# Computer Networks
# COL 334/672

Link Layer

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*Slides adapted from KR*

Sem 1, 2024-25

Quiz 2 on Moodle

Password: oddsbodikins

**Question 2**

Correct

Mark 2.00 out of 2.00

Flag question

Consider the bit stuffing approach discussed in class, what bit sequence will the sender transmit for the data sequence **0111110101**?

0 1111101001

Select one or more:

- [ ] a. 01111101001
- [ ] b. 0111110101
- [x] c. 01111100101 ✓
- [ ] d. 01111110101

The correct answer is: 01111100101

**Question 3**

Incorrect

Mark 0.00 out of 2.00

Flag question

Assuming odd parity is used for error detection, which of the following received sequences definitely has a bit error? (select all that apply)

**Question 4**

Correct

Mark 2.00 out of 2.00

Flag question

Consider a 4-bit checksum, what will be the checksum bits for the data sequence 1110 0010 0101?

1110 0001
0010 0101
10000 0110

Select one or more:

- [ ] a. 1011
- [x] b. 0110
- [ ] c. 0111
- [ ] d. 1010

The correct answer is: 0110

**Question 5**

Incorrect

Mark 0.00 out of 2.00

Flag question

Consider a burst of 10 packets arriving at a router, what is the **average queuing delay** in milliseconds (ms)? Assume 1 packet is served in 10 ms. (enter only the number without units).

d. 1010

The correct answer is: 0110

**Question 5**

Incorrect

Mark 0.00 out of 2.00

Flag question

Consider a burst of 10 packets arriving at a router, what is the **average queuing delay** in milliseconds (ms)? Assume 1 packet is served in 10 ms. (enter only the number without units).

Answer: 9

1st → 0
2nd → 10
... 10th → 90
average = 0+10 .. +90 / 10
= 45

The correct answer is: 45

Finish review

← Assignment-1

Jump to...

Quiz3 →

QUIZ NAVIGATION

1 2 3 4 5

| | |
|---|---|
| **Started on** | Wednesday, 7 August 2024, 9:04 AM |
| **State** | Finished |
| **Completed on** | Wednesday, 7 August 2024, 9:07 AM |
| **Time taken** | 2 mins 47 secs |
| **Grade** | **4.00** out of 10.00 (**40**%) |

**Question 1**

Incorrect

Mark 0.00 out of 2.00

Flag question

**Which of the following is NOT a service provided by the Link Layer?** F E R L

Select one or more:

- [ ] a. Routing
- [x] b. Link access ✗✓
- [ ] c. Error detection ✓
- [ ] d. Framing ✓

The correct answer is: Routing

**Question 2**

Correct

The correct answer is: 01111100101

**Question 3**

Incorrect

Mark 0.00 out of 2.00

Flag question

Assuming odd parity is used for error detection, which of the following received sequences definitely has a bit error? (select all that apply)

Select one or more:

- [ ] a. 01110000 3
- [x] b. 01101010 ✓ 5
- [x] c. 01010101 ✓ 5
- [x] d. 010001001 ✗ 3

The correct answers are: 01101010, 01010101

**Question 4**

Correct

Mark 2.00 out of 2.00

Flag question

Consider a 4-bit checksum, what will be the checksum bits for the data sequence 1110 0010 0101?

Select one or more:

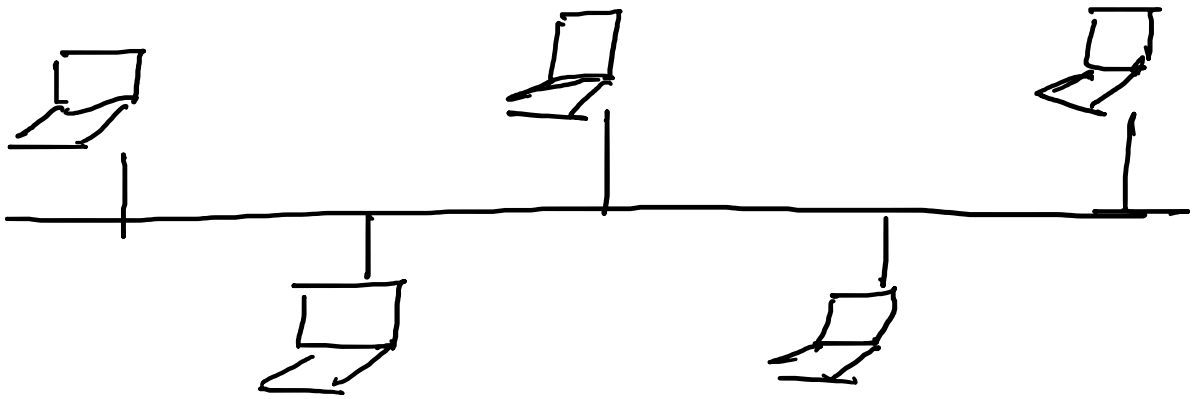
- [ ] a. 1011

# Link Layer: Services

- Framing
- Error detection
- Reliability
- **Link access**

# Medium Access Control (MAC) protocol

Broadcast link



- algorithm that determines how nodes share channel, i.e., determine when node can transmit
  - *Assumptions: distributed, no out-of-band channel for coordination*
- Two classes of protocols
  - Channel partitioning: FDMA, TDMA
  - Random access: Slotted Aloha, Carrier Sense Multiple Access (CSMA) /Collision Detection (CD)

# CSMA (carrier sense multiple access)

Simple CSMA: listen before transmit:

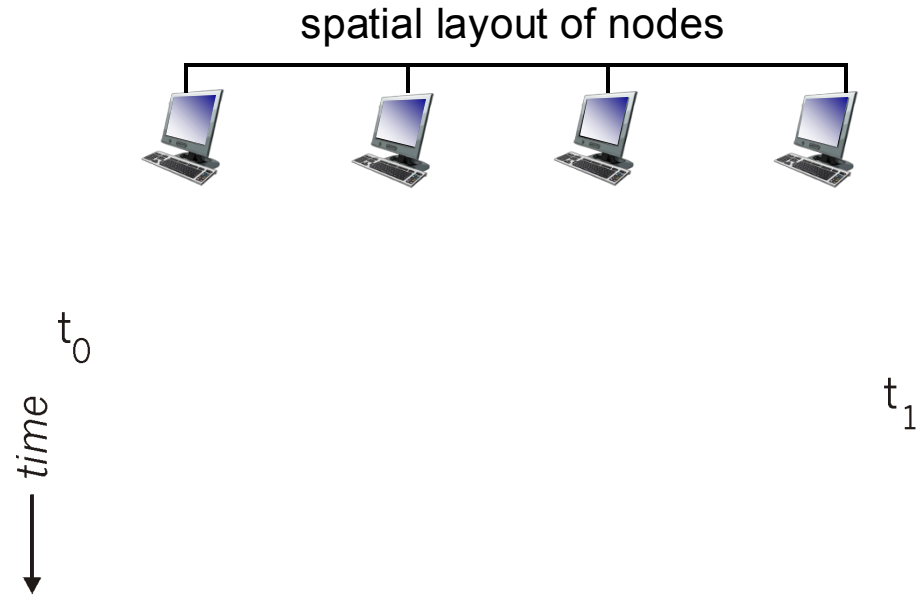
- if channel sensed idle: transmit entire frame
- if channel sensed busy: defer transmission

- Can collisions still occur on such a channel?

# CSMA: collisions

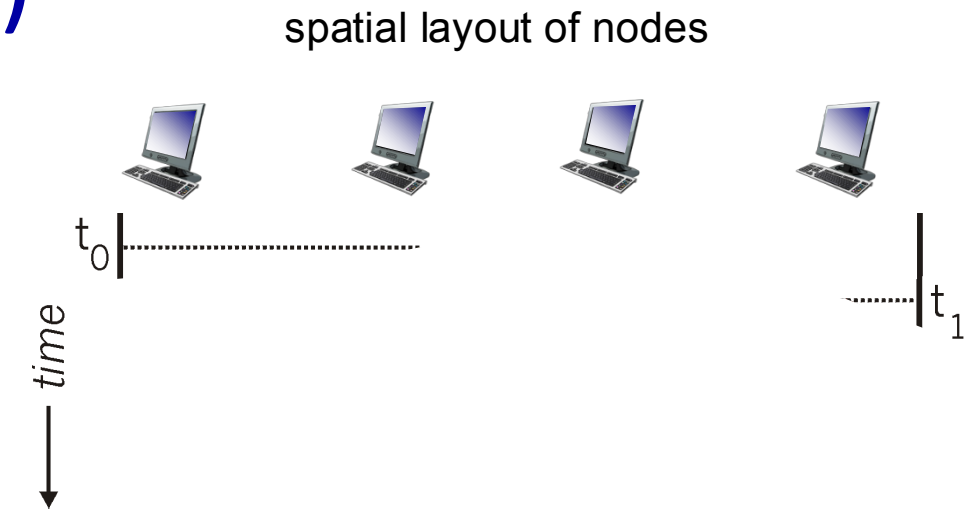
- collisions can *still* occur with carrier sensing:
  - propagation delay means two nodes may not hear each other's just-started transmission
- collision: entire packet transmission time wasted

***What to do in case of collision?*** ??

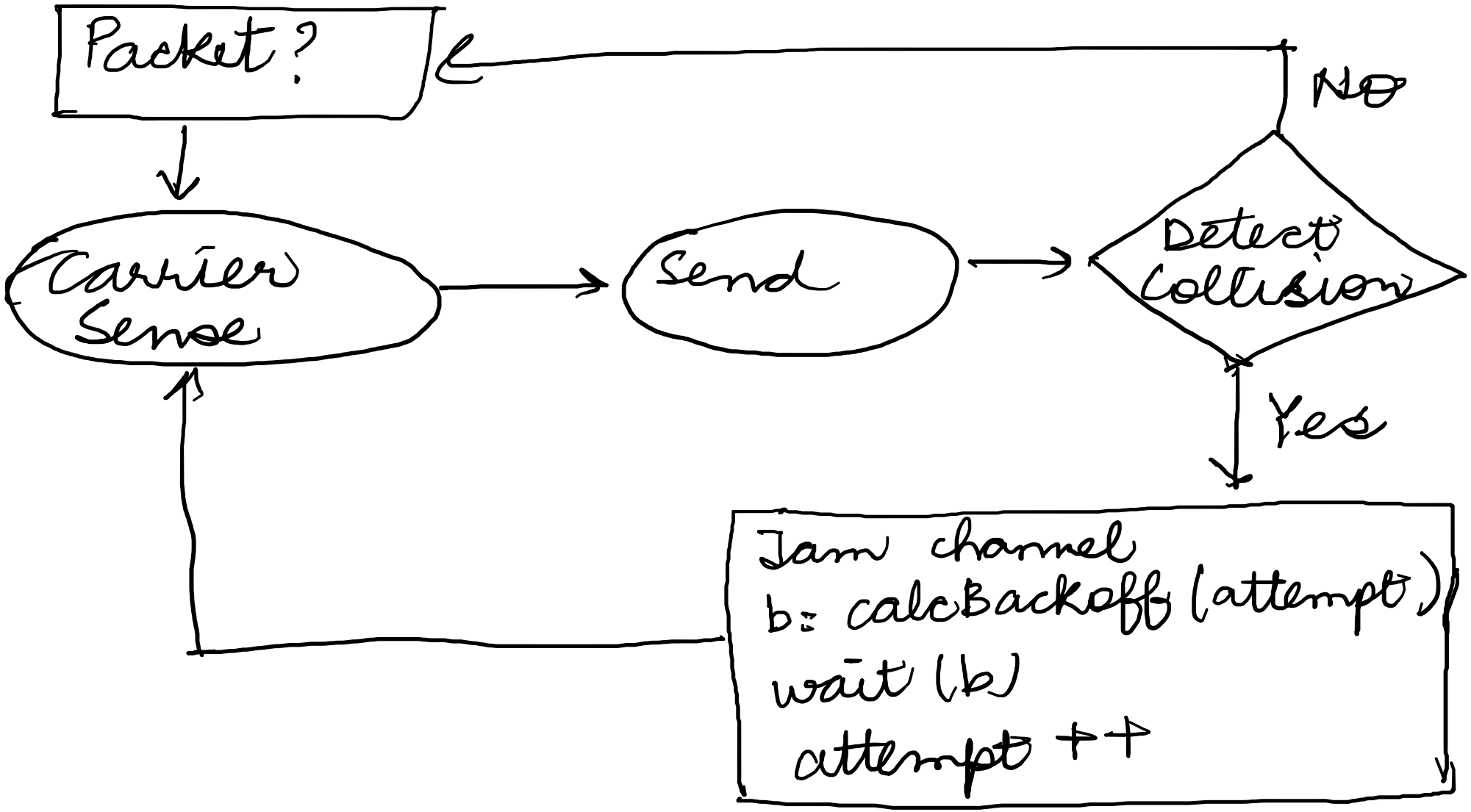


# CSMA/Collision Detection (CD)

- CSMA/CD reduces the amount of time wasted in collisions
  - Transmission aborted on collision detection
  - Send a jamming signal
- What happens after?
  - *Backoff:* Try after some random time!
- How to decide the backoff time?
  - Use binary exponential backoff
  - after *m*th collision, chooses *K* at random from $\{0,1,2, \ldots, 2^m-1\}$



# State Diagram for CSMA/CD



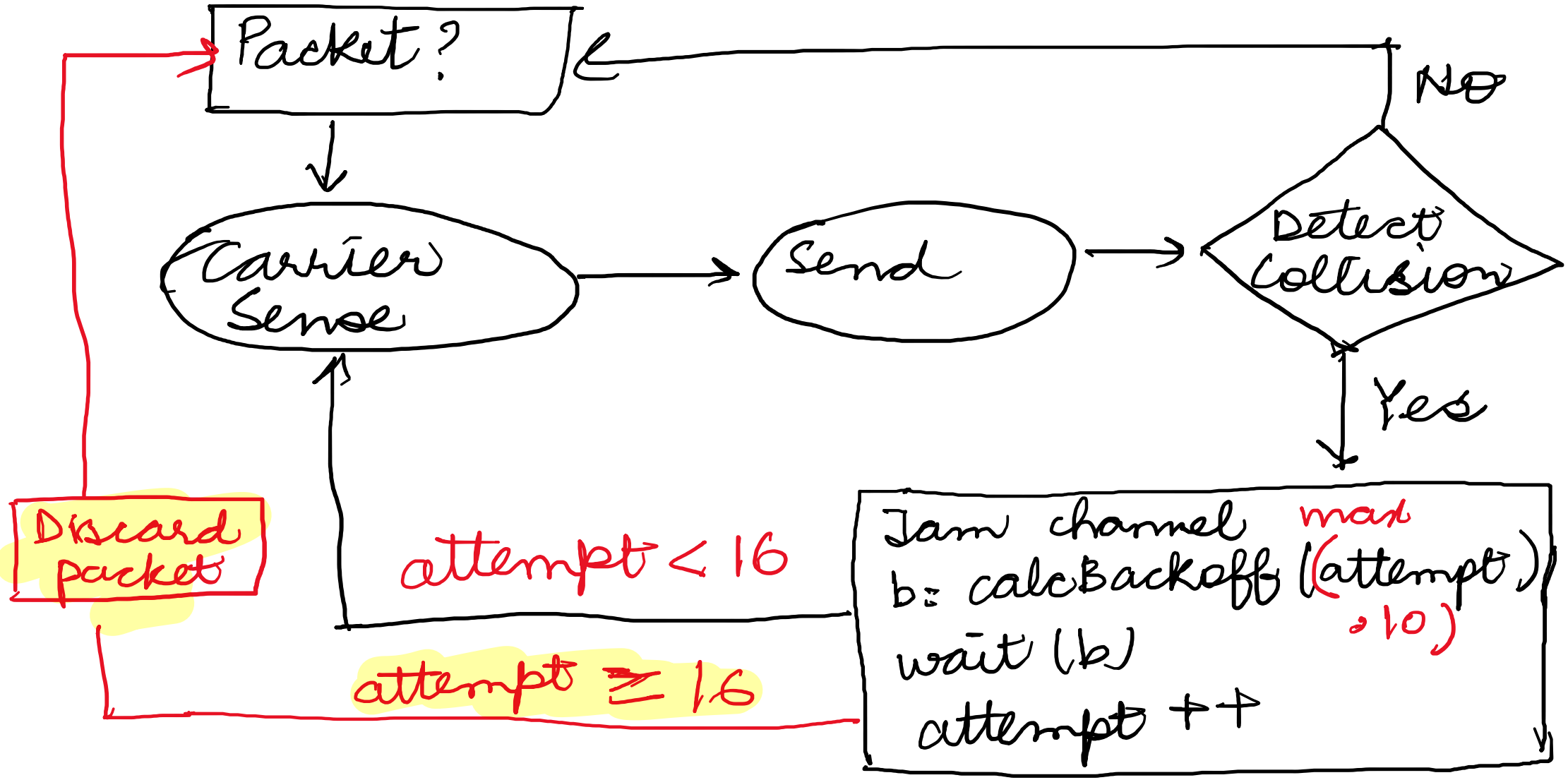
# Ethernet MAC Protocol

- Ethernet uses CSMA/CD
- Gap between two frames is **96-bit times** Why?
- Uses a minimum frame size (e.g. 64 bytes on 10 Mbps Ethernet) Why?
  - What if the frame is smaller?
  - Zero-pad for smaller packets

# Ethernet MAC Protocol

- Ethernet uses CSMA/CD
- Gap between two frames is **96-bit times** Why?
- Uses a minimum frame size (e.g. 64 bytes on 10 Mbps Ethernet) Why?
  - What if the frame is smaller?
  - Zero-pad for smaller packets
- Uses a maximum frame size Why?
  - Larger frames → higher probability of bit error
  - Others need to wait longer
  - Memory requirements on the network adapter

# State Diagram for Ethernet MAC



# CSMA/Collision Avoidance (CA): MAC for wireless network

- Two challenges
  - Detecting collisions
  - Hidden terminal problem

The hidden terminal problem occurs when two devices (or nodes) in a wireless network are unable to detect each other's transmissions due to being out of each other's range, but they are both within the communication range of a third device (e.g., a common access point or another node). As a result, these two devices may transmit simultaneously, leading to collisions at the third device, even though each device is unaware that the other is transmitting.

- How to know packet has been correctly transmitted?
  - Rely on acknowledgements, no ack ➔ loss
  - But it is slow

- ***Can we do better?***

# CSMA/CA

- Use control frames before sending data frames
  - Request To Send (RTS)
  - Clear To Send (CTS)
- Only transmit if CTS is received
- Any node that hears RTS/CTS will remain silent for some duration
- Duration specified in RTS/CTS frames known as **Network Allocation Vector (NAV)**
- Does this solve hidden terminal problem? Yes

# Summary: Ethernet Frame Structure

**802.3 Ethernet packet and frame structure**

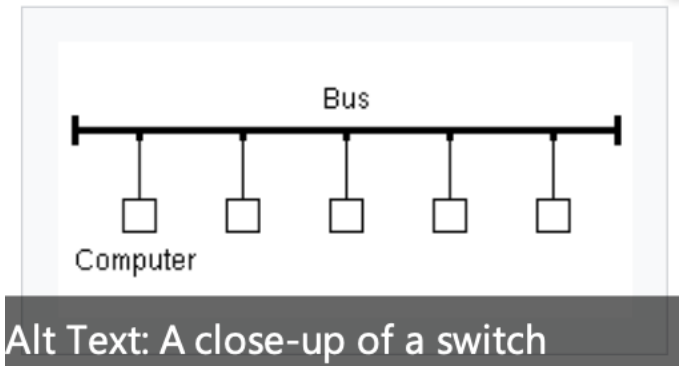
| Layer | Preamble | Start frame delimiter (SFD) | MAC destination | MAC source | 802.1Q tag (optional) | Ethertype (Ethernet II) or length (IEEE 802.3) | Payload | Frame check sequence (32-bit CRC) | Interpacket gap (IPG) |
|---|---|---|---|---|---|---|---|---|---|
| Length (octets) | 7 | 1 | 6 | 6 | (4) | 2 | 42–1500[c] | 4 | 12 |
| Layer 2 Ethernet frame | (not part of the frame) | | ← 64–1522 octets → | | | | | | (not part of the frame) |
| Layer 1 Ethernet packet & IPG | ← 72–1530 octets → | | | | | | | | ← 12 octets → |

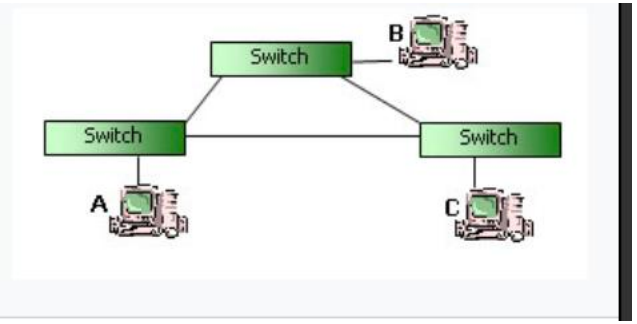
Can you detect headers related to link layer functions?

- Framing
- Error detection
- Reliability
- Link access

# Ethernet Evolution

- Ethernet has been dominant technology over 40 years
- Does it mean it has not changed? NO!
- Bus topology → Hub topology → Switched topology (collision free)
- What are the factors for its success?
  - Easy to administer and manage
  - Inexpensive
  - Newer versions were backward compatible --> incremental deployment



# Attendance