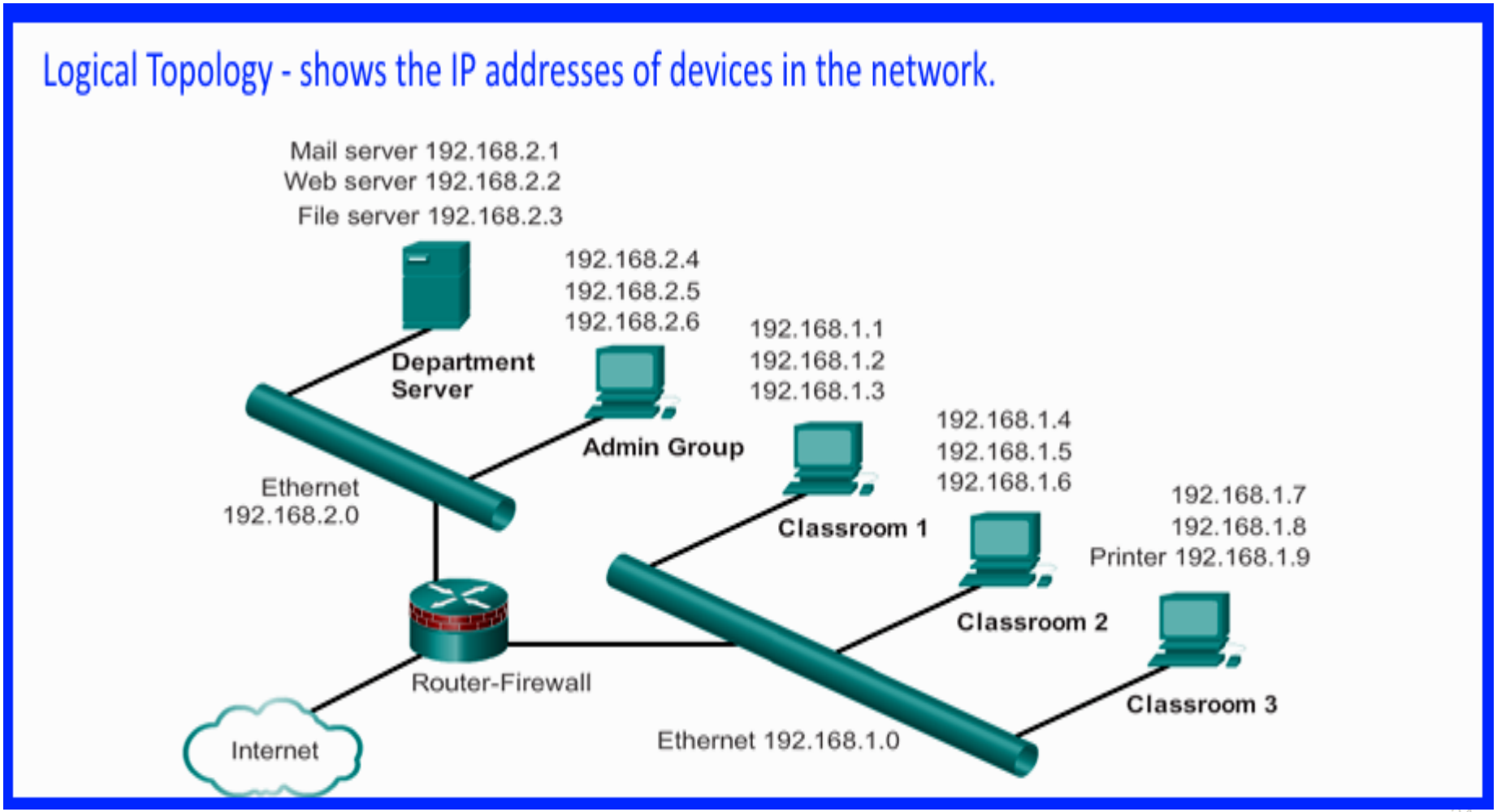
OSI Data Link Layer - Physical Topology

Physical topology is the placement of the various components of a network, including device location and cable installation.



OSI Data Link Layer - Logical Topology

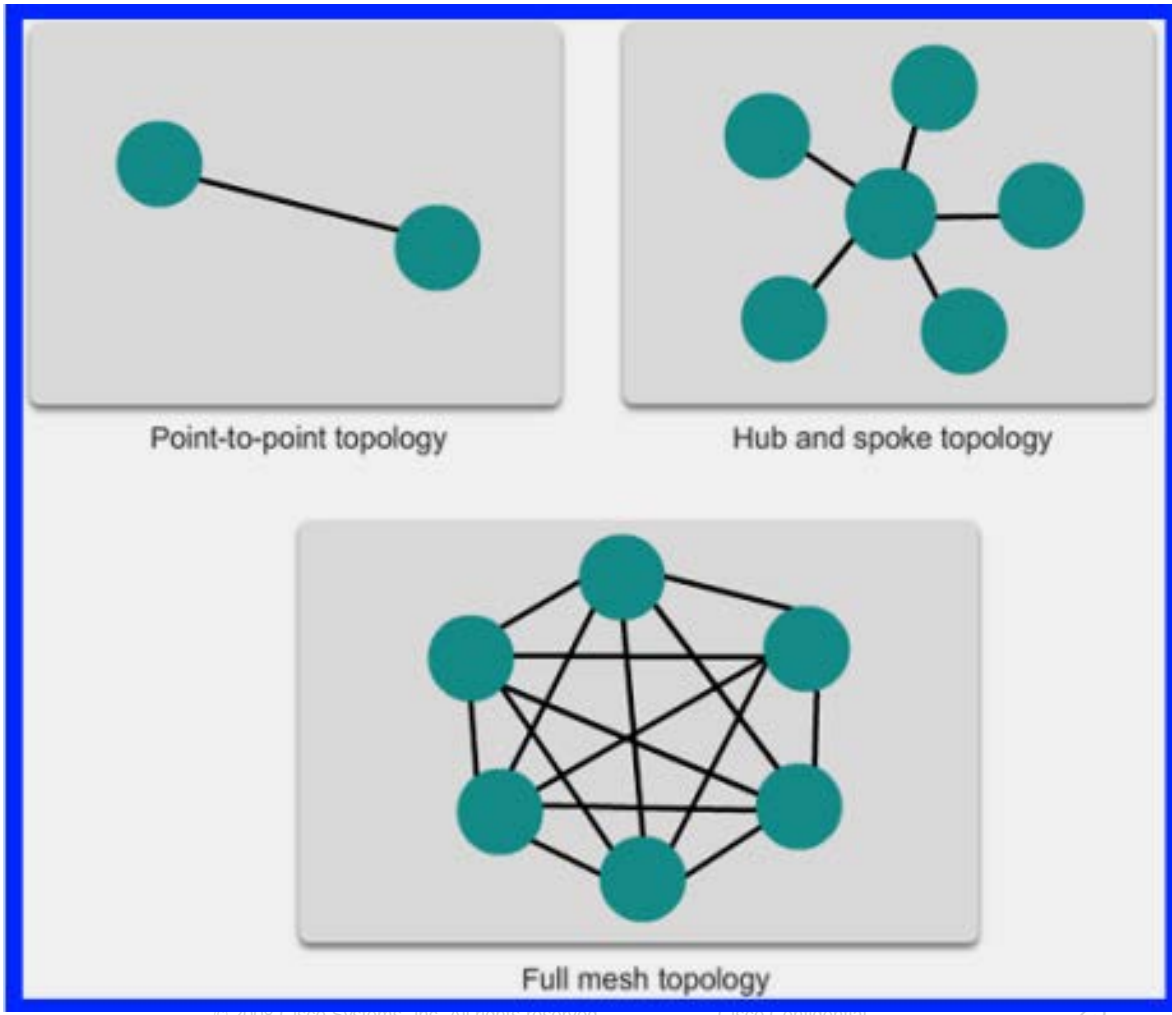
Logical topology illustrates how data flows within a network, regardless of its physical design.



OSI Data Link Layer –
Common Physical WAN Topologies

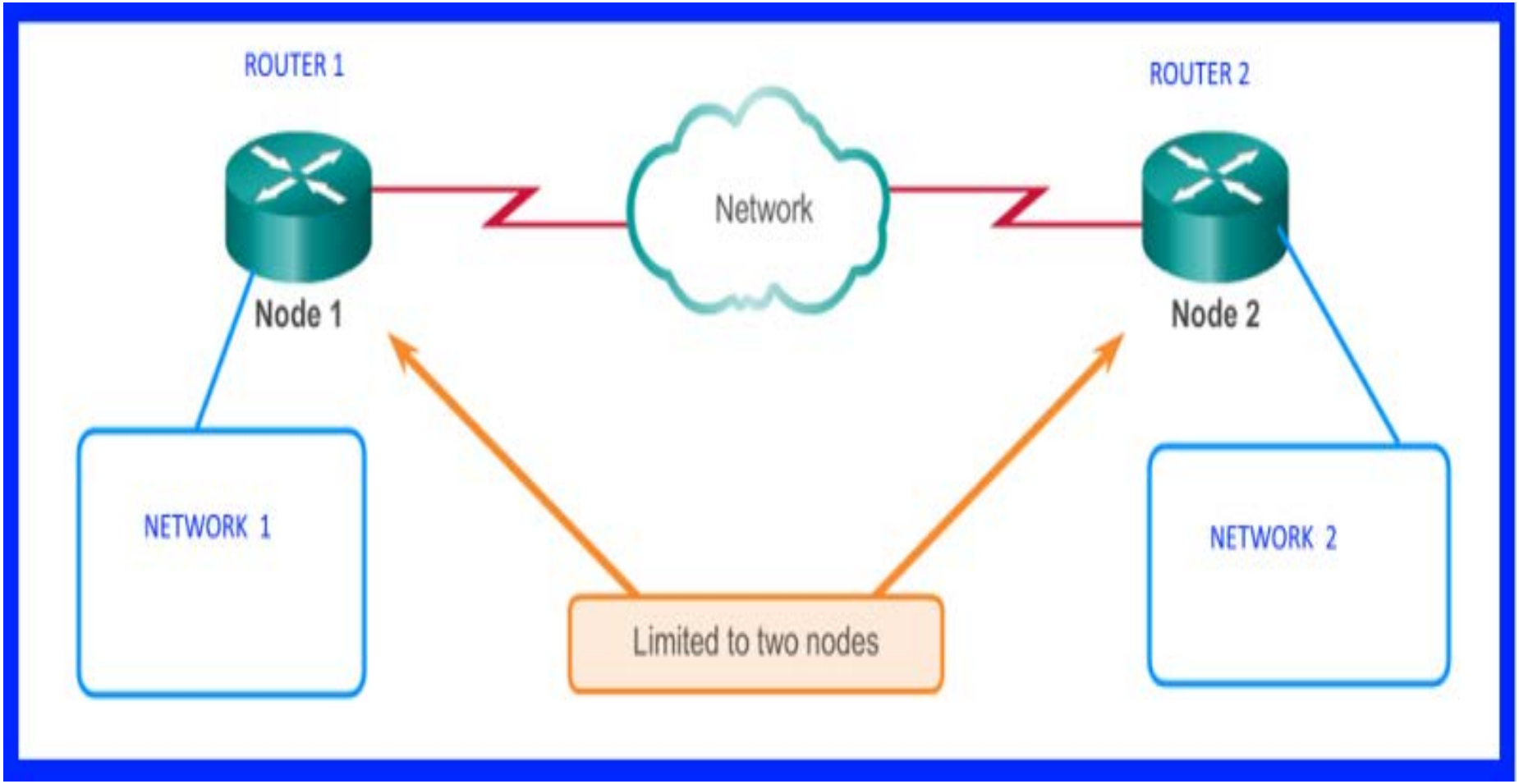
Common Physical WAN Topologies include:

- Point-to-Point
- Hub and Spoke
- Full Mesh



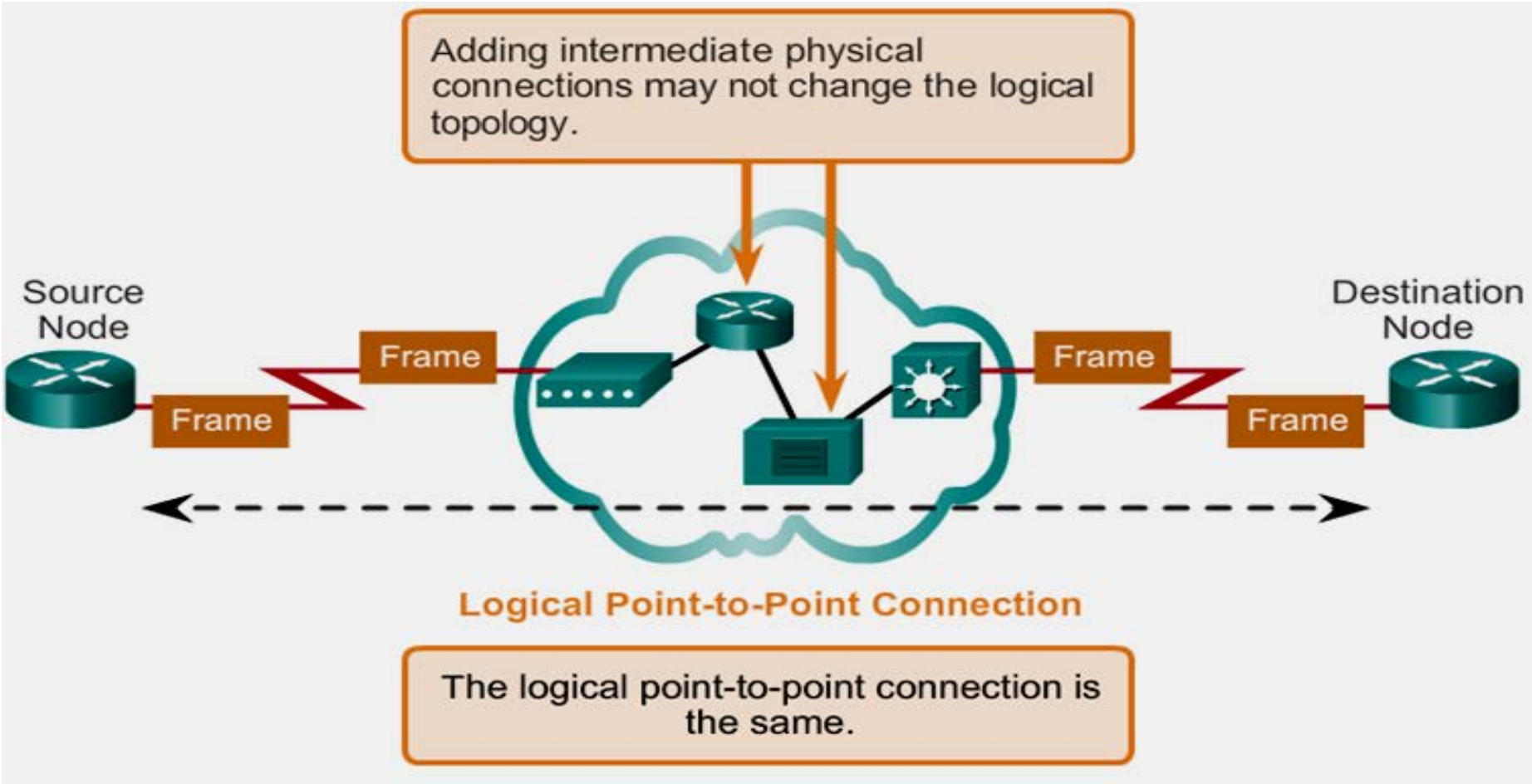
OSI Data Link Layer –
WAN Physical Point-to-Point Topology

Point-to-Point Topology is limited to having 2 nodes.



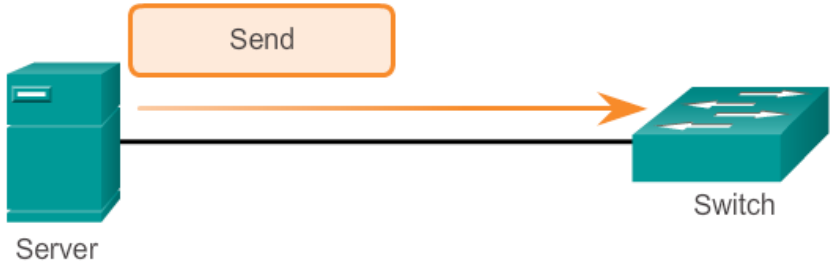
OSI Data Link Layer -
WAN Logical Point-to-Point Topology

Adding more devices or changing locations do not affect the logical topology of a network.

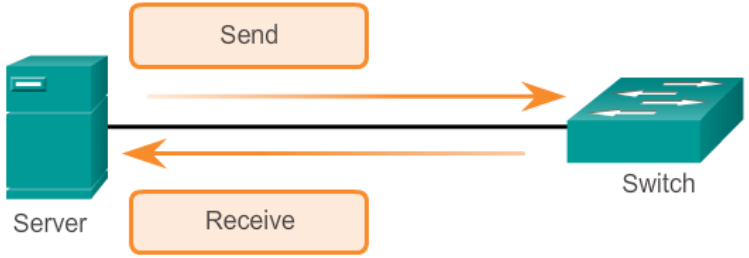


OSI Data Link Layer –
WAN Half- and Full-Duplex

Half-Duplex – Data can be sent in one direction at any one time.



Full-Duplex – Data can be sent/received in both directions at the same time.
Faster data transfer can be achieved.

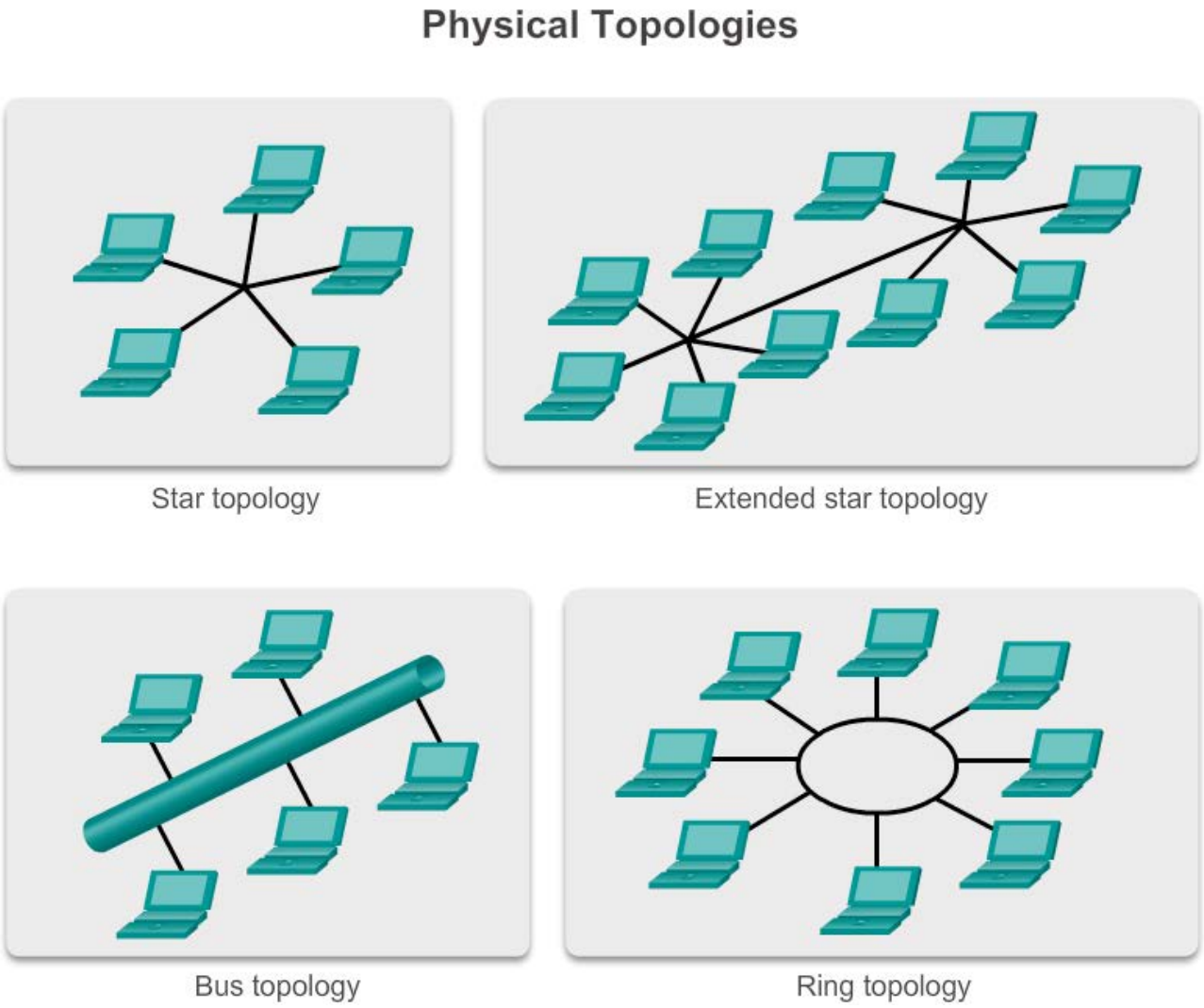


OSI Data Link Layer –
Physical LAN Topologies

WAN Topologies – some are same as

LAN Topologies, some are not

OSI Data Link Layer –
Physical LAN Topologies



OSI Data Link Layer –
LAN Logical Topology for Shared Media

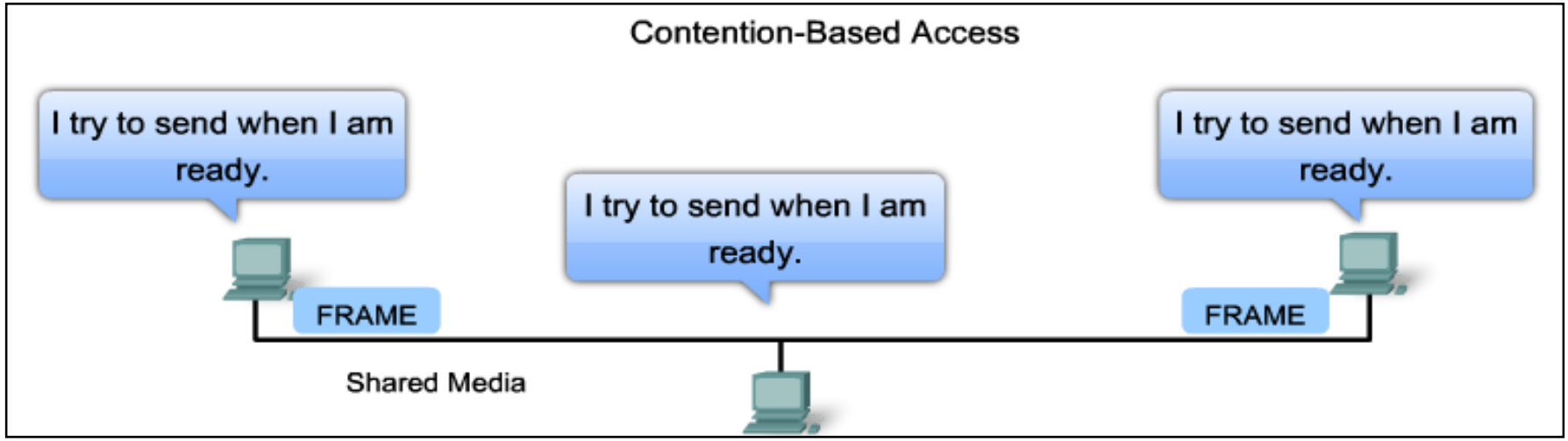
There are two methods of sharing media (data) in a LAN:

- Contention-based Access Method
- Controlled Access Method

OSI Data Link Layer –
LAN Logical Topology for Shared Media

Contention-Based Access Method
This method is based on devices contending to send data whenever there is room for traffic in the network.

Characteristics	Contention-Based Technologies
• Stations can transmit at any time • Collision of frames can take place as there is no control of transmission • There are mechanisms to resolve contention for the media	• CSMA/CD for 802.3 Ethernet networks • CSMA/CA for 802.11 wireless networks

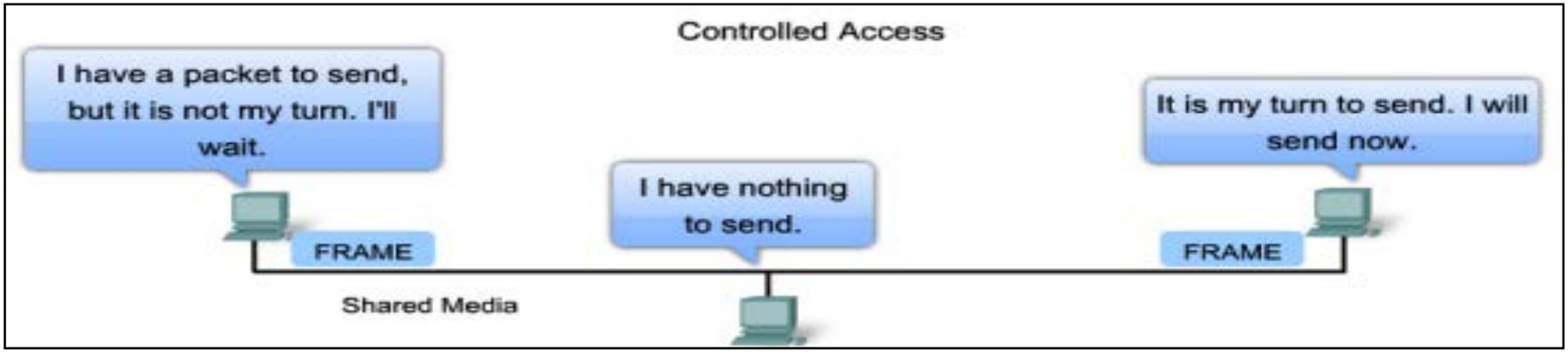


OSI Data Link Layer –
LAN Logical Topology for Shared Media

Controlled Access Method

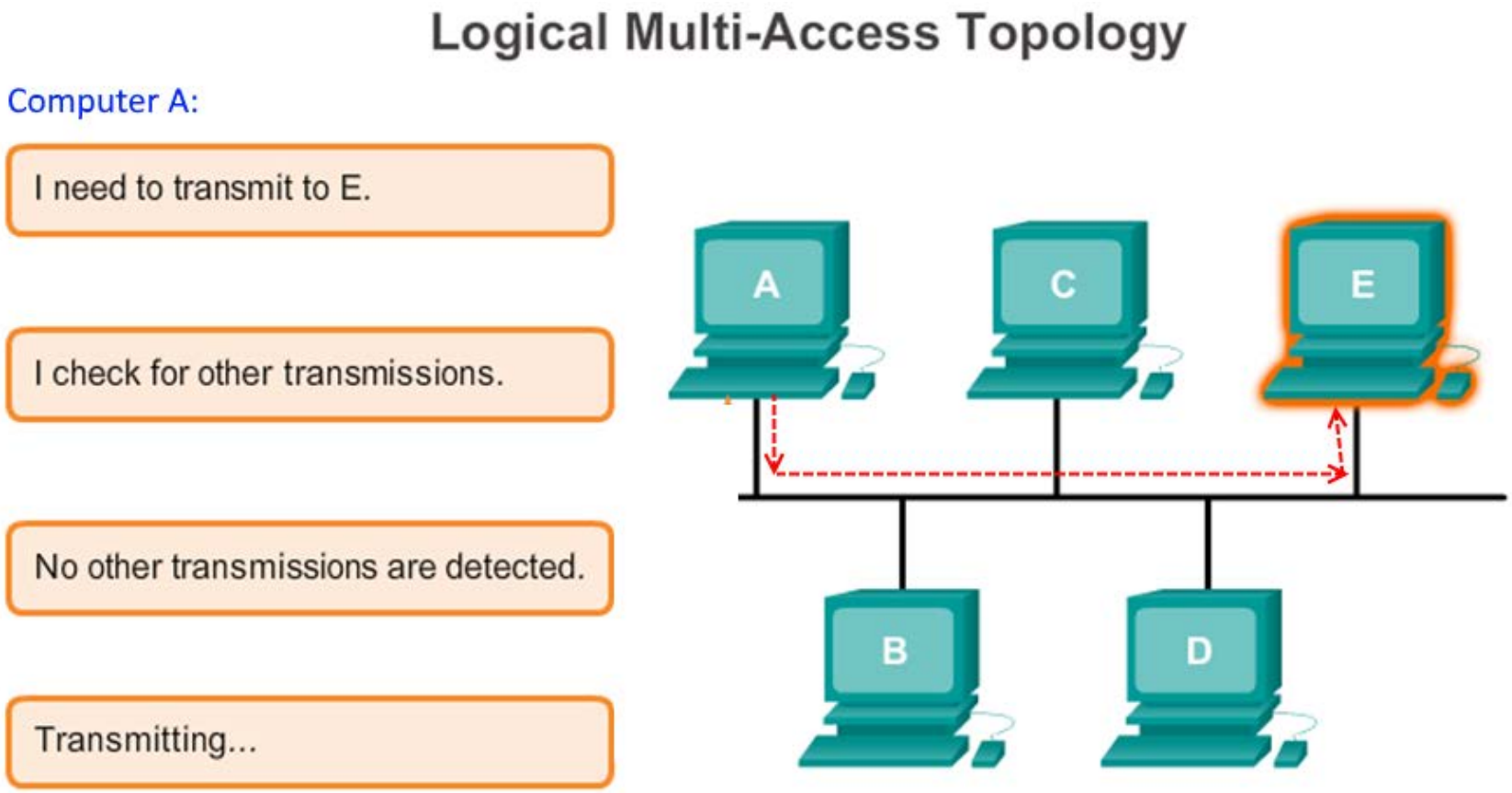
This method allows a device to send data only when it is given the right.

Characteristics	Controlled Access Technologies
• Only one station can transmit at a time • Devices wanting to transmit must wait their turn • No collisions of frames at all • May use a token passing method (token passing - a signal called a token is passed between nodes; it authorizes the node to communicate	• Token Ring (IEEE 802.5) • FDDI



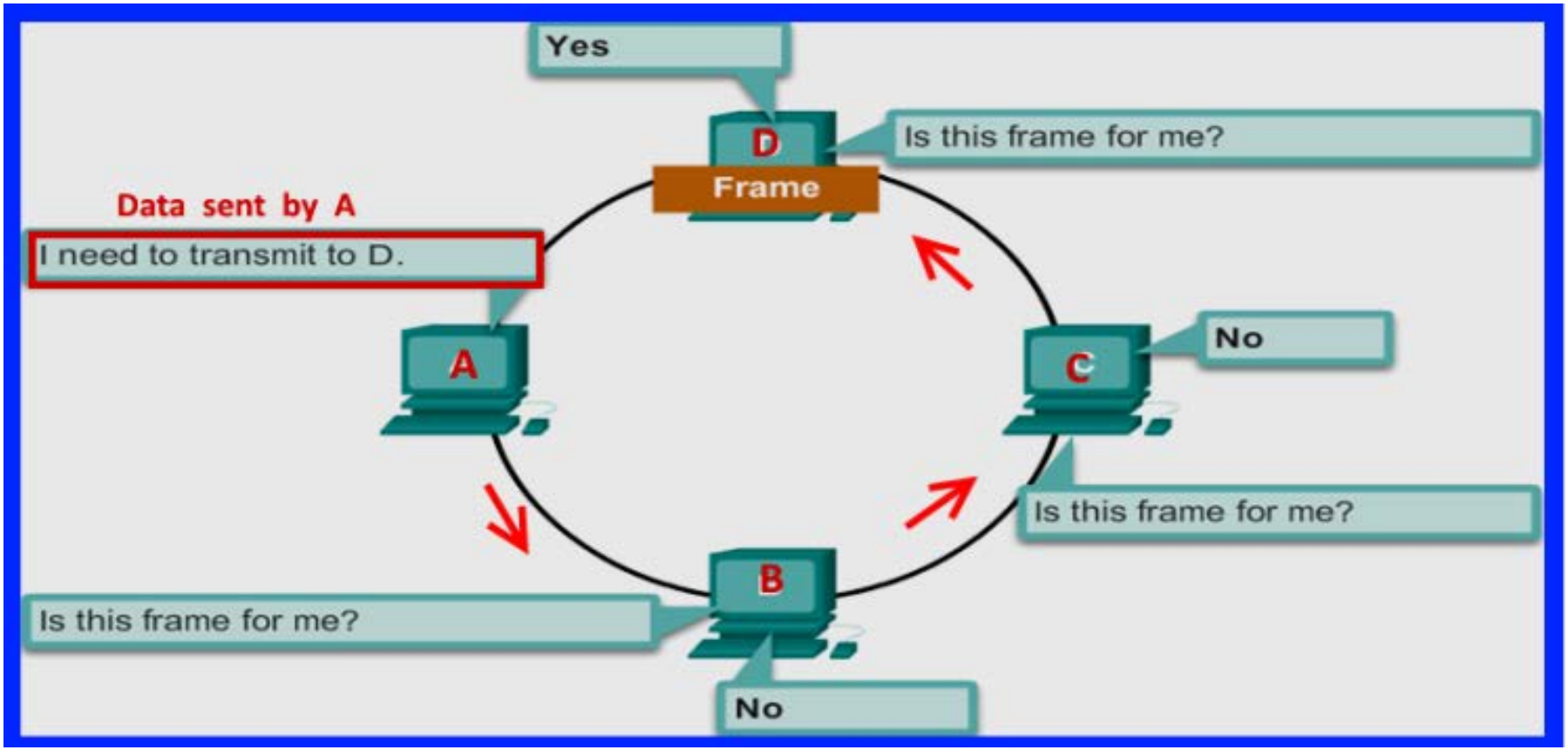
OSI Data Link Layer –
LAN Multi-Access Topology

Only one device is allowed to transmit data at any one time.



OSI Data Link Layer – LAN Ring Topology

In a LAN Ring Topology, a frame sent out stops at every device.
If it is not meant for the device, the frame is sent to the next, until one device accept the frame.
This is time consuming.



OSI Data Link Layer –

Fragile vs Protected Environment

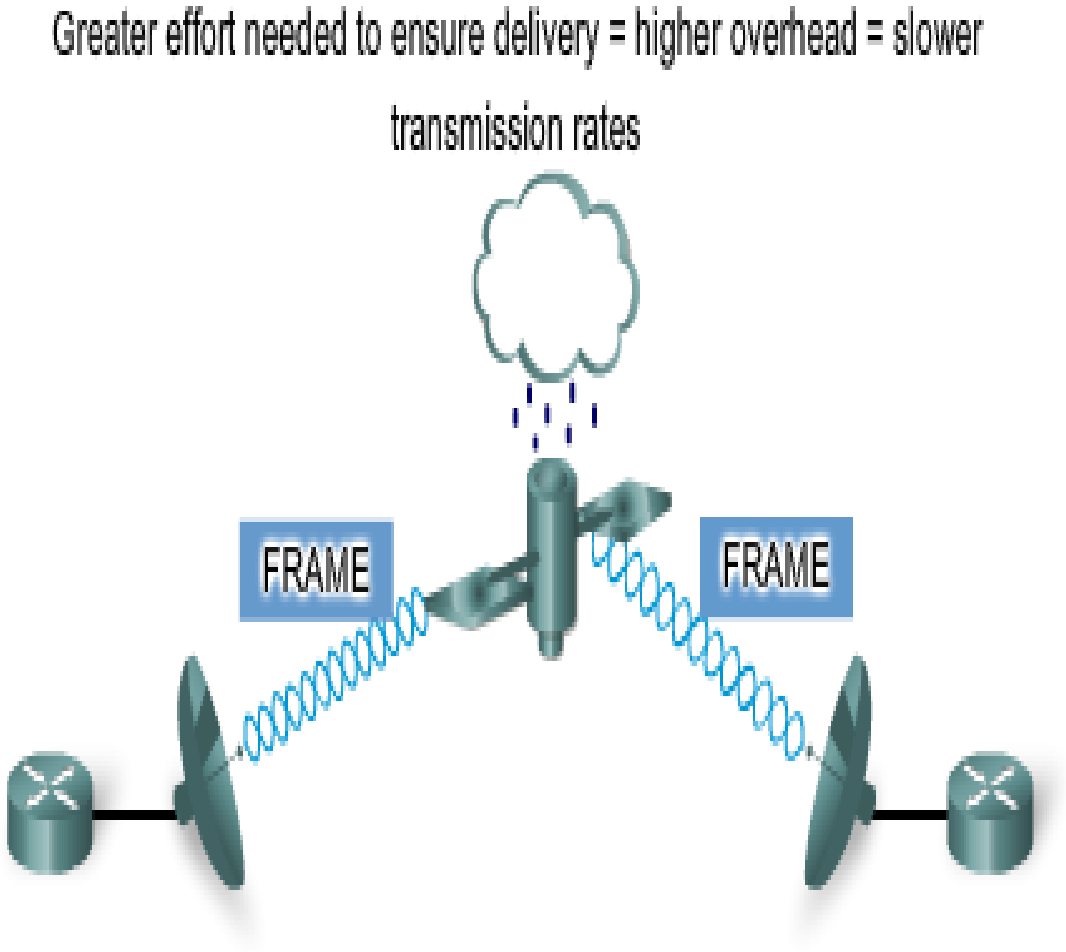
There are two network environments:

- Fragile environment
  Open air, weather interference, uncontrolled factors, etc.
- Protected environment
  In a building, all factors controllable

OSI Data Link Layer –

Fragile Environment

In a fragile environment, more controls are needed to ensure delivery. The header and trailer fields are larger as more control information is needed.

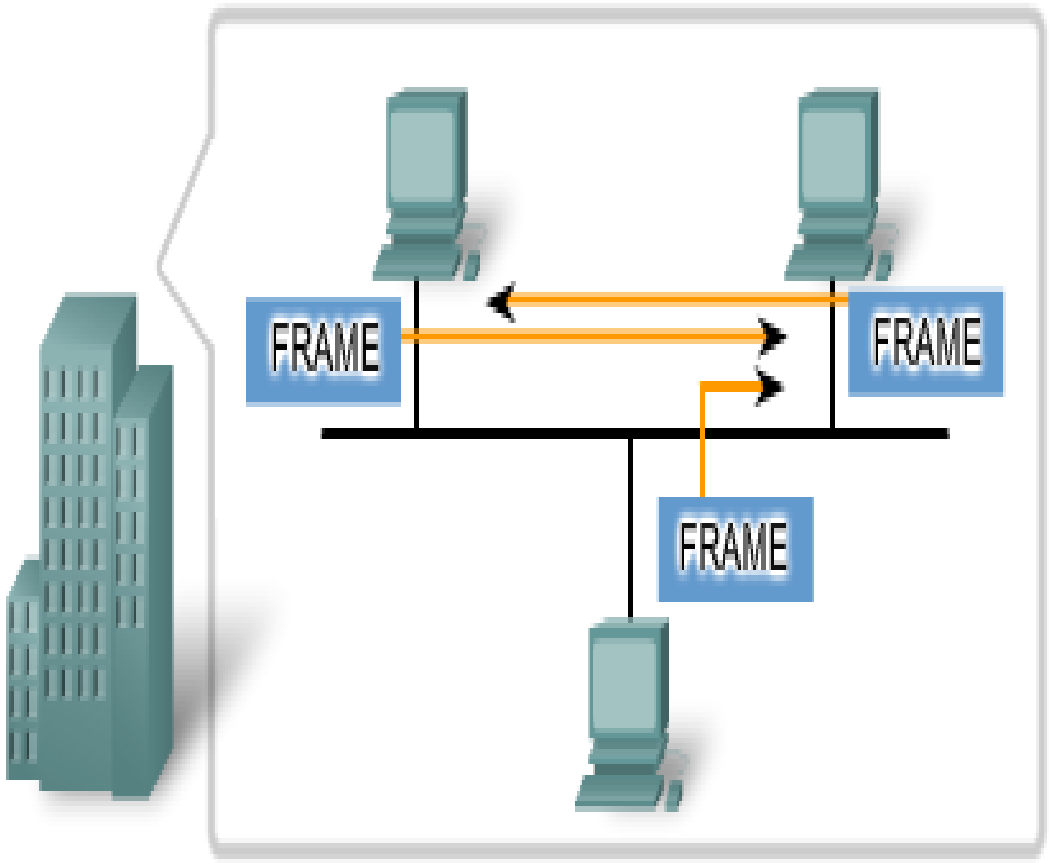


OSI Data Link Layer –

Protected Environment

In a protected environment, we can count on the frame arriving at its destination. Fewer controls are needed, resulting in smaller fields and smaller frames.

Less effort needed to ensure delivery = lower overhead = faster transmission rates



Review

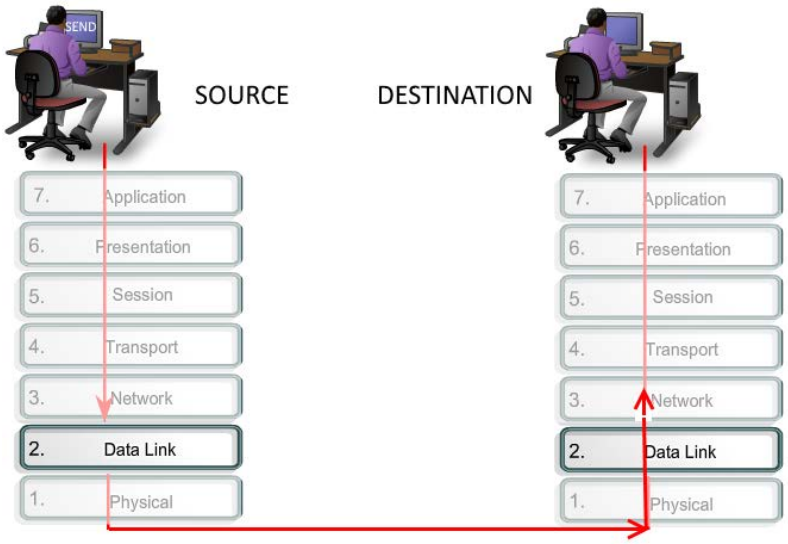
1. The OSI has ___ layers.

The Data Link Layer is the _____ layer, just above the Physical Layer.

Review

1. The OSI has 7 layers.

The Data Link Layer is the second layer, just above the Physical Layer.



Review

2. This data link layer is the _____ layer.
It _____ data between adjacent network nodes.

It is concerned with local delivery of frames between devices.
A _____ is a digital data transmission unit.

Review

3. The Data Link Layer protocols govern how to format a _____.

Review

3. The Data Link Layer protocols govern how to format a frame.

Review

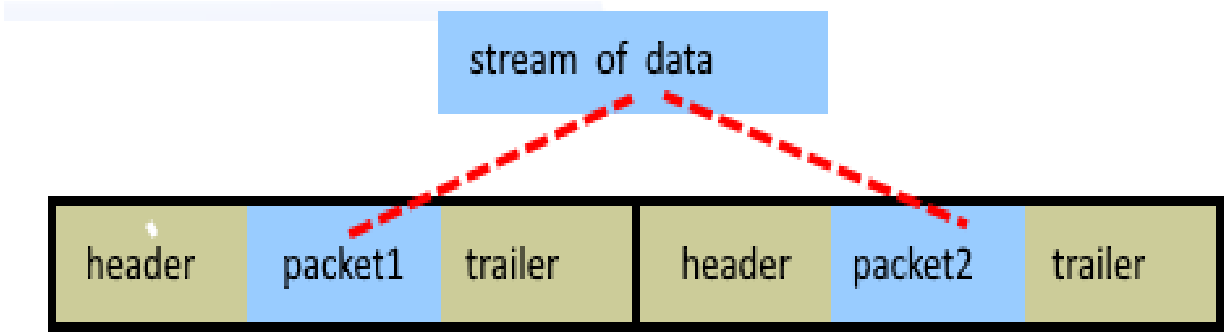
4. _____ is a technique performed by the Data Link layer.

It _____ the bit stream into discrete frames.

Review

4. Framing is a technique performed by the Data Link layer.

It breaks the bit stream into discrete frames.



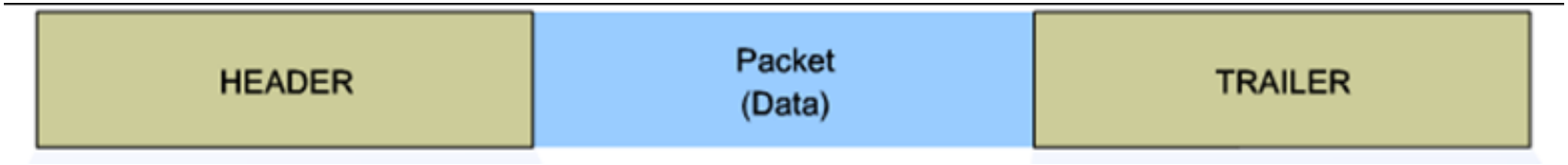
Review

5. A frame comprises,

- A _____
- A _____
- A trailer

Review

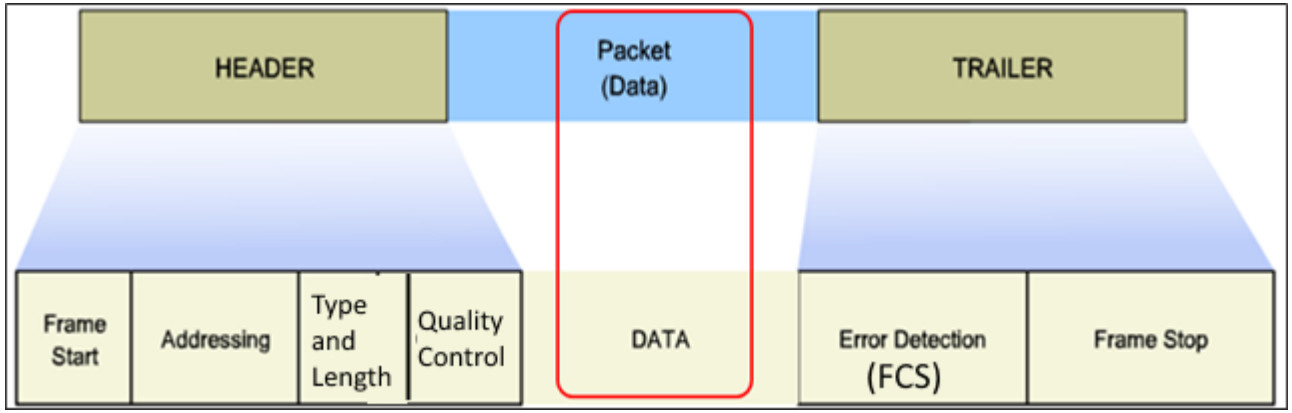
5. A frame comprises,
- A header
- A packet
- A trailer



OSI Data Link Layer - The Data Link Header

6. A frame consists of a header, data, and a trailer. A header consists of a _____ frame, address type and control.
A trailer consists of a _____ (Frame Check Sequence) and stop frame.

OSI Data Link Layer - The Data Link Header



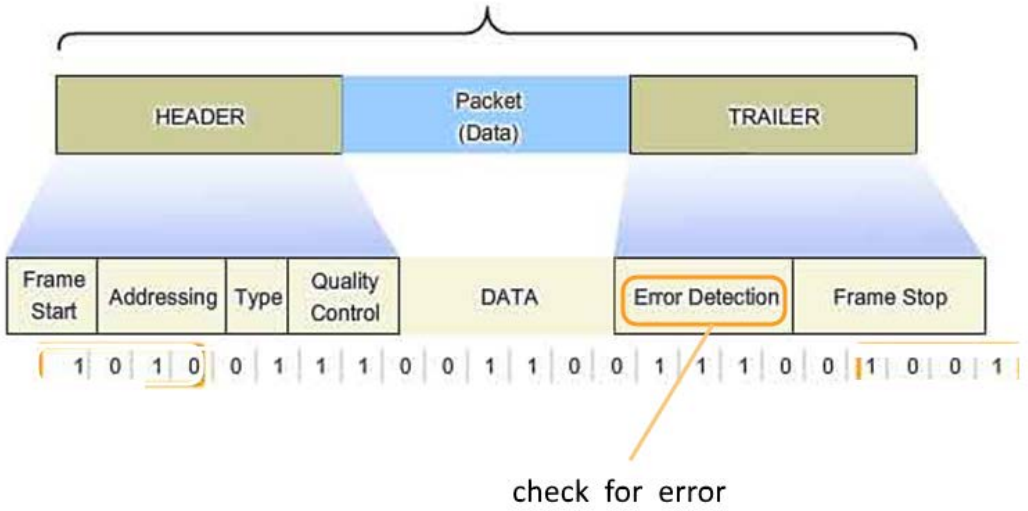
6. A frame consists of a header, data, and a trailer. A header consists of a start frame, address type and control.
A trailer consists of a FCS (Frame Check Sequence) and stop frame.

Review

7. _____ Detection for the frame is done. If error is detected, the frame will _____ be transmitted.

Review

7. Error Detection for the frame is done. If error is detected, the frame will not be transmitted.



Review

8. PPP stands for _____

The PPP frame has ___ fields.

Each field contains bytes of information.

Review

8. PPP stands for Point-to-Point Protocol.

The PPP frame has 6 fields.

Each field contains bytes of information.

Review

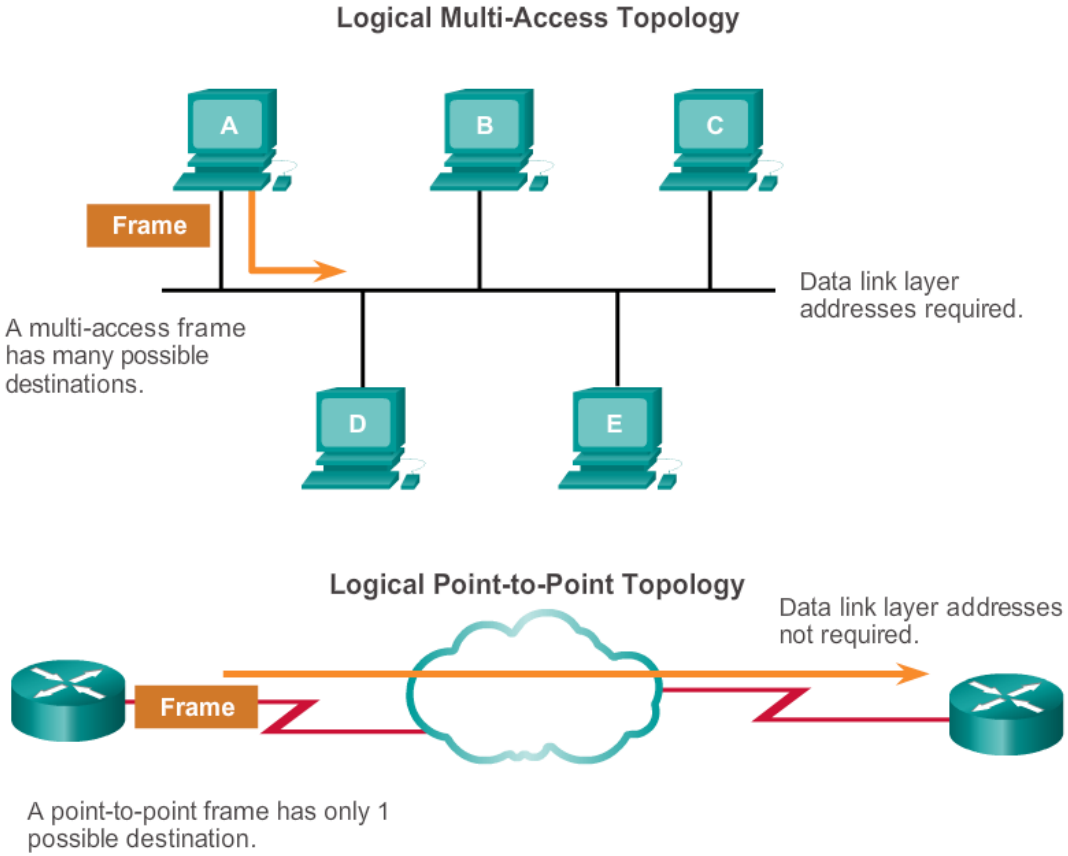
9. A multi-access frame has _____ destinations, while

A point-to-point access frame has ____ destination.

Review

9. A multi-access frame has many destinations, while

A point-to-point access frame has only one destination.



Review

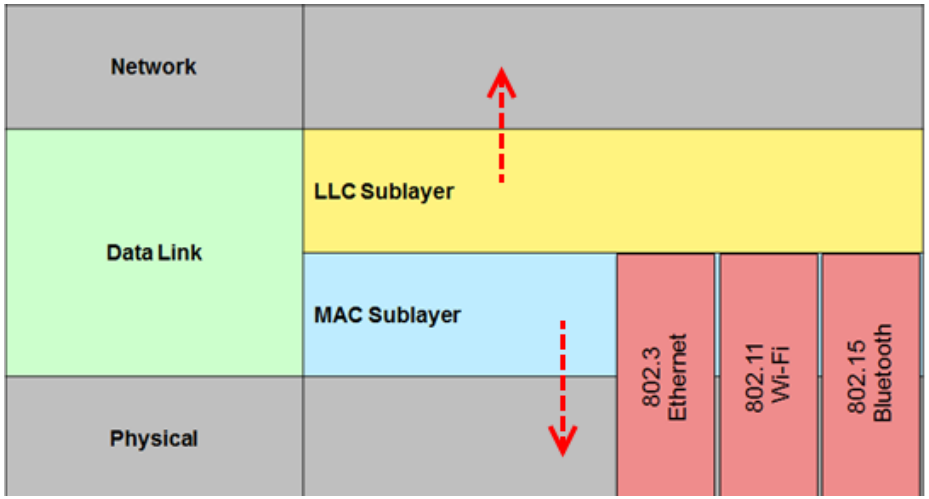
10. The Data Link layer has 2 _____:

- LLC (Logical Link Control) Layer interacts with Network Layer
- MAC (Media Access Control) Layer interacts with Physical Layer

Review

10. The Data Link layer has 2 _____:

- LLC (Logical Link Control) Layer interacts with Network Layer
- MAC (Media Access Control) Layer interacts with Physical Layer

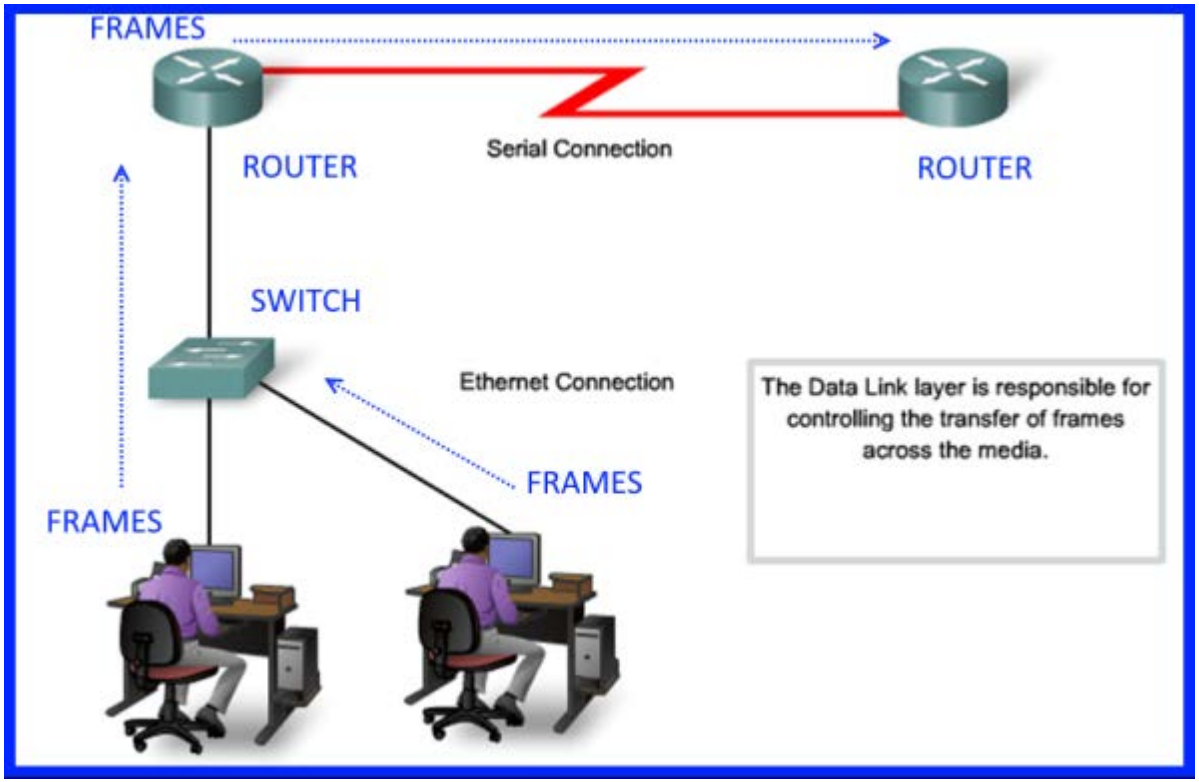


Review

11. The Data Link Layer controls the transfer of _____.

Review

11. The Data Link Layer controls the transfer of frames.



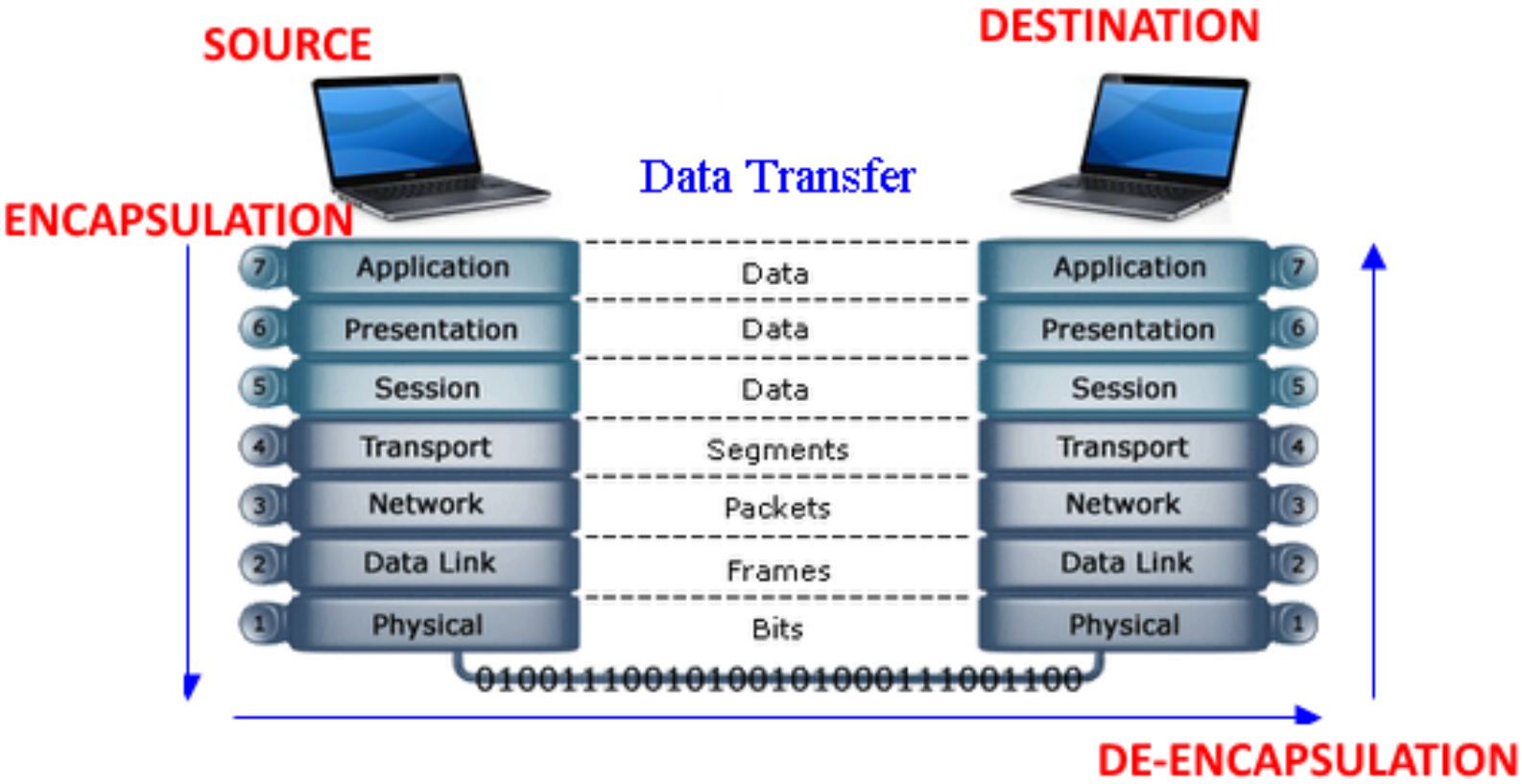
OSI Data Link Layer –

Summary of data transfer

Data from a source go through the 7 layers (7 to 1) during encapsulation.

Bits sent from one source goes through the 7 layers (1 to 7) during de-encapsulation.

Device at destination receives data sent.



OSI Data Link Layer
Topology

Review

12. Topology is the way in which constituent parts are interrelated or arranged.

There are two types of network topology:

- _____
- _____

Review

12. Topology is the way in which constituent parts are interrelated or arranged.

There are two types of network topology:

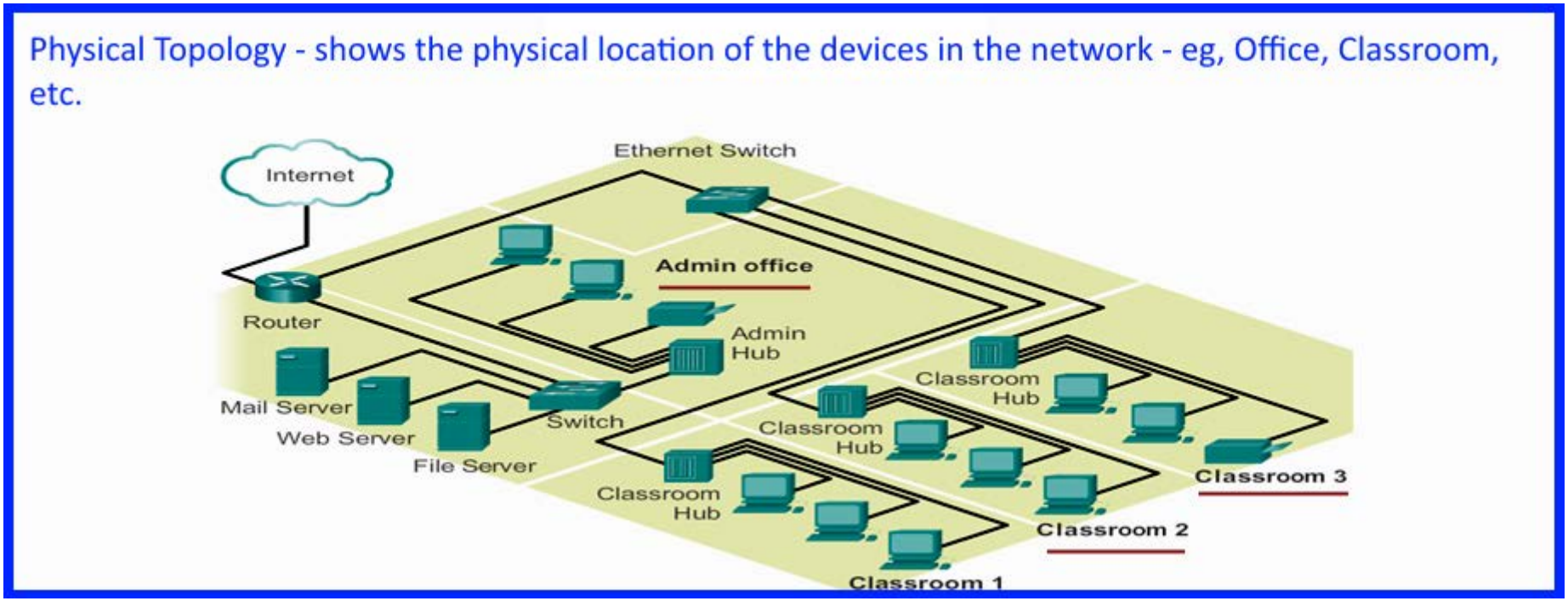
- Physical
- Logical

Review

13. _____ _____ is the placement of the various components of a network, including device location and cable installation.

Review

13. Physical topology is the placement of the various components of a network, including device location and cable installation.

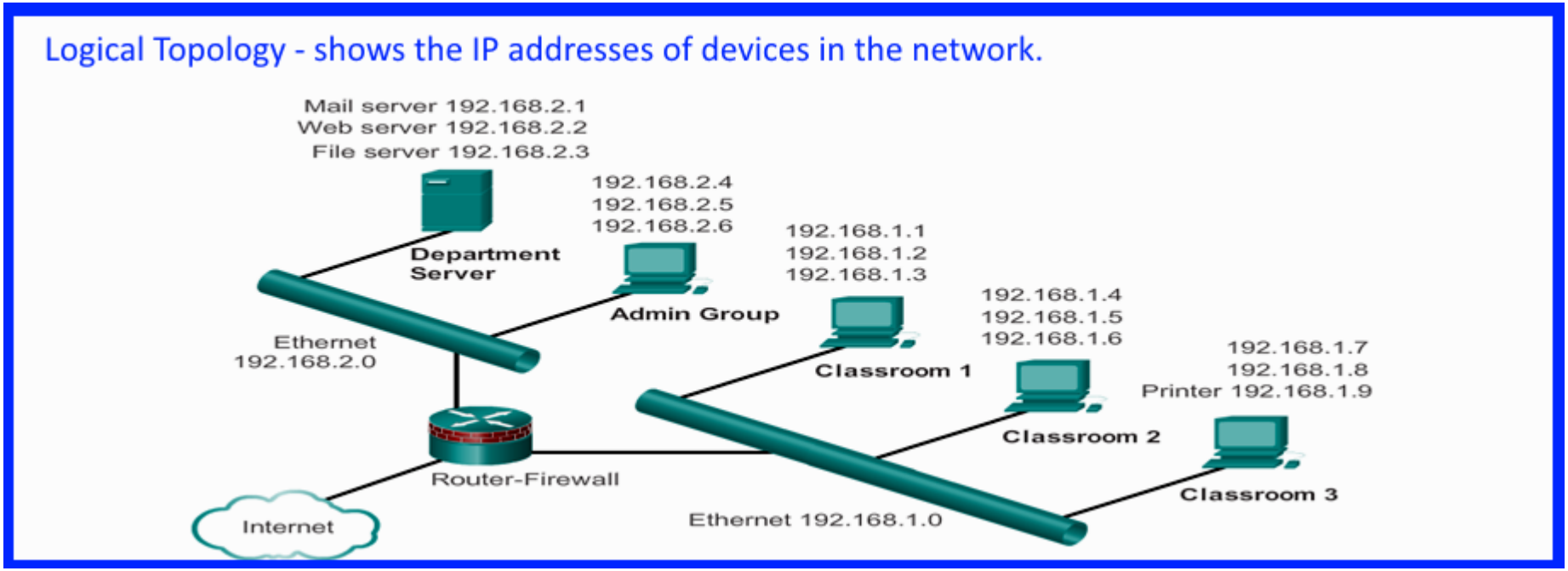


Review

14. _____ _____ illustrates how data flows within a network, regardless of its physical design.

Review

14. Logical topology illustrates how data flows within a network, regardless of its physical design.



Review

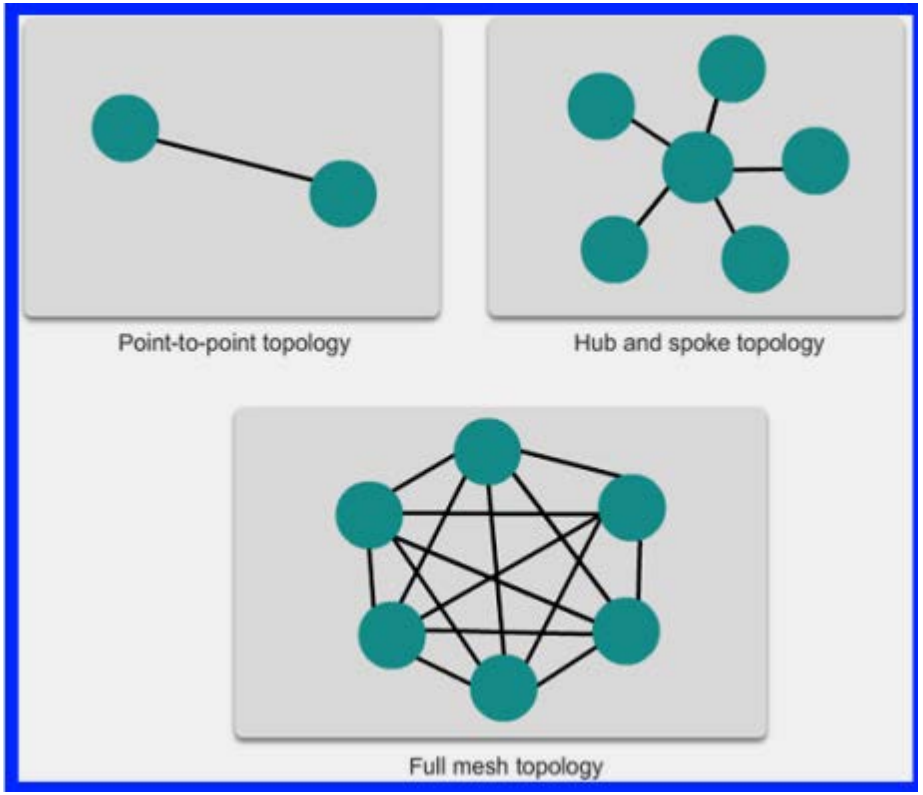
15. Common Physical WAN Topologies include:

- Point-to-Point
- _____
- Full Mesh

Review

15. Common Physical WAN Topologies include:

- Point-to-Point
- Hub and Spoke
- Full Mesh

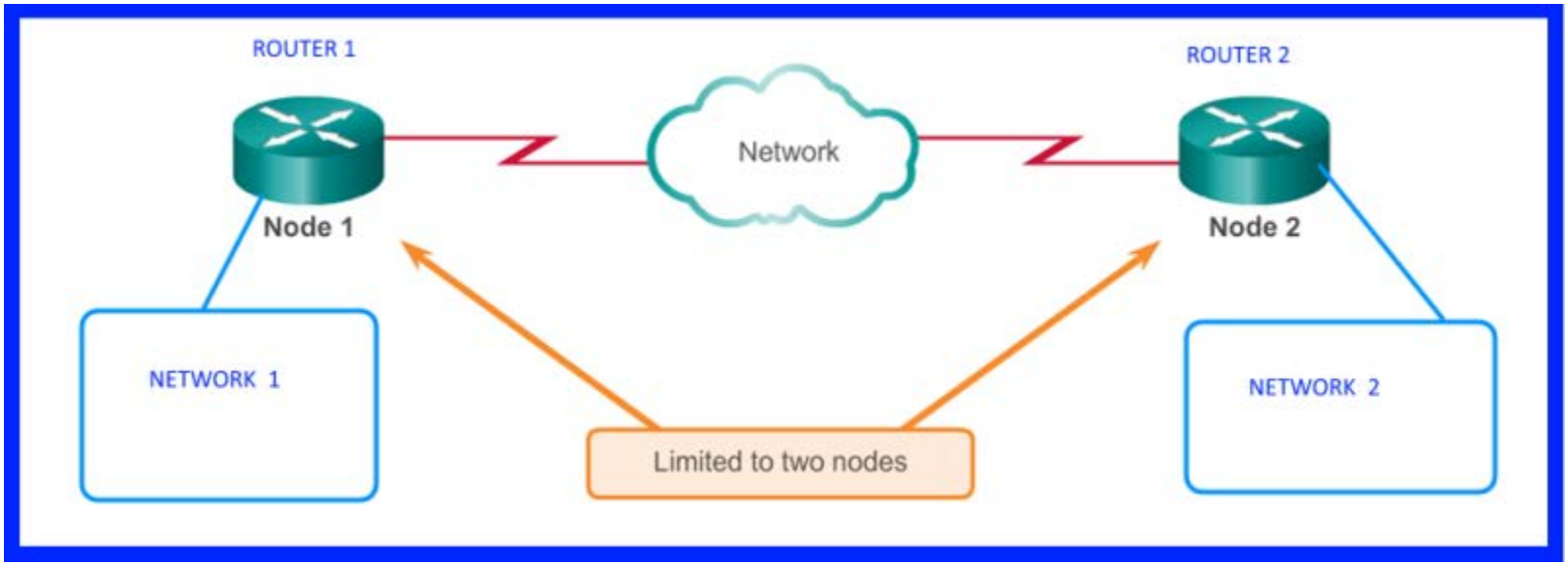


Review

16. Point-to-Point Topology is limited to having ____ nodes.

Review

16. Point-to-Point Topology is limited to having 2 nodes.

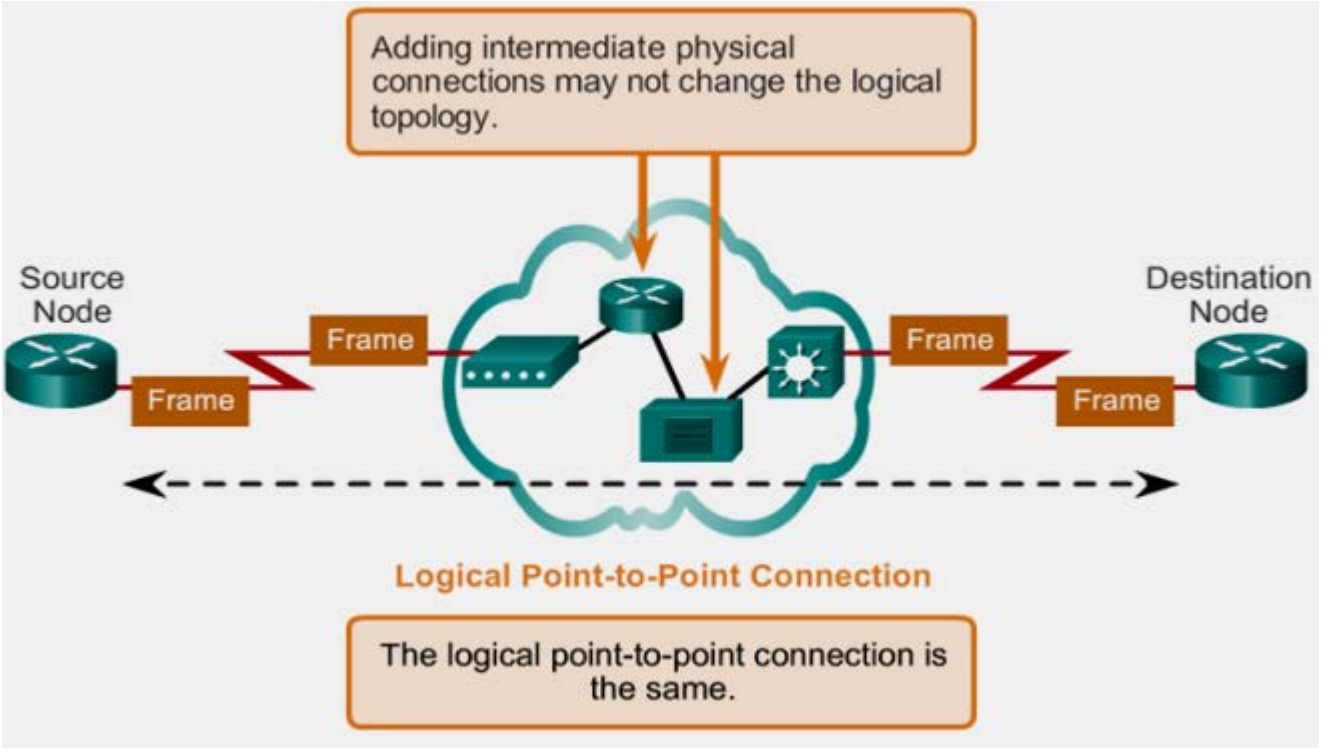


Review

17. Adding more devices or changing locations do not affect the _____ topology of a network.

Review

17. Adding more devices or changing locations do not affect the logical topology of a network.



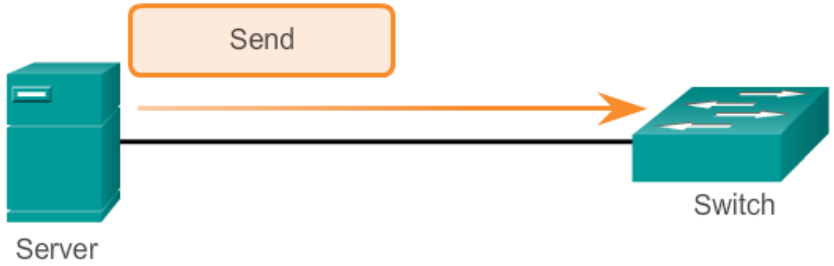
Review

18. Half-Duplex – Data can be sent in ____ direction at any one time.

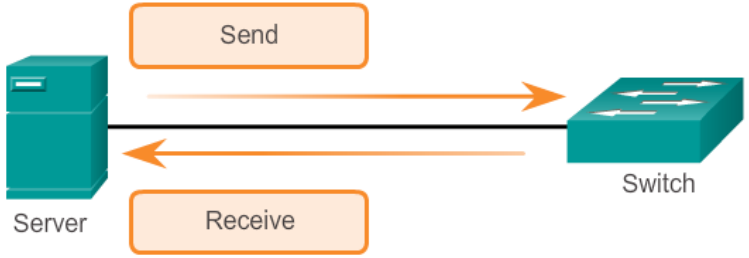
Full-Duplex – Data can be sent/received in ____ directions at the same time.
Faster data transfer can be achieved.

Review

18. Half-Duplex – Data can be sent in one direction at any one time.

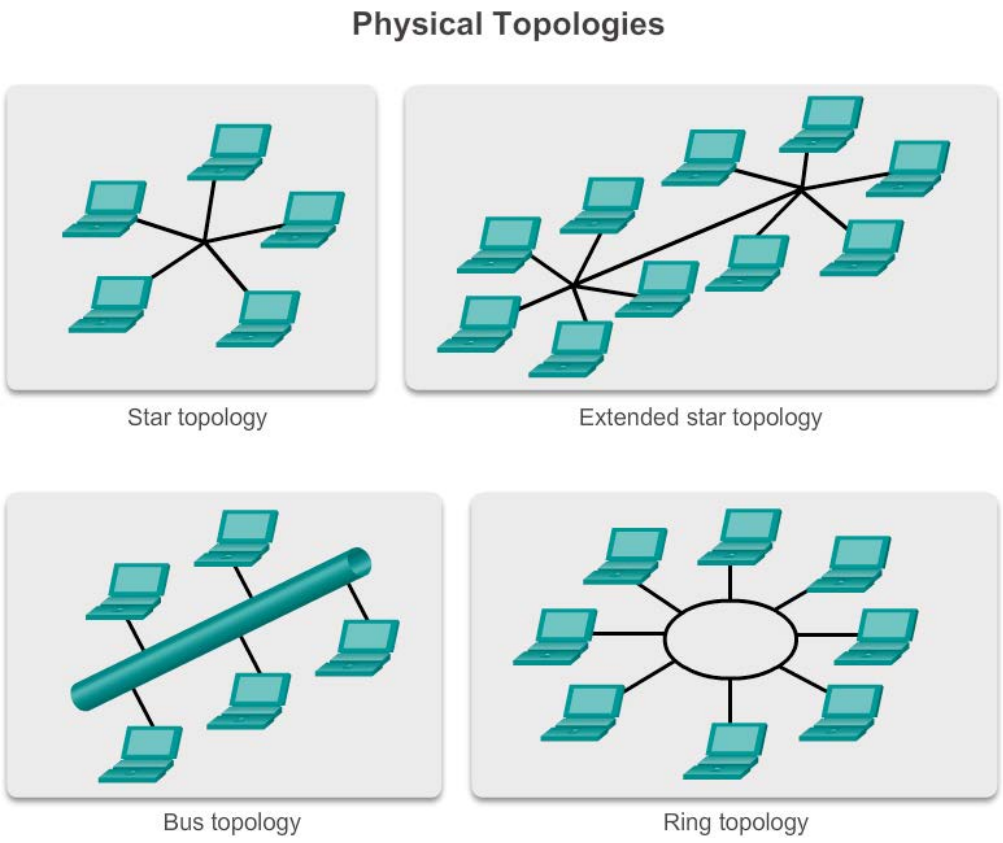


Full-Duplex – Data can be sent/received in both directions at the same time.
Faster data transfer can be achieved.



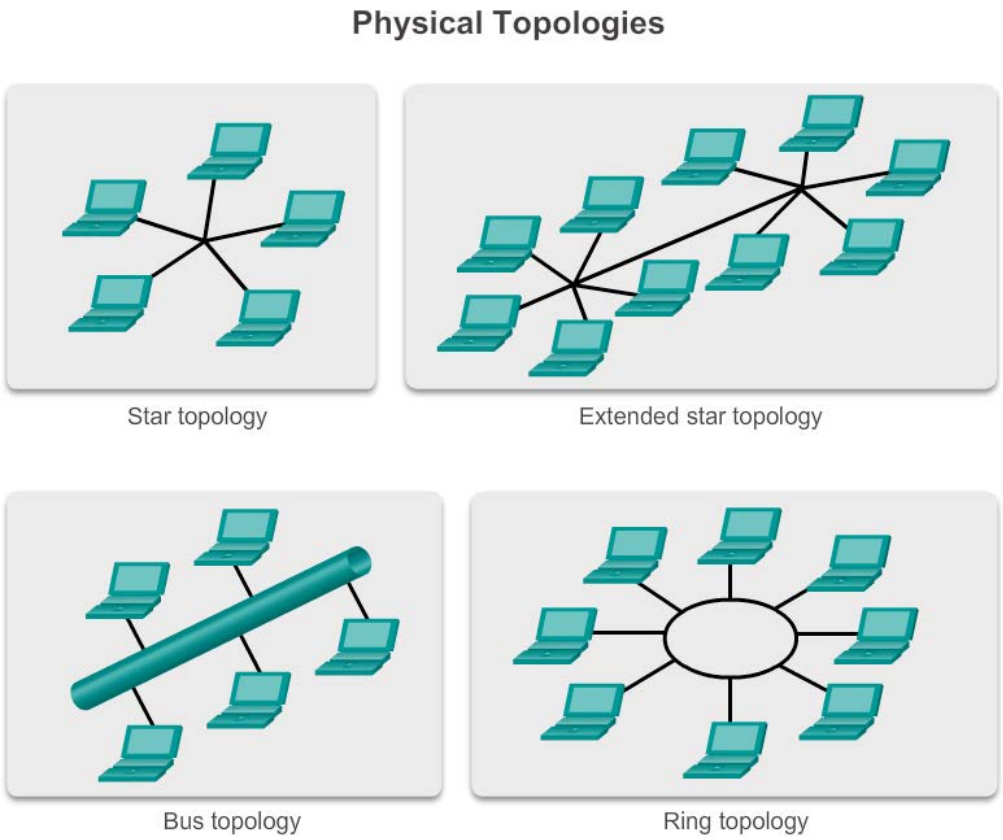
Review

19. The 4 physical WAN topologies are Star, _____, _____ and Ring.



Review

19. The 4 physical WAN topologies are Star, Extended, Bus and Ring.



Review

20. There are two methods of sharing media (data) in a LAN:

- _____ Access Method
- _____ Access Method

Review

20. There are two methods of sharing media (data) in a LAN:

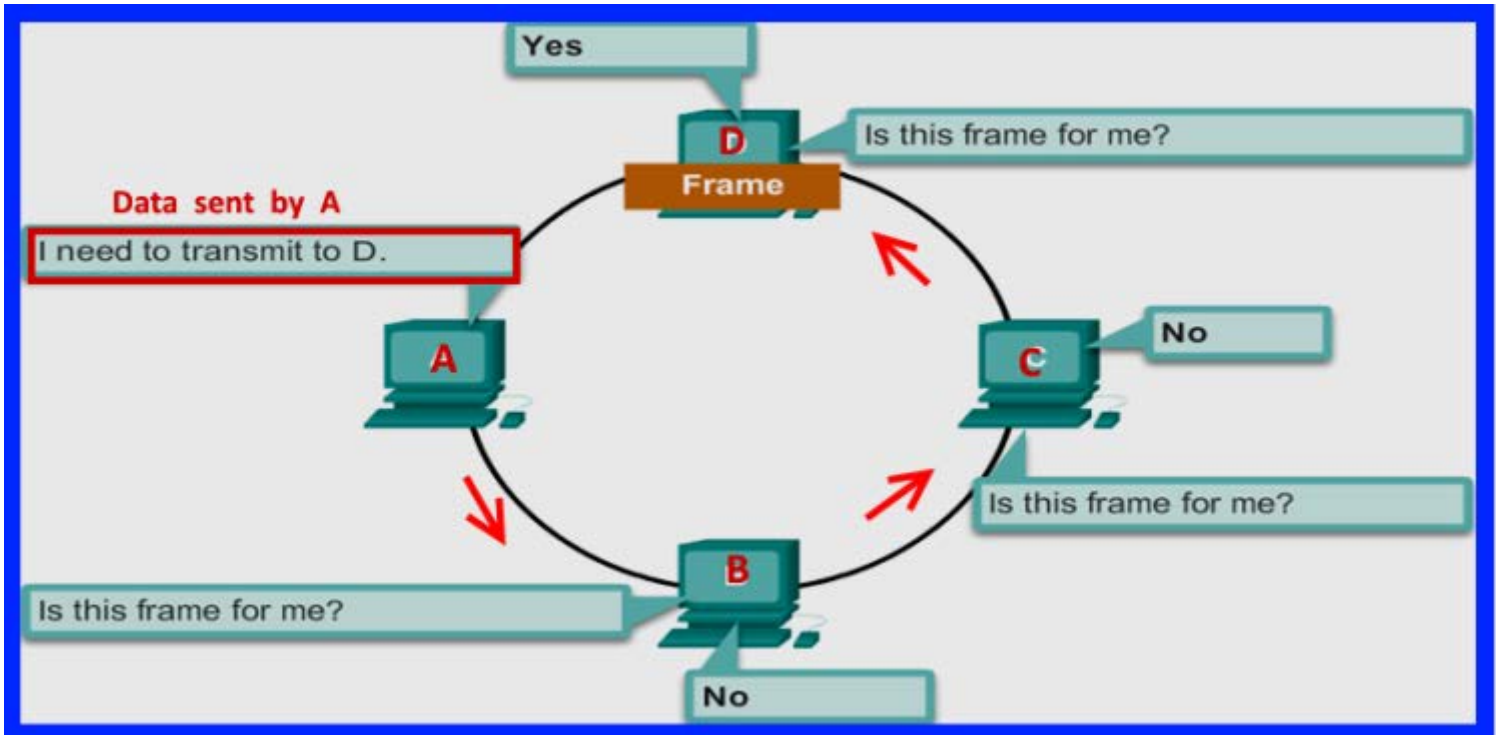
- Contention-based Access Method
- Controlled Access Method

Review

21. In a LAN Ring Topology, a frame sent out stops at _____ device.

Review

21. In a LAN Ring Topology, a frame sent out stops at every device.



Review

22. There are two network environments:

- _____ environment
- _____ environment

Review

22. There are two network environments:

- Fragile environment
  Open air, weather interference, uncontrolled factors, etc.
- Protected environment
  In a building, all factors controllable

End of Review