

Lecture 2b - Ethernet

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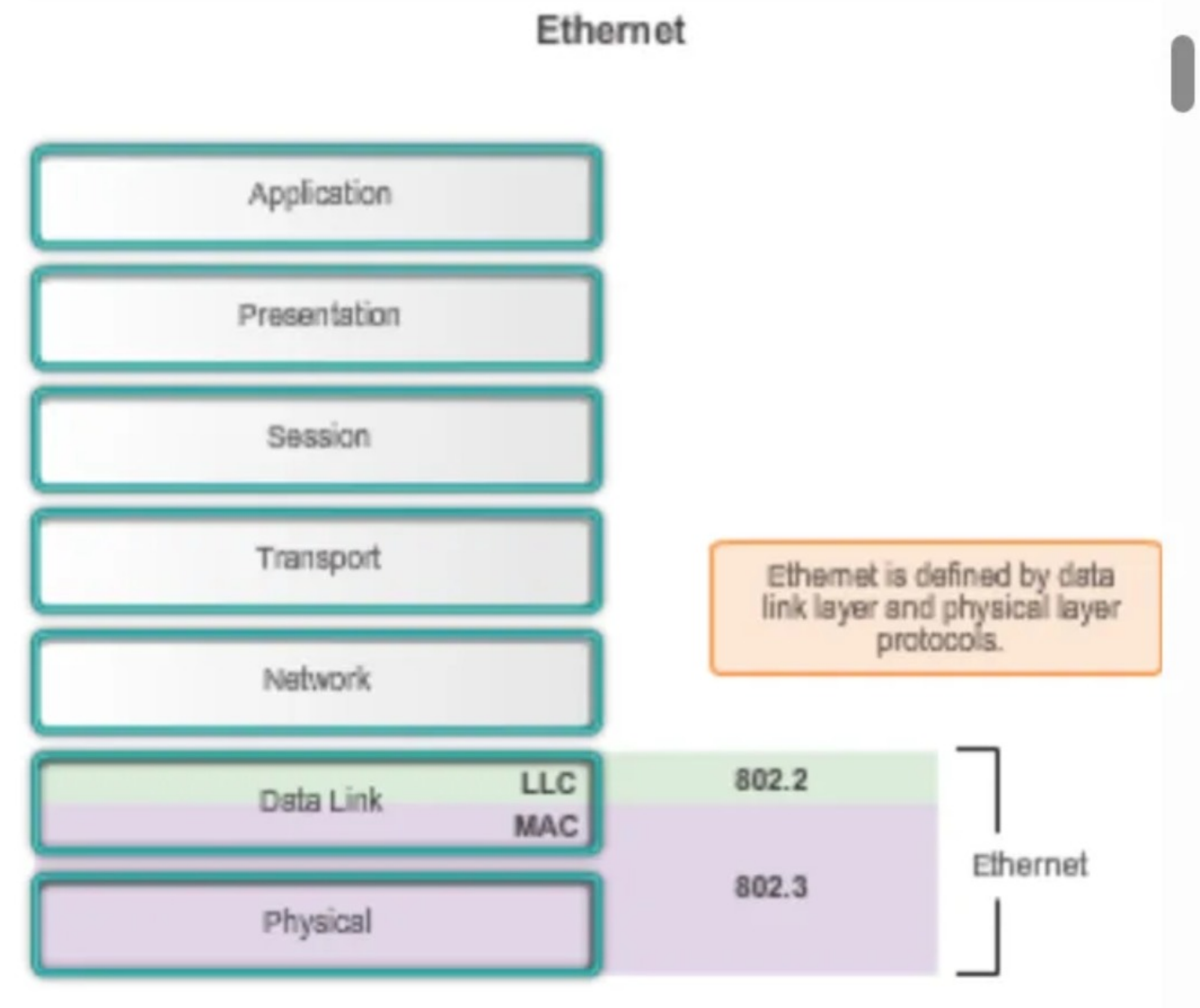
1. Ethernet History
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- 3.3: CSMA/CA:
4. MAC Address: Ethernet Identity
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1. Ethernet History

- Original concept via ALOHA net
 - Radio-based network connecting various campuses in Hawaii
 - Original wireless network
- Radio waves are the obvious shared medium
- Need to control access to minimize collisions

2. Ethernet Operation

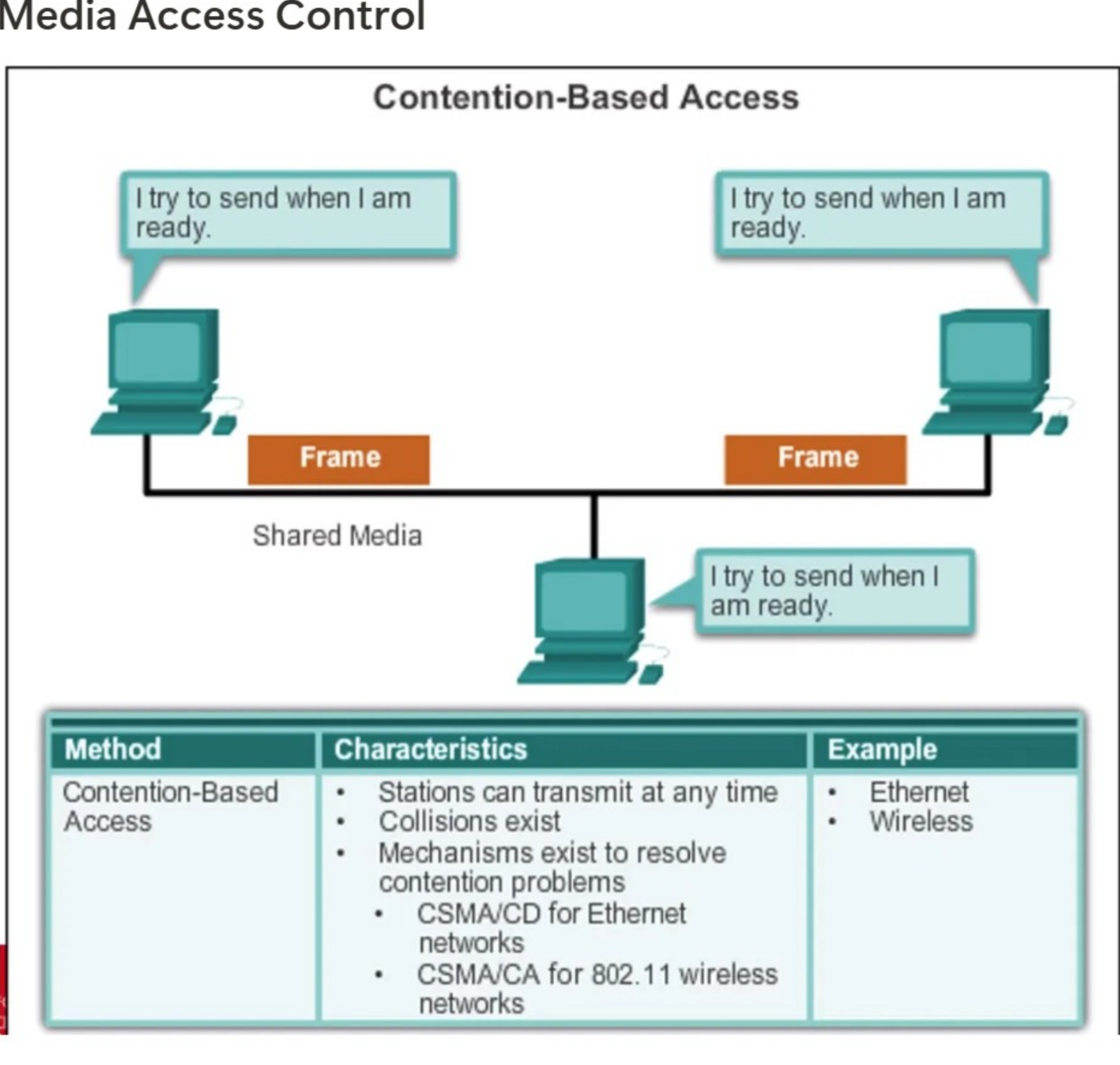
- Ethernet is defined by Data link layer (OSI layer 2) and Physical layer (OSI layer 1) protocols.



- 802.1q
- LLC (Logical link control):
 - Implemented in **software**
 - Handles communication between **upper** and **lower** layers
 - Allows **multiple L3 protocols** on the same media
- MAC (Media Access Control):
 - Implemented in **hardware**
 - Constitutes the lower sublayer of the data link layer
 - Implemented by **hardware**, typically in the computer NIC
 - Two **primary** responsibilities:
 - Data **encapsulation**
 - Media **access control**

3. Ethernet MAC Layer

3.1: Media Access Control



3.2: CSMA/CD:

- Wired network
- Carrier Sense Multiple Access with Collision Detection
- Often used in **wired** Ethernet network
- Carrier Sense:
 - Listen to medium (Can hear any signal currently being transmitted)
 - Don't send until the medium is **free**
- Multiple Access:
 - Bus topology
 - Shared Medium
- Collision Detection:
 - Detect when a collision occurs
- Collision can still occur:
 - When 2 nodes send data at the same time
 - The speed of electricity is not infinite
- Steps of CSMA/CD:
 - Listen to the medium before sending
 - Send data when the medium is free
 - Listen to the medium while sending
 - When a collision is detected:
 - Stop sending
 - Send **jamming** signal
 - ⇒ To make the collision continue a little longer and ensure it's detected by all nodes involved.
 - Wait to retransmit at a **random** time.
 - ⇒ To avoid retransmitting at the same time, as that would cause yet another collision.
 - Listen to the medium before re-sending
- Why do nodes increase the back-off time if subsequent collisions are detected?
 - ⇒ To **slow down** the transmission, as **multiple collisions** might be a sign of congestion.

3.3: CSMA/CA:

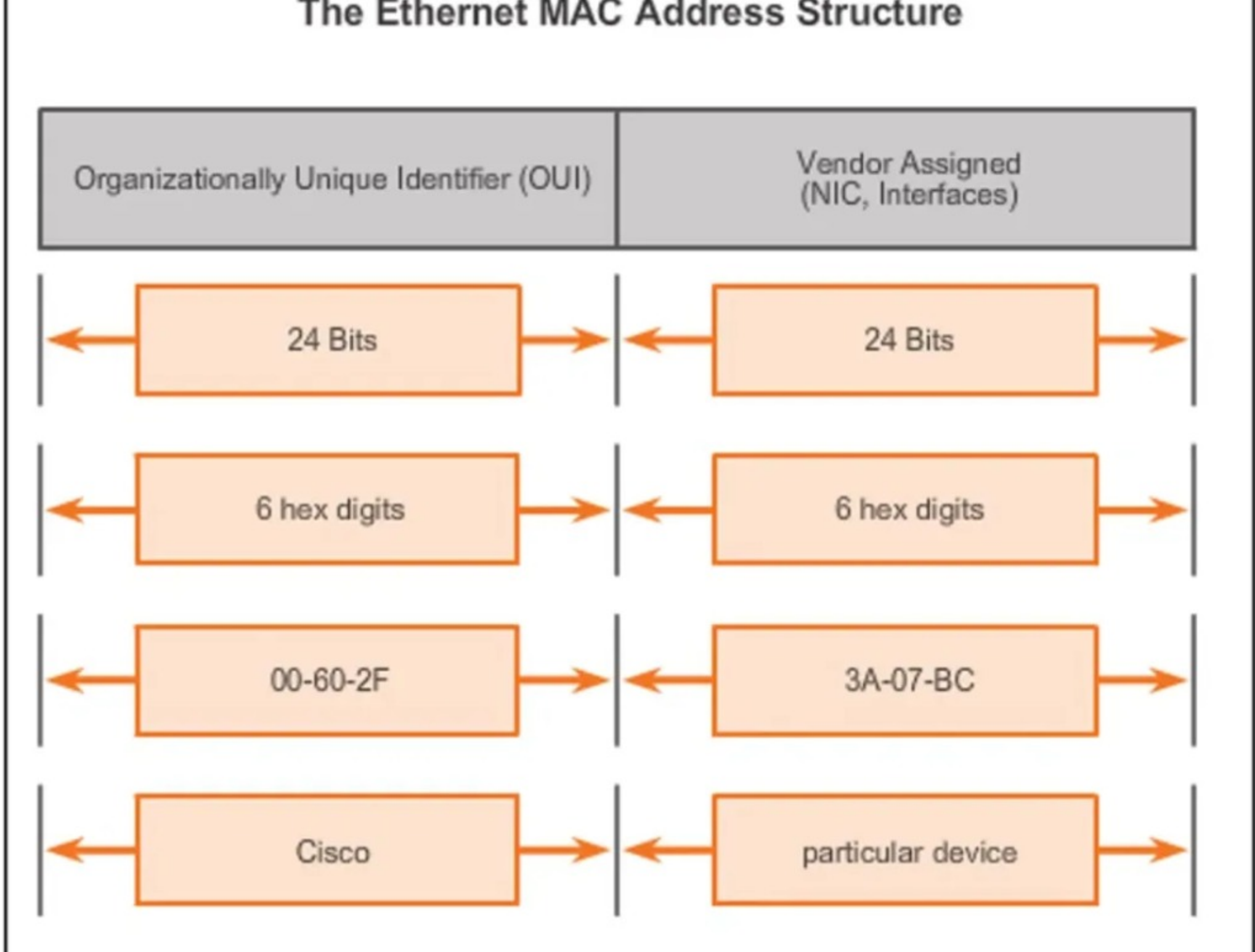
- Carrier Sense Multiple Access with Collision Avoidance
- Often used in **wireless** network
- Collision Avoidance:
 - After media is **free** – send **notification** of stations intent to use medium

💡 **Note:** In this step of **CSMA/CD**, the nodes will immediately send data.

- Wait for a response from the controller
- Transmit

4. MAC Address: Ethernet Identity

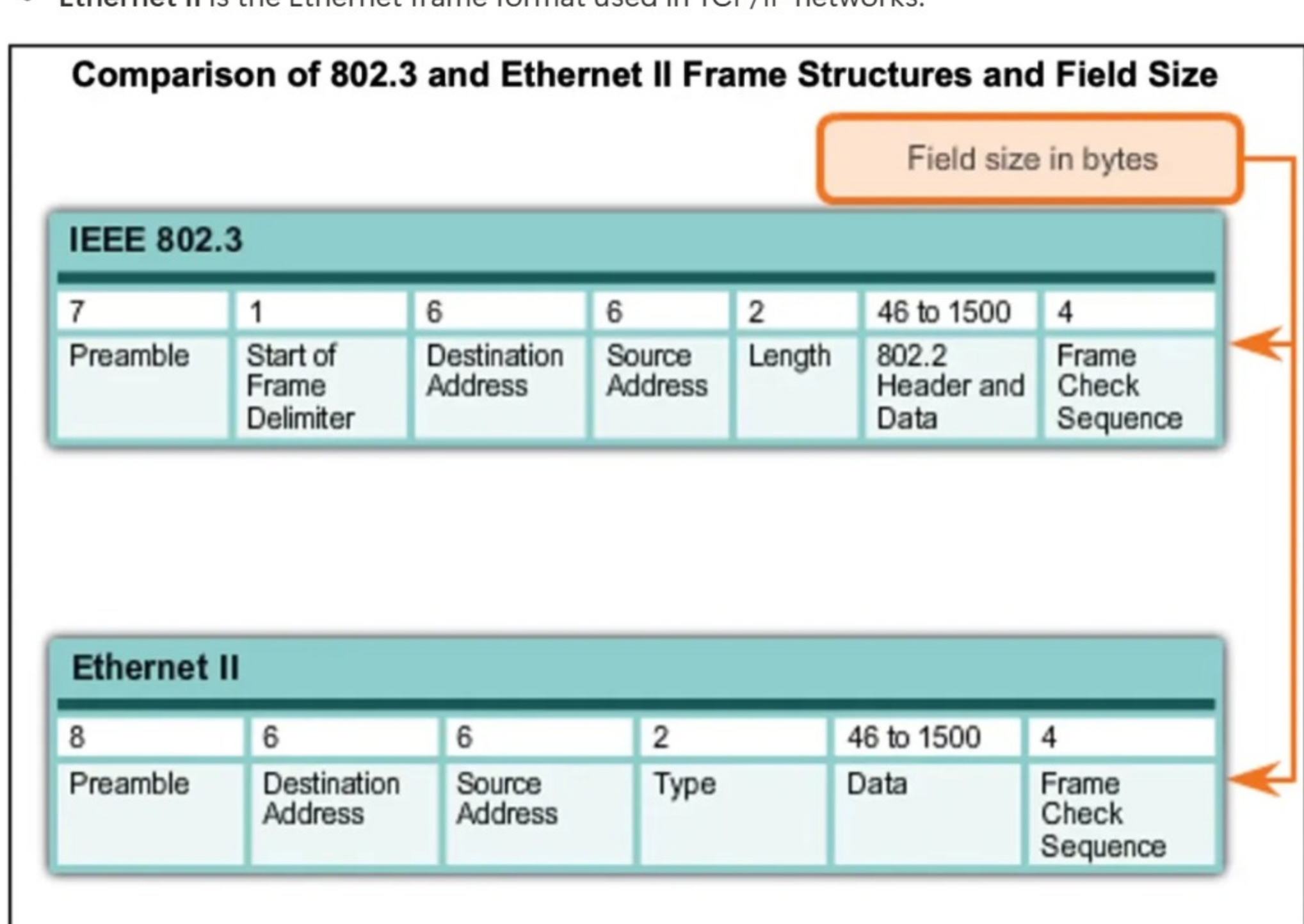
- Layer 2 Ethernet MAC address is a 48-bit binary value (6 bytes) expressed as 12 hexadecimal digits
- It is **not** allocated by Network admin
- IEEE requires a vendor to follow these rules:
 - The **first 3 bytes** are the vendor's assigned OUI (vender ID)
 - The **last 3 bytes** are unique NIC (Network Interface Card) identifier that assigned by the vendor.



- MAC address is unique in the same local network. When used on a global network, we need to use an IP address.
 - ⇒ That means it is a unique **Ethernet** node ID, but not a unique **Internet** node ID

5. Ethernet Frame

- Ethernet Encapsulation:
 - Ethernet II is the Ethernet frame format used in TCP/IP networks.



- Fields in Ethernet II frame:
 - Preamble:
 - Synchronisation signal (0101010...)
 - Allows receivers to synchronise clocks for rest of frame
 - Addresses:
 - Who is sending/receiving this frame
 - Type:
 - Tells Ethernet layer what **Network Layer Protocol** is carried in Data
 - Frame check:
 - Check for errors
 - Data:
 - 46-1500 bytes
 - Why we have maximum:
 - ⇒ Make sure no one sends a large frame and uses the media for too long, which will prevent other nodes from sending data.
 - Why we have a minimum:
 - ⇒ In CSMA/CD Ethernet networks, nodes listen to the medium while sending data to detect collisions.
 - ⇒ This ensures that nodes keep listening for long enough to detect a collision that happens at the farthest possible point.
 - These restrictions are no longer valid but backward compatibility requires that they remain.
 - ⇒ Collision is no longer an issue for modern switches.

6. Quizzes:

- All Data Link layer protocols uniquely identify the source and destination nodes within the frame header.
 - ⇒ **False**
 - Based on their **Logical topology**, networks can have **different** addressing and media access control requirements.
 - Different** Data Link layer protocols define **different frame formats**.
 - For **example**: in a point-to-point topology, source and destination addresses **do not need** to be included in the frame header.

- FF-FF-FF-FF-FF-FF is the universal Ethernet **broadcast** MAC address.
- 00-07-E9-42-AC-28 is an example of Ethernet **unicast** MAC address.