School of Advanced Technology

Networking Basics

Week 03
Data Link Layer (OSI Layer 2)

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ALGONQUIN COLLEGE

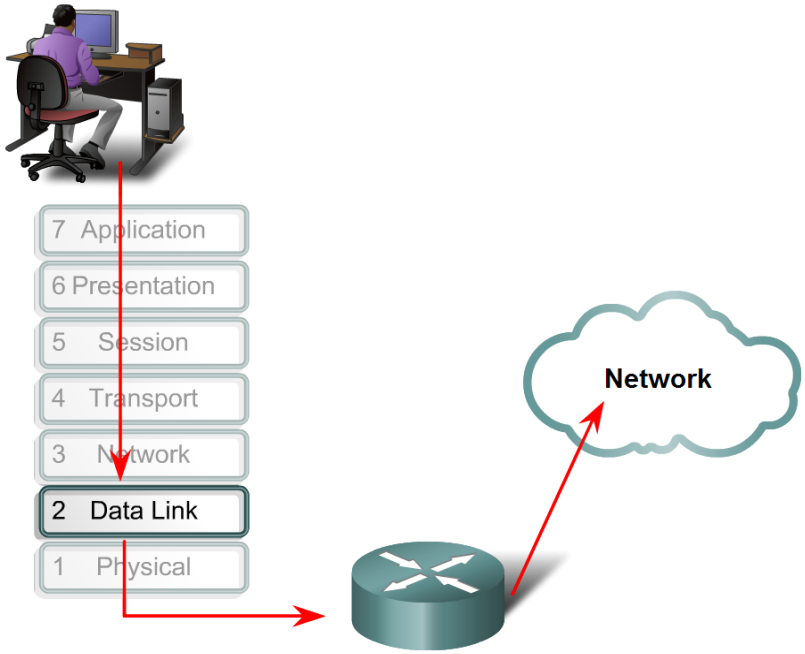
Reference

- Cisco Chapter 4
  - Sections 4.3 & 4.4

Learning Outcomes

- 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.

Layer 2 – Data Link



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

Layer 2 - Overview

- Layer 2 PDU – Frame
- Most widely used Layer 2 LAN standard – Ethernet (CISCO Chapter 5)
- Layer 2 is about moving frames between device connected to the same network segment (media). This is in contrast to Layer 3 which is about getting messages from one network to another using IP addresses.
- The Layer 2 address is the physical address. The Ethernet consists of 48 bits represented using hexadecimal numbers
- A switch is a Layer 2 device
- A hub is a Layer 1 device
- A wireless Access Point is a Layer 2 device
- A bridge is a Layer 2 device

Primary Function

- The primary job of the Data Link layer is to move messages between devices of the same network segment. This in contrast to the Network layer, whose job is to perform inter-network routing.

Layer 2 - Services

- The Data Link layer (Layer 2) performs two key services.
  - Links the upper layers (Network and Transport) to the physical media (Layer 1).
    - Data Link Layer enables upper layers to be media independent.
      - Layer 3 does not need to worry about the complexities of interfacing with different media types
  - Controls the hardware at the Physical layer, which includes
    - determining when a device can transmit on the physical media (media access control),
    - marking the start and end of a message (framing),
    - indicating which device on the physical circuit is to receive the message (addressing) and
    - Detecting and sometimes correcting any errors in transmission over the physical media (error detection).

Protocols and Standards

- IEEE
  - 802.2 Logical link control
  - 802.3 Ethernet
  - 802.5 Token ring
  - 802.11 Wi-fi
- Various WAN standards: ISDN, Frame relay, HDLC/CHDLC, PPP, ATM

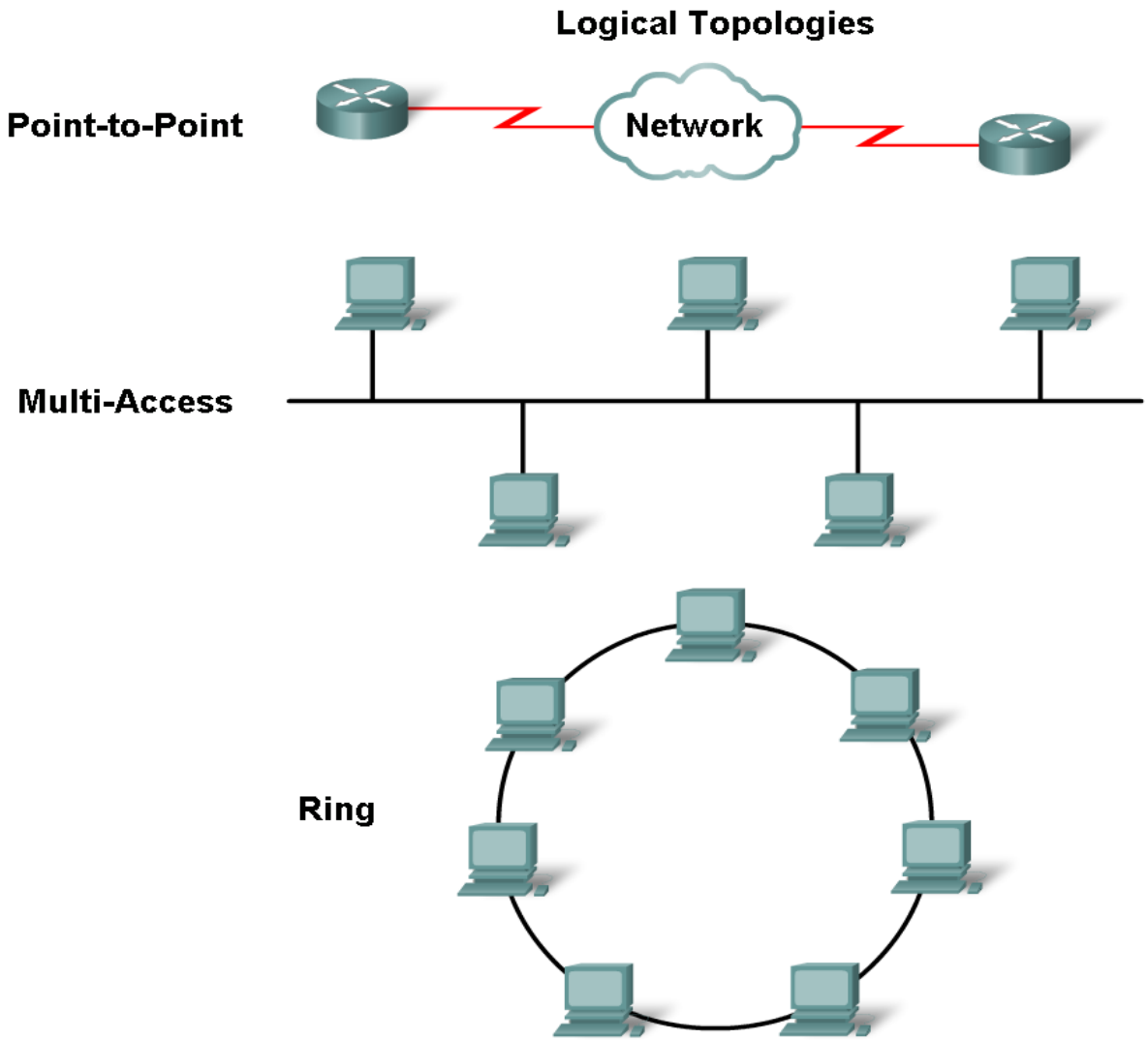
Media Access Control (MAC)

- Process of controlling when nodes can transmit on the physical media
- The Media Access Control (MAC) method is dictated by the network's logical topology
  - The logical topology (specific to layer 2) depicts how nodes appear to be connected from the layer 2 perspective
  - The physical topology (specific to layer 1) depicts how nodes are actually physically connected

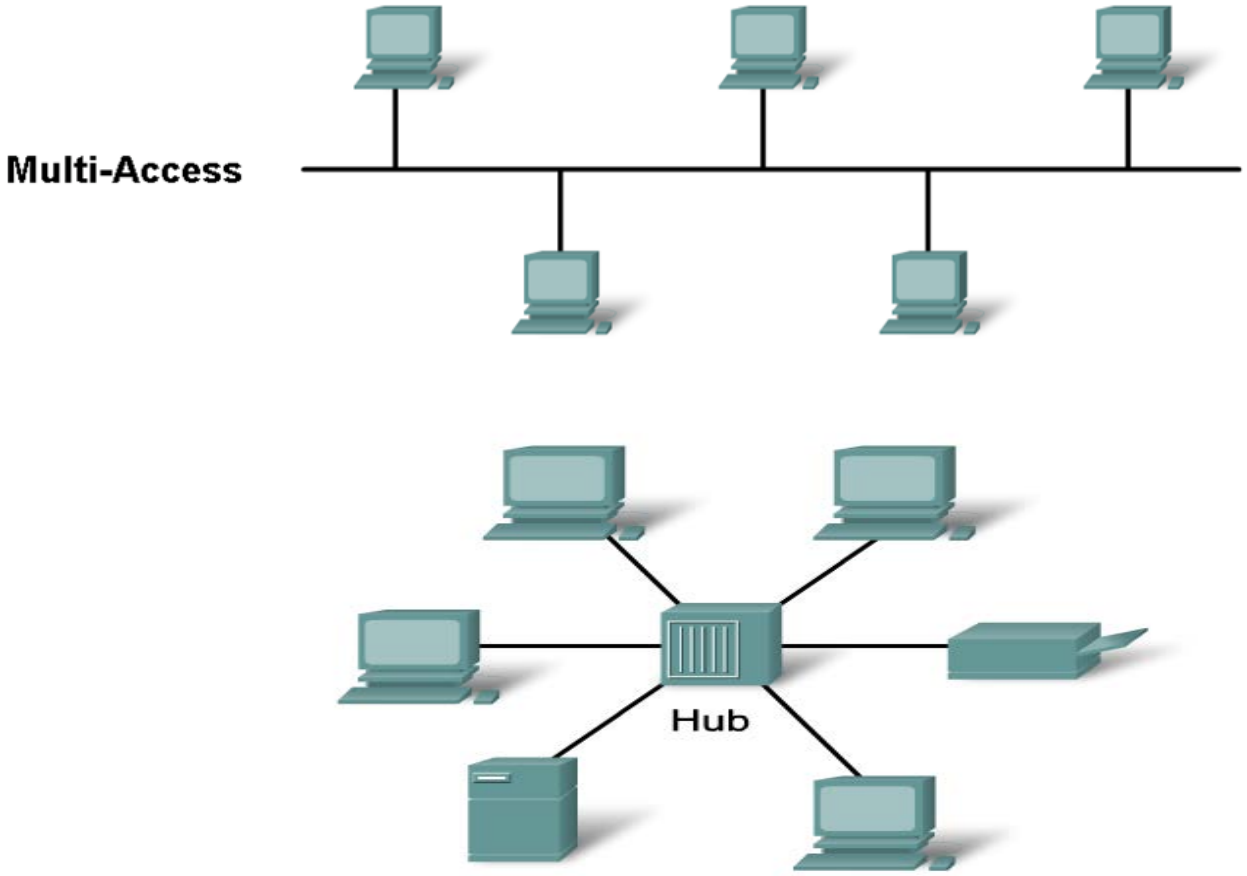
Note the logical and physical topologies may or may not be identical

- Example:
  - Ethernet network that uses a hub

Logical Topologies

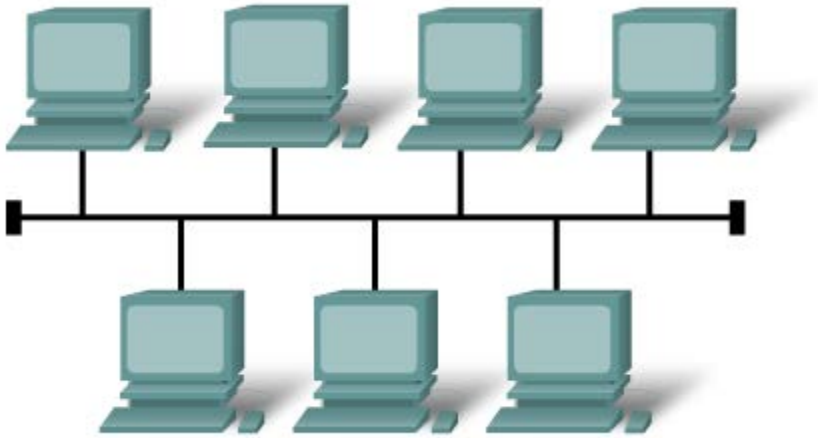


Logical versus Physical Topologies



MAC – Multi-Access Topology

- Media Access Control is critical in a multi-access logical topology



MAC – Multi-Access Topology

- Contention Based (collisions)
  - Non-deterministic (low overhead)
  - Stations can transmit at any time
  - Throughput is a function of traffic
  - Protocols
    - Ethernet CSMA/CD
    - Wifi CSMA/CA
- Controlled (high overhead)
  - Deterministic (high overhead)
  - Throughput is predictable
  - Protocols
    - FDDI
    - Token Ring

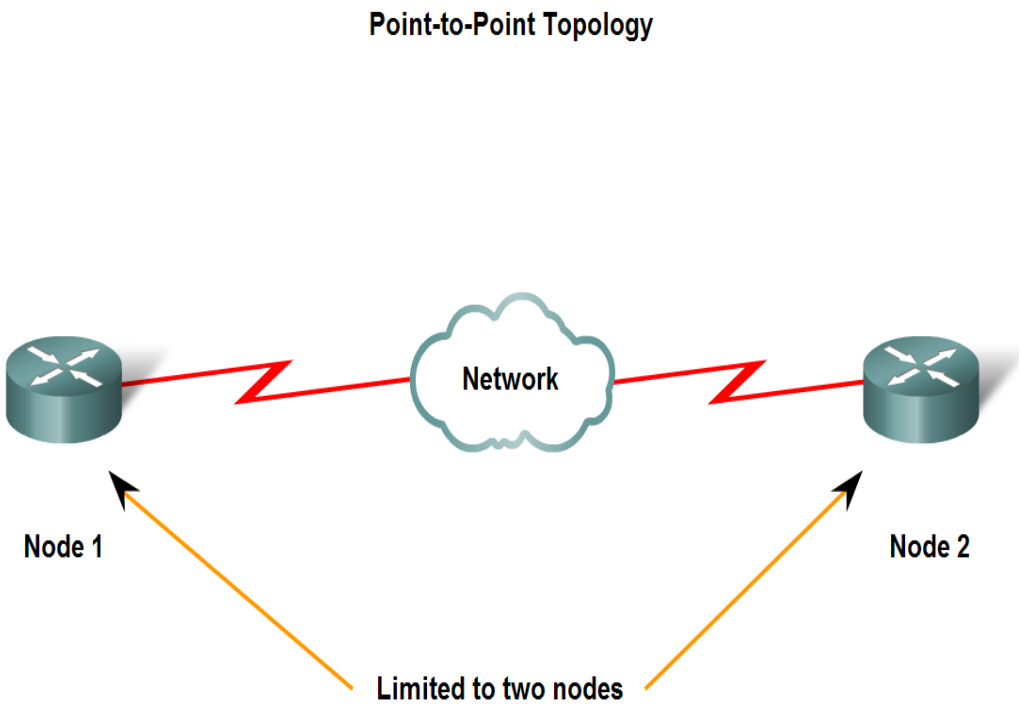
MAC – Point to Point Logical Topology

Only two devices on the network

Full duplex: both can send at the same time,
- no problem with media access

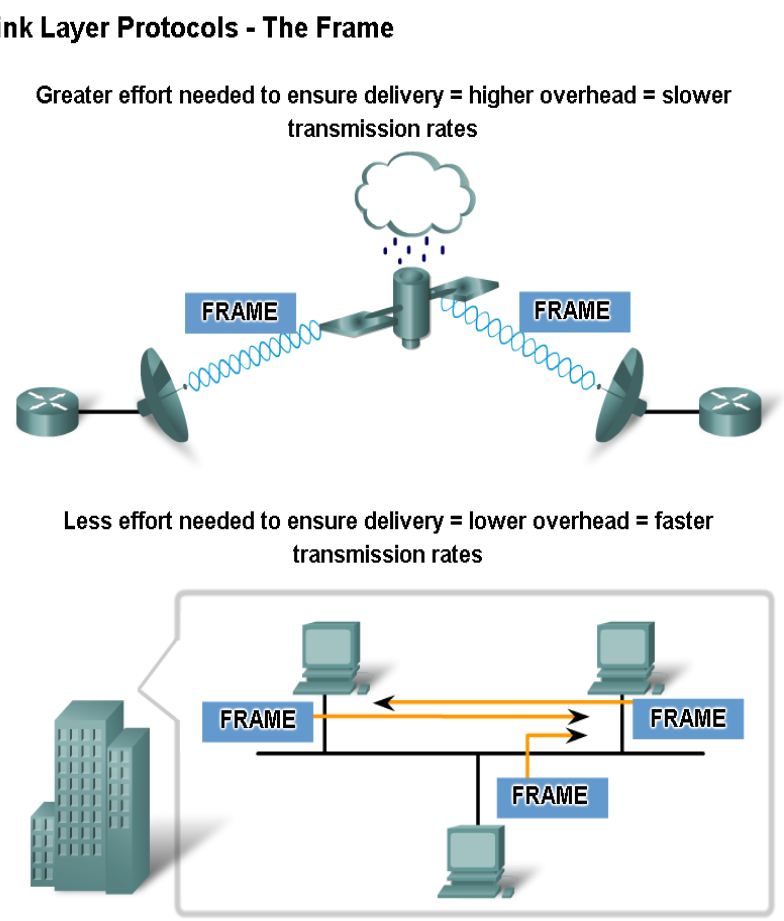
Half duplex: data can only travel one way at a time so one device can send at a time.
- Simple media access control.

Each switch port and the device it connects is a point to point logical topology!



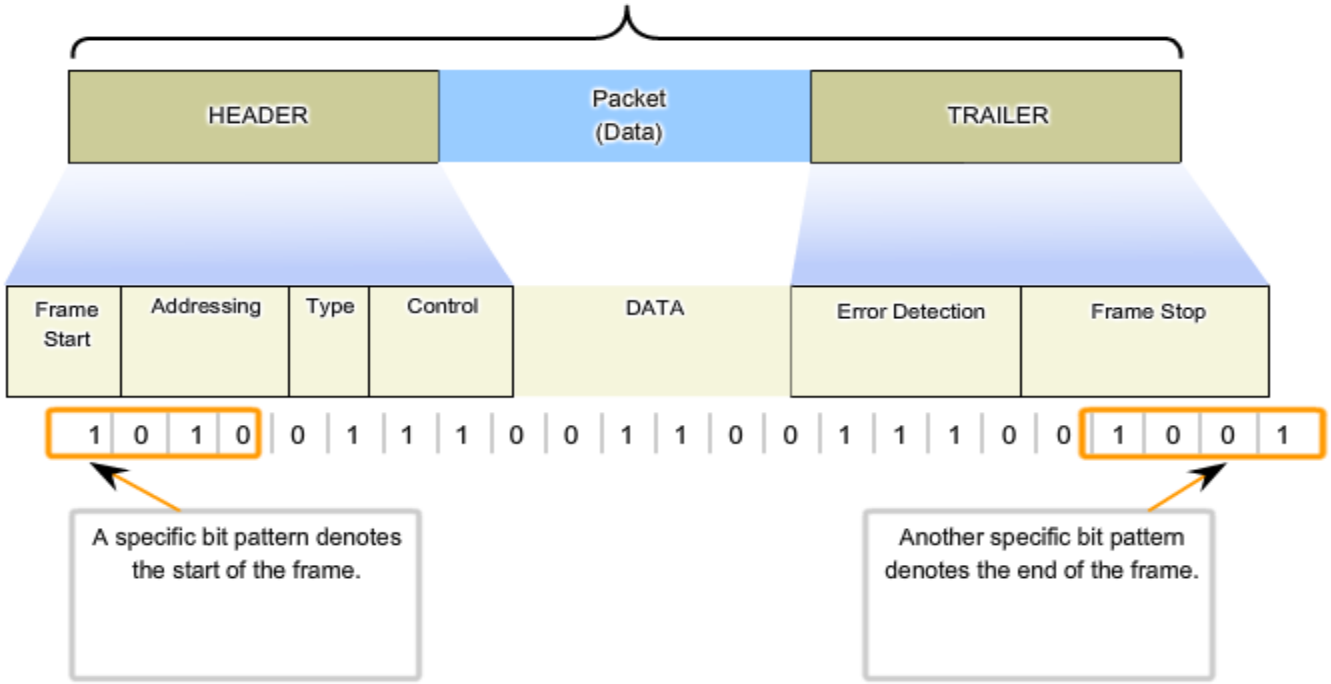
The Frame

- The frame is used by most standards and has three parts:
  - Header
  - Data
  - Trailer
- Framing
  - Marks the start and end of a transmissi on



Layer 2 Frame Format

- All protocols have the same general form but there are some variations.



Ethernet Frame

- Multi-access links.
- Full addressing
- No control
- Same for all Ethernet types/bandwidths

Preamble	Destination	Source	Type	Data	Frame Check Sequence
8 bytes	6 bytes	6 bytes	2 bytes	46 - 1500 bytes	4 bytes
Timing and start	Addresses 48 bits each		Layer 3 protocol	Packet	Check and stop

PPP Frame

- Minimal addressing and control

Flag	Address	Control	Protocol	Data	FCS
1 byte	1 byte	1 byte	2 bytes	variable	2 or 4 bytes

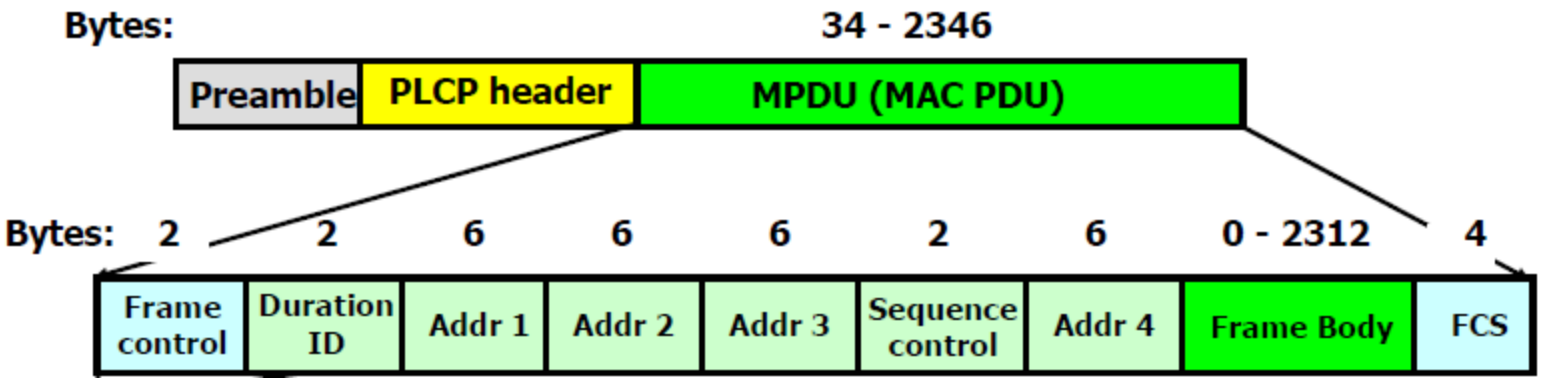
Start

Minimal address

Packet

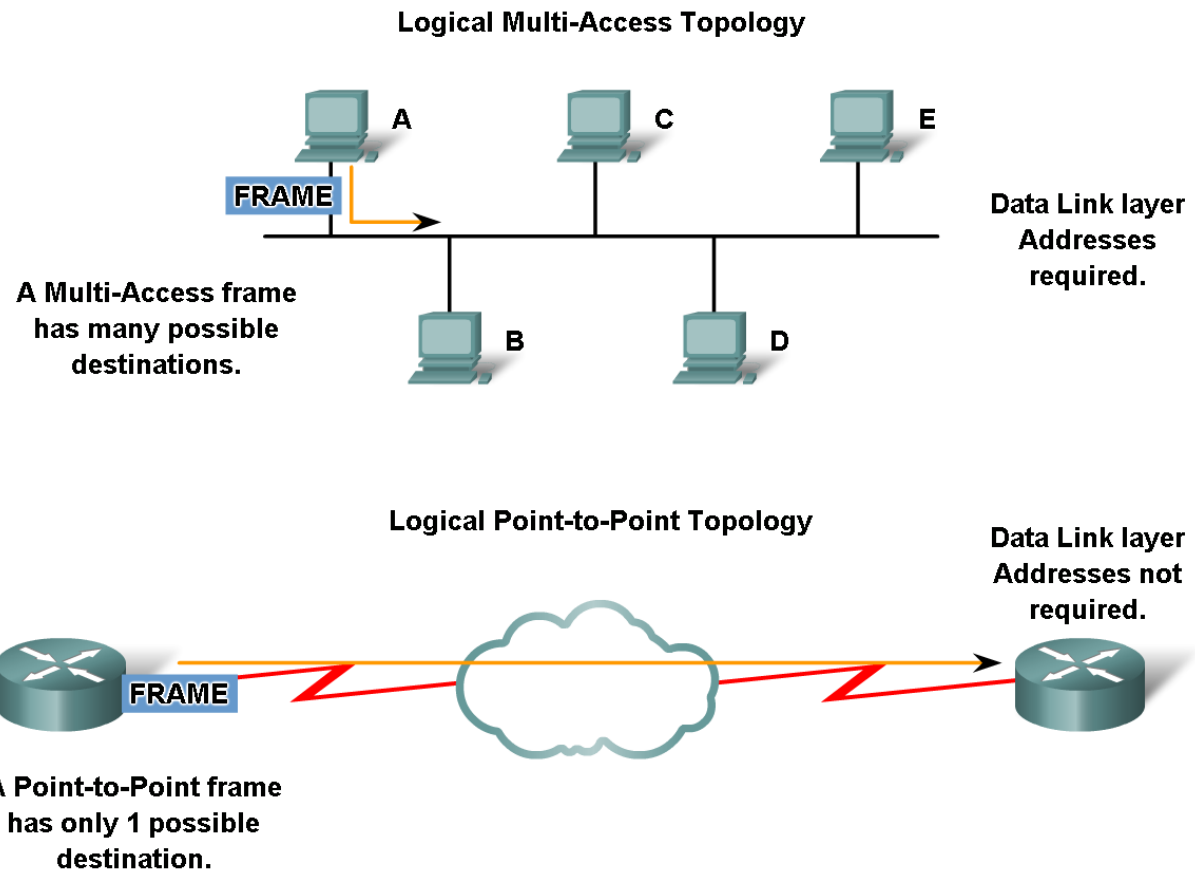
Check and stop

802.11 Wi-Fi Frame



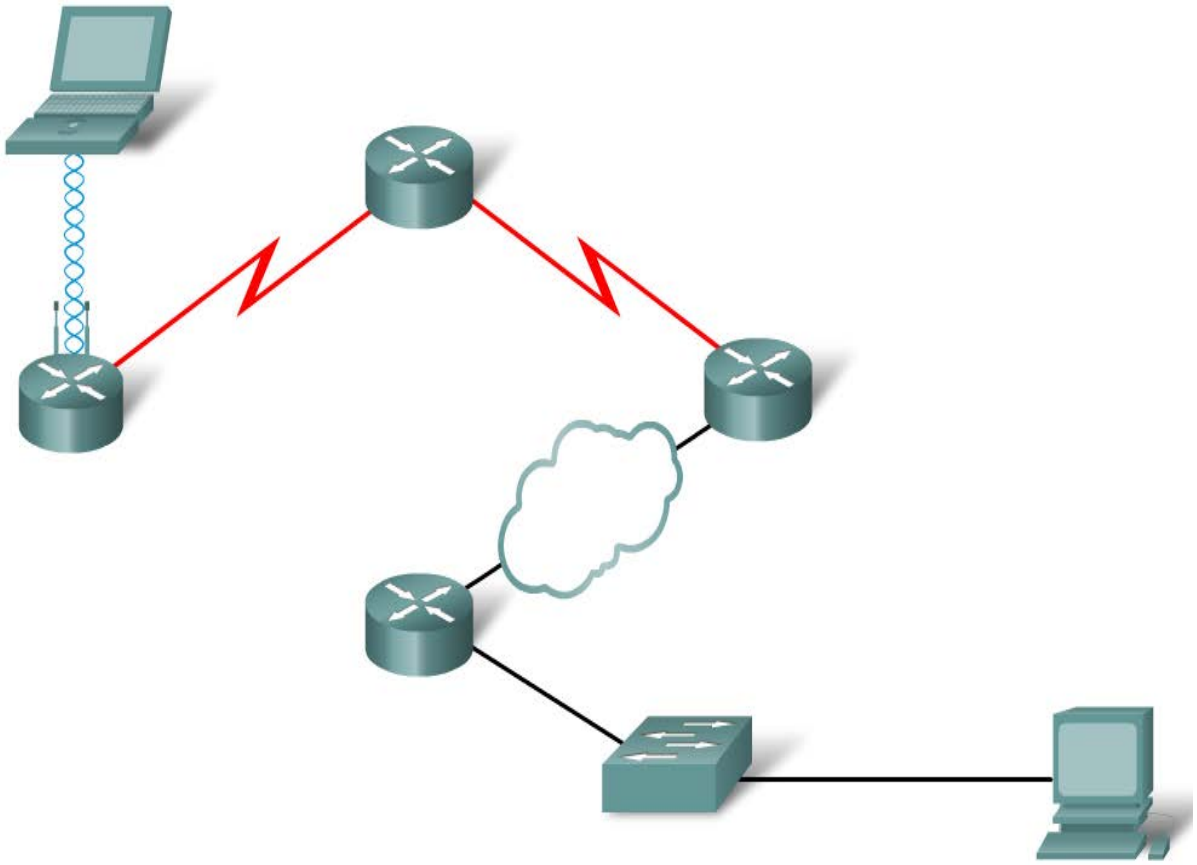
Layer 2 Addressing

- Ethernet
  - Physical address
    - 48 bits



End to End

- The packet remains unchanged from source to destination
- The packet is encapsulated in a new frame at each hop or media transition



Important Note

- Some slides copied from:
  - –Cisco Academy Slide set
  - –Online Cisco Curriculum
  - –Professor McBride slide decks
  - –Professor Anderson slide decks