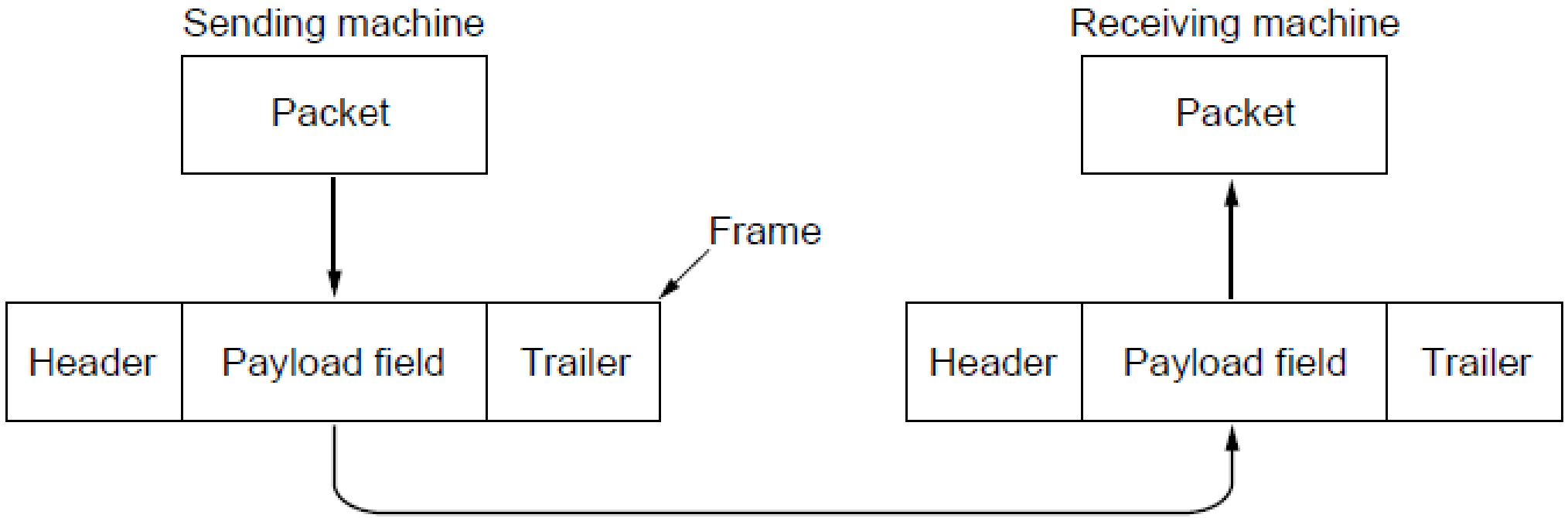
Unit 4: Issues in Data Link Layer Design

Contents

- Services provided to the Network Layer
- Framing
- Error Control (error detection and correction code)
- Flow Control
- Data Link Layer in the Internet (SLIP, PPP)
- MAC sub layer: CSMA/CD/CA
- IEEE standards (IEEE802.3 Ethernet IEEE 802.4 Token Bus, IEEE 802.5 Token Ring)

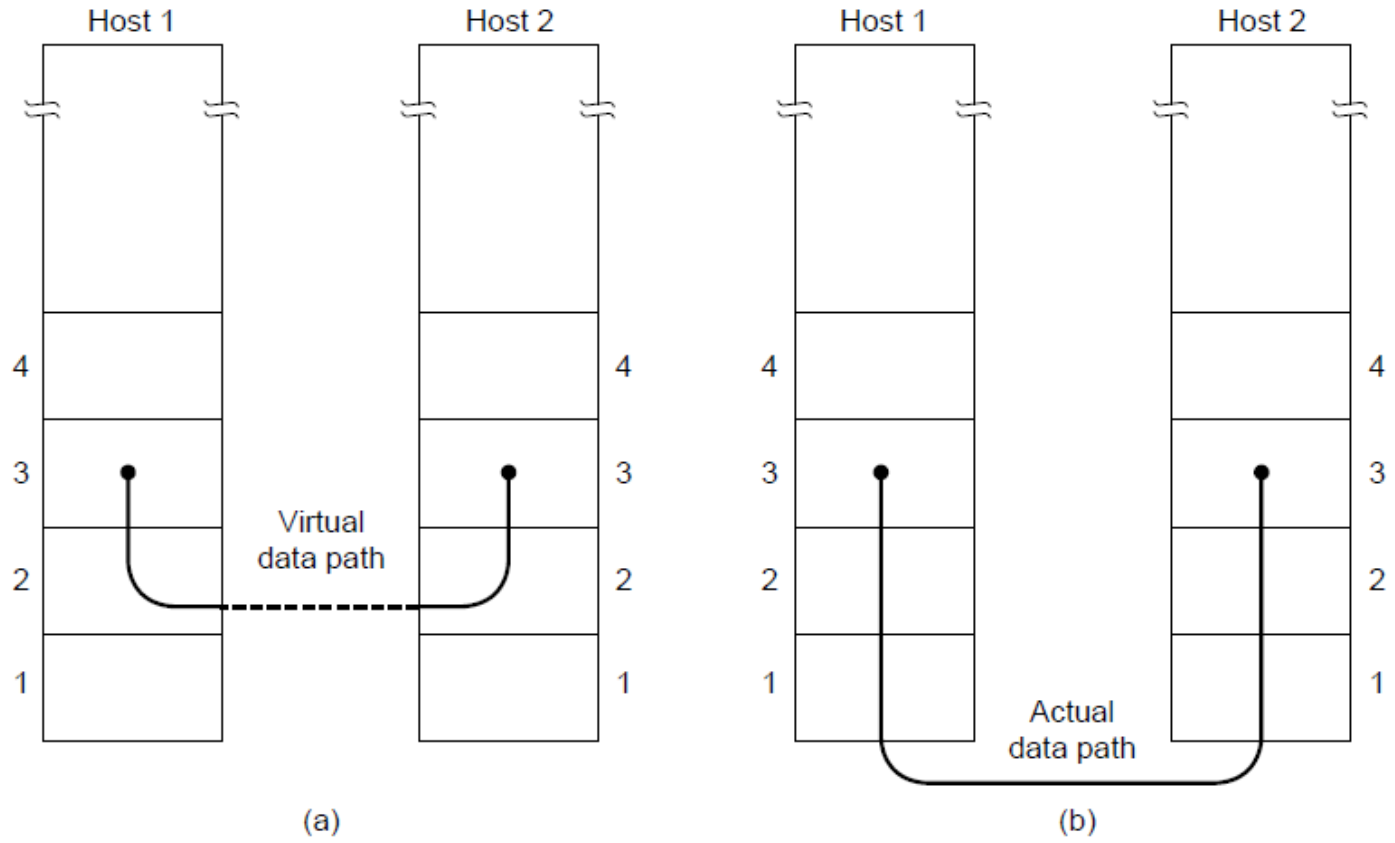
Services Provided to the Network Layer

- Packets & Frames



Services provided to the Network Layer

- (a) Virtual communication (b) Actual Communication



Services provided to the Network Layer

- Possible services
  - Unacknowledged connectionless service.
  - Acknowledged connectionless service.
  - Acknowledged connection-oriented service.

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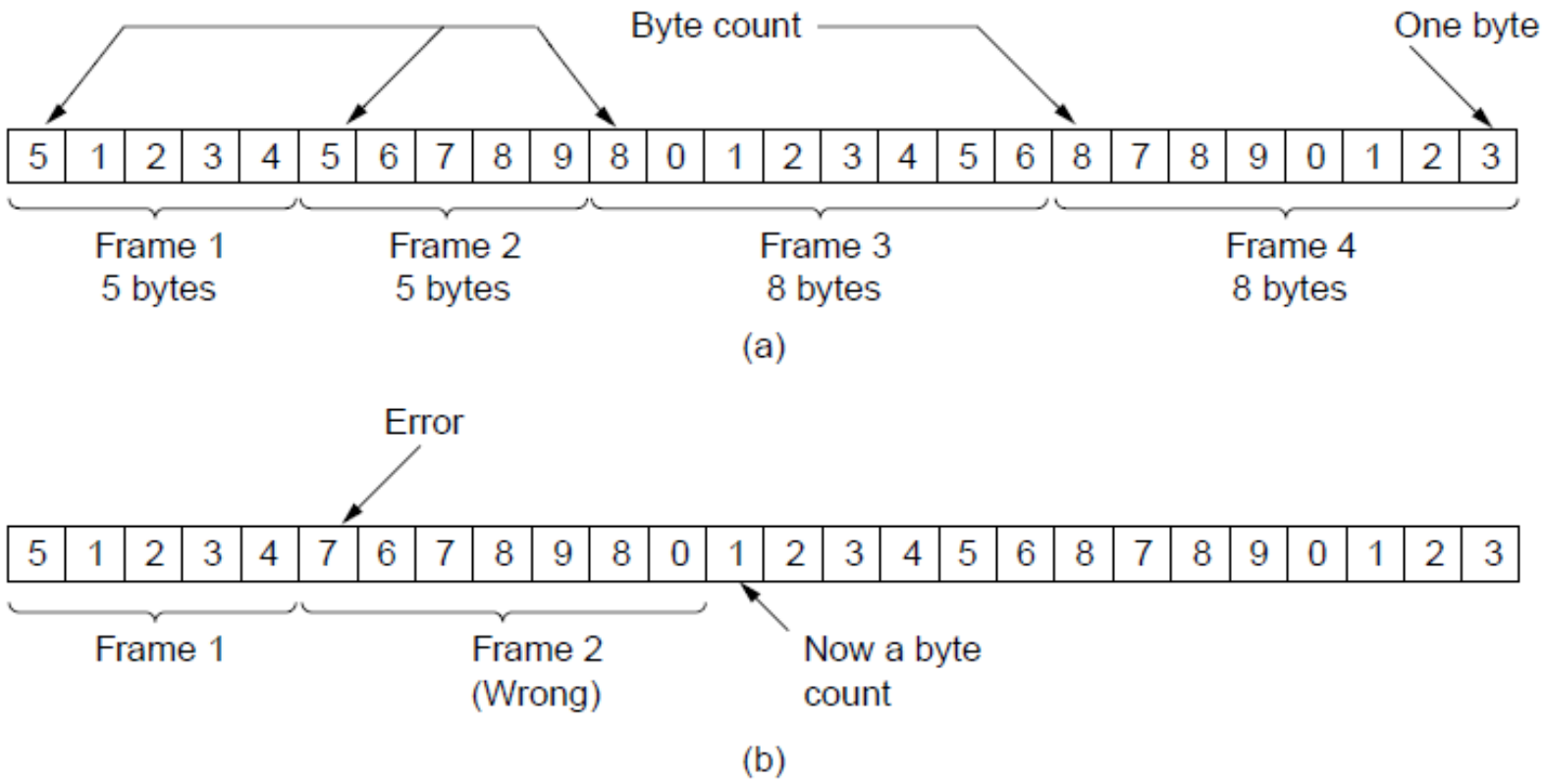
Framing

- Byte Count
- Flag bytes with byte stuffing
- Flag bits with bit stuffing
- Physical layer coding violations

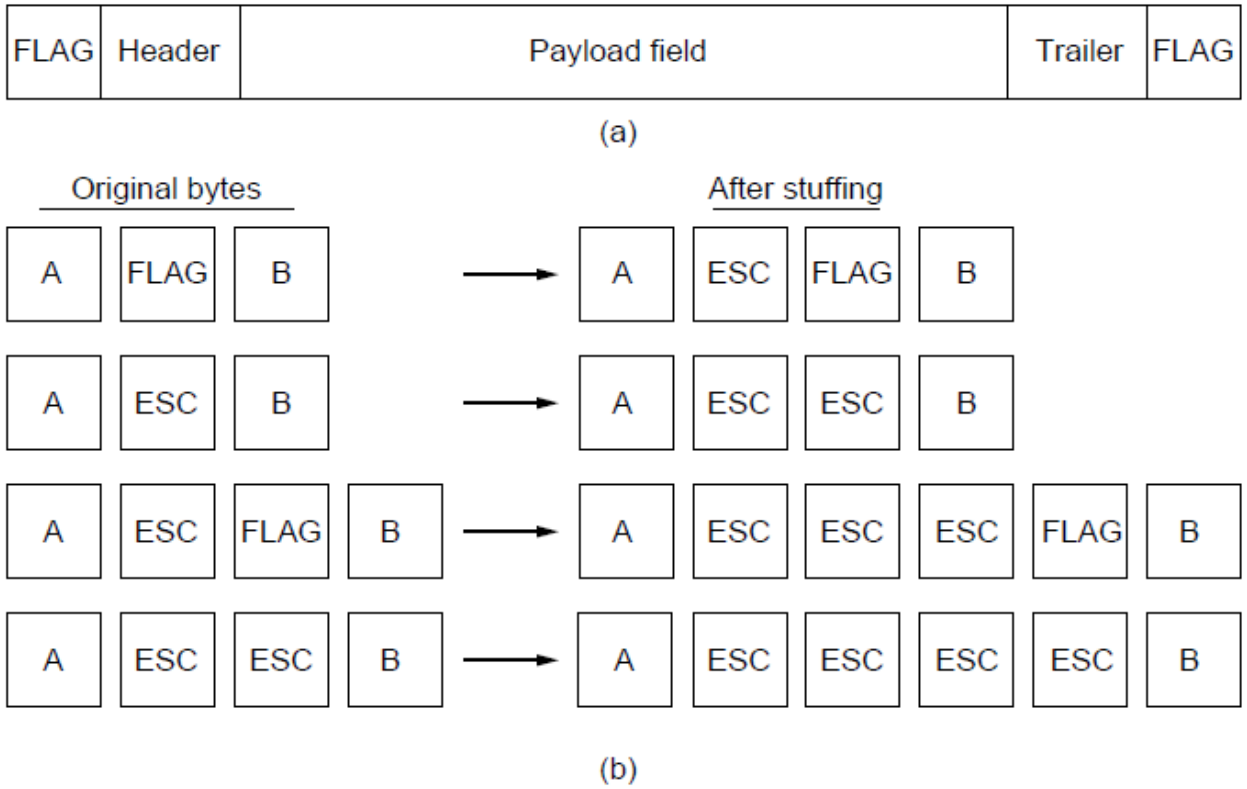
Framing

- A byte stream (a) without error (b) with error



Framing

- (a) A frame delimited by flag bytes
- (b) Four examples of byte sequences before and after byte stuffing.



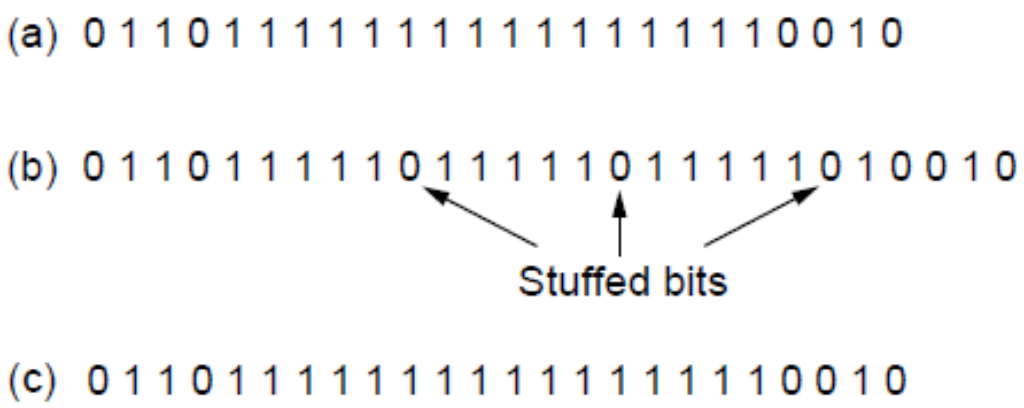
Framing

Bit stuffing.

(a) The original data.

(b) The data as they appear on the line.

(c) The data as they are stored in the receiver's memory after destuffing.



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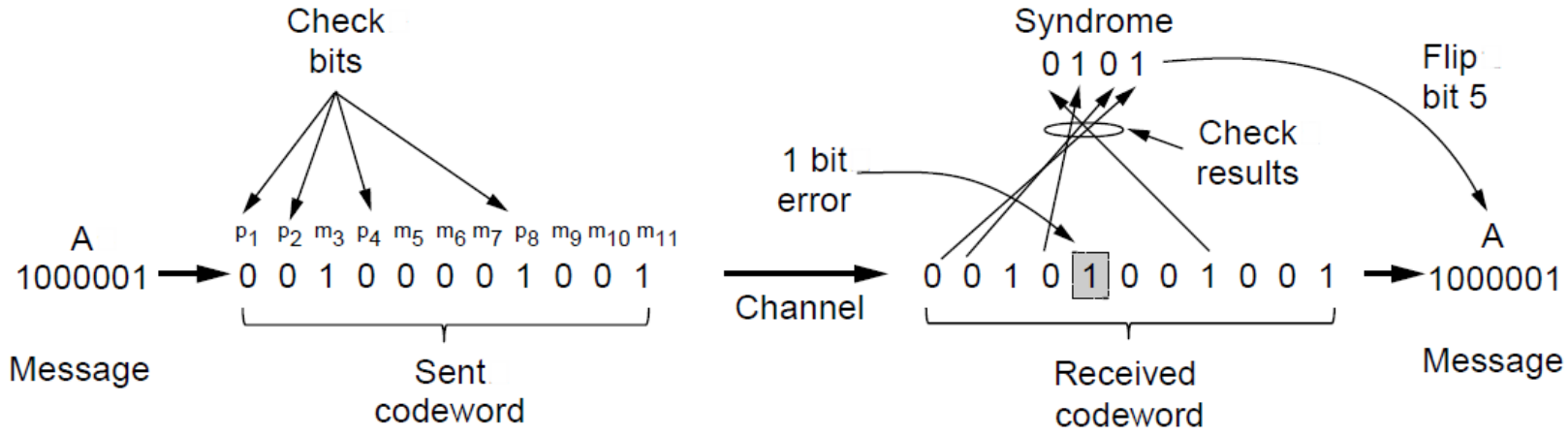
Error Control (error detection and correction code)

1. Hamming codes.
2. Binary convolutional codes.
3. Reed-Solomon codes.
4. Low-Density Parity Check codes.

Error Control (error detection and correction code)

- Example of an (11, 7) Hamming code correcting a single-bit error.

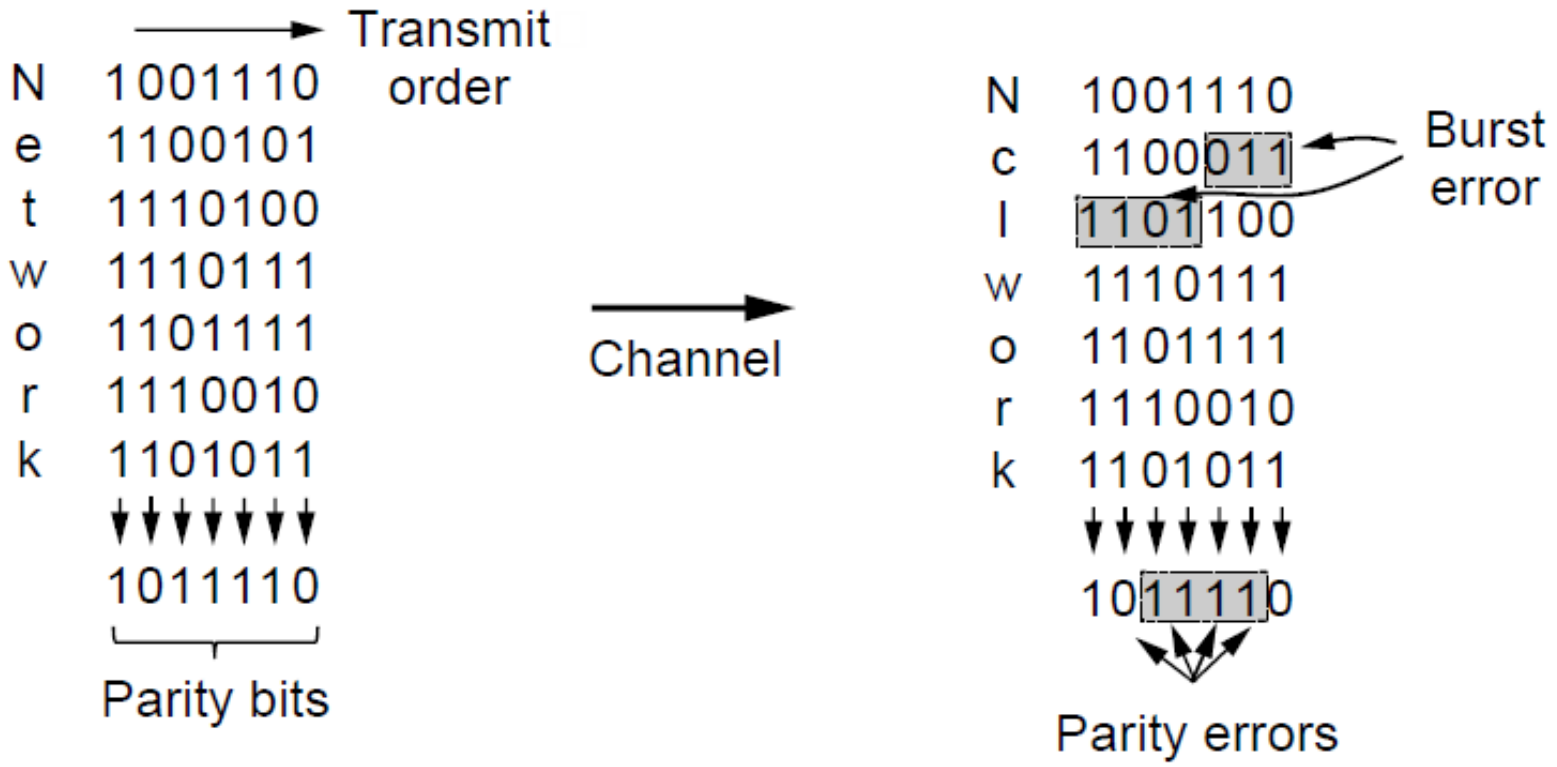


Error Control (error detection and correction code)

- Linear, systematic block codes
  - Parity.
  - Checksums.
  - Cyclic Redundancy Checks (CRCs).

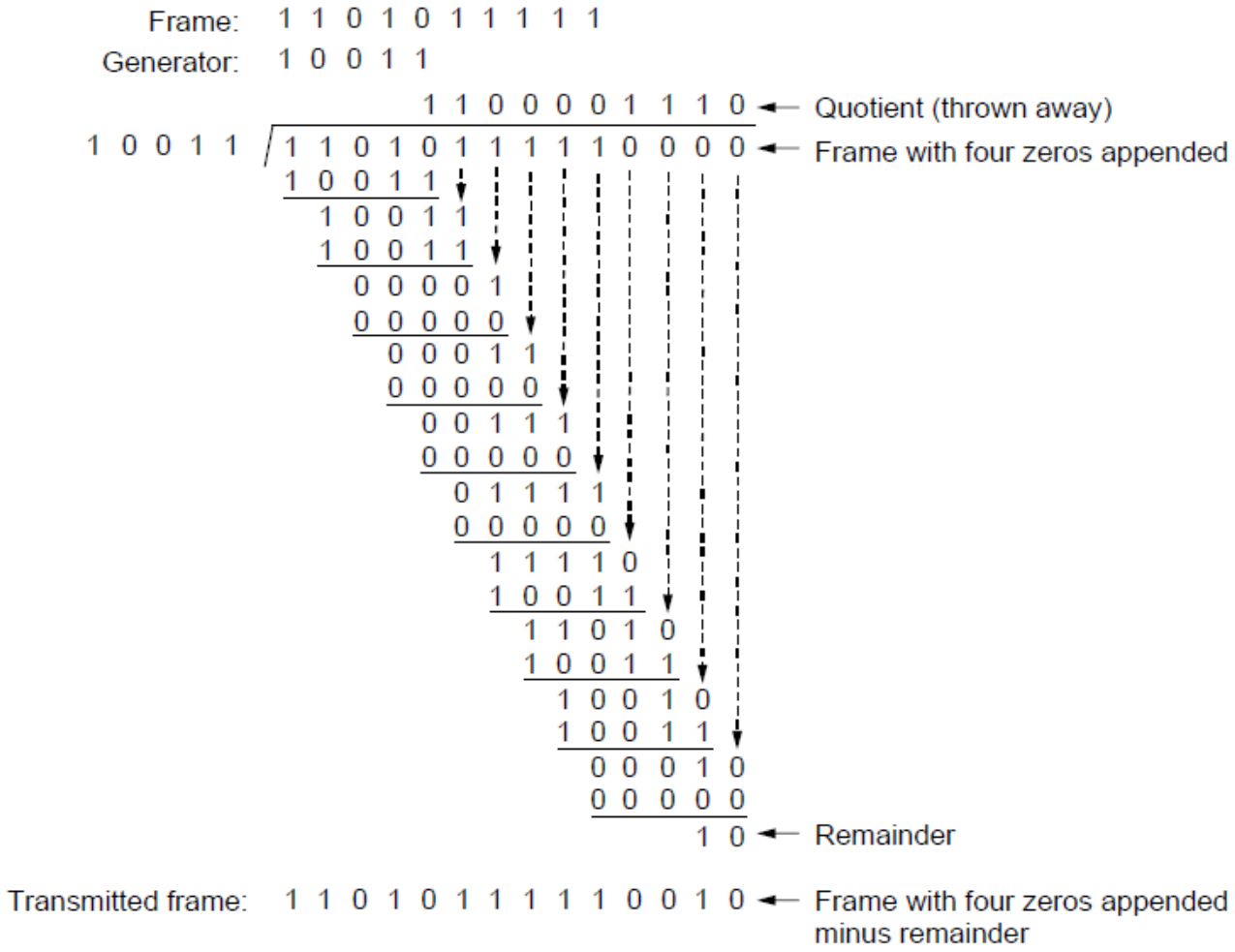
Error Control (error detection and correction code)

- Interleaving of parity bits to detect a burst error.



Error Control (error detection and correction code)

- Example calculation of the CRC



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Flow Control

- Two types of flow control:
  - Feedback based flow control
  - Rate based flow control

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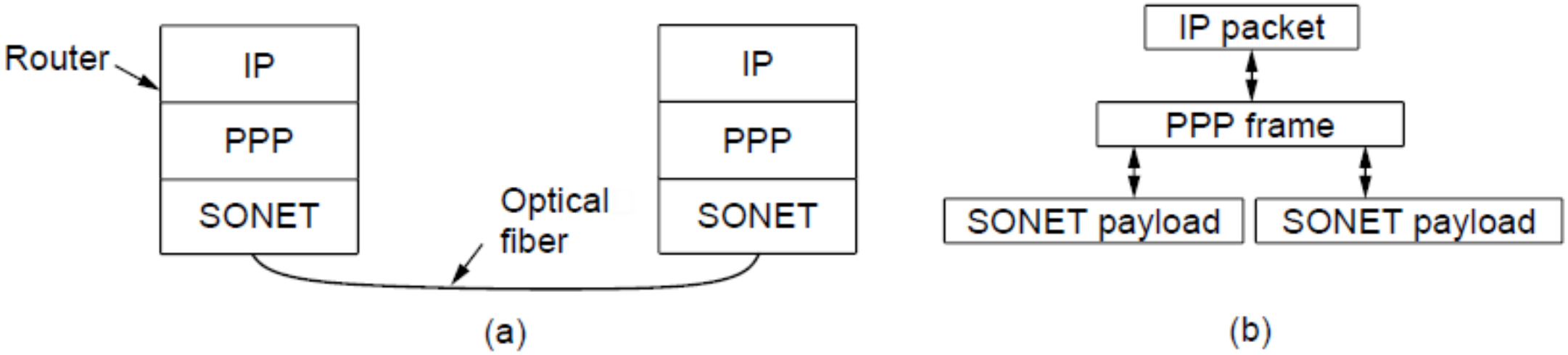
Data Link Layer in the Internet (SLIP, PPP)

- Packet over SONET. (a) A protocol stack. (b) Frame relationships

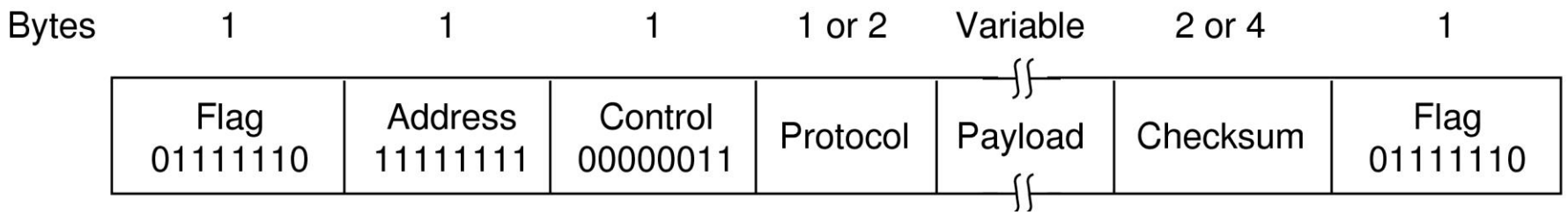


Data Link Layer in the Internet (SLIP, PPP)

- PPP Feature
  - Separate packets, error detection
  - Link Control Protocol
  - Network Control Protocol

Data Link Layer in the Internet (SLIP, PPP)

- The PPP full frame format for unnumbered mode operation



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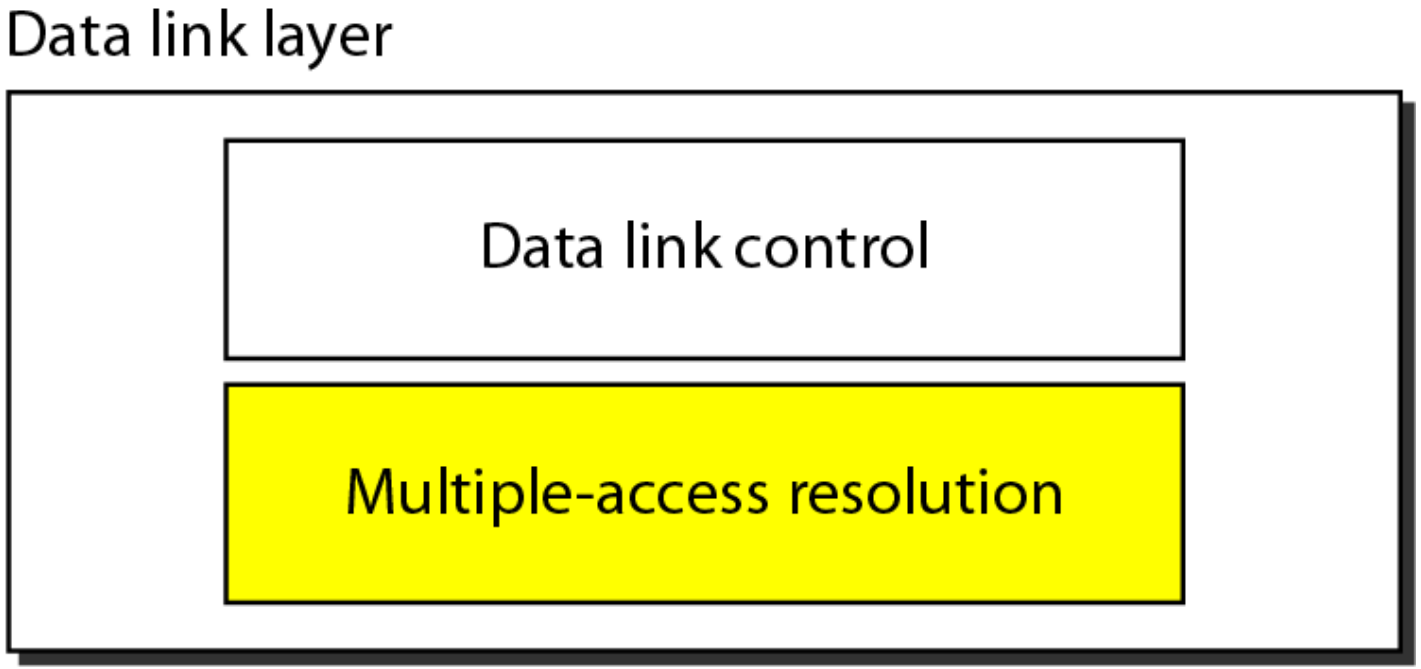
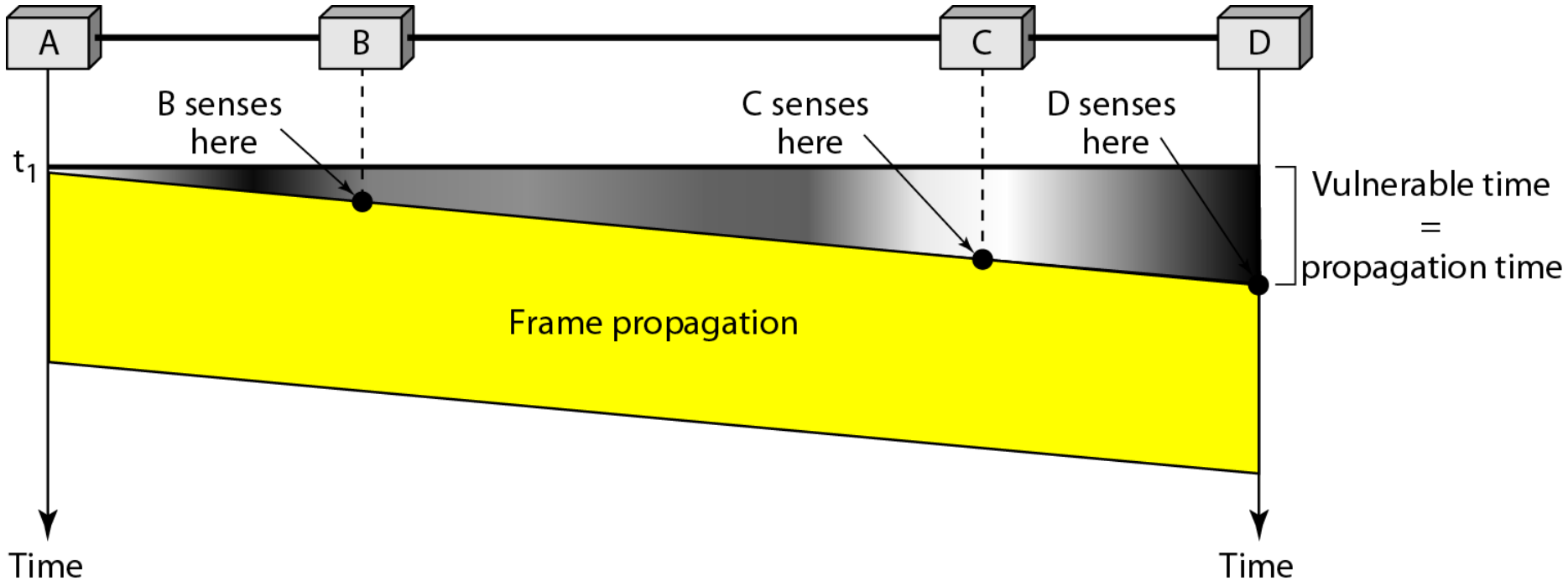
MAC sub layer: CSMA/CD/CA



MAC sub layer: CSMA/CD/CA

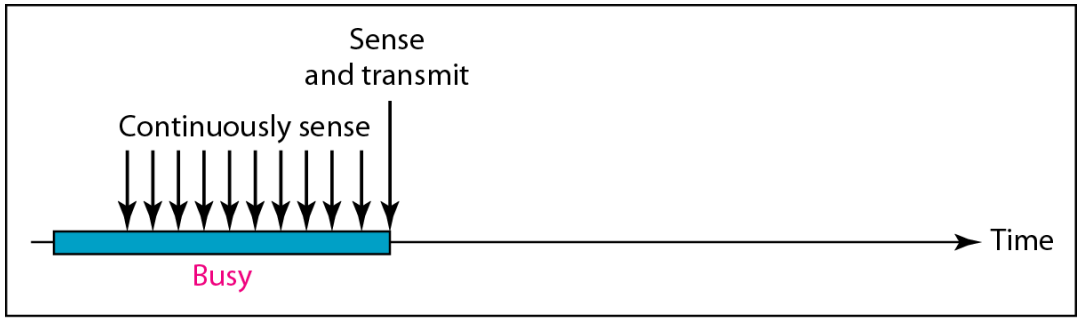
- Carrier sense Multiple Access (CSMA)
- To minimize chance of collision.
- Based on principle “sense before transmit” or “listen before talk”.
- CSMA can reduce the possibility of collision, but it cannot eliminate it.

MAC sub layer: CSMA/CD/CA

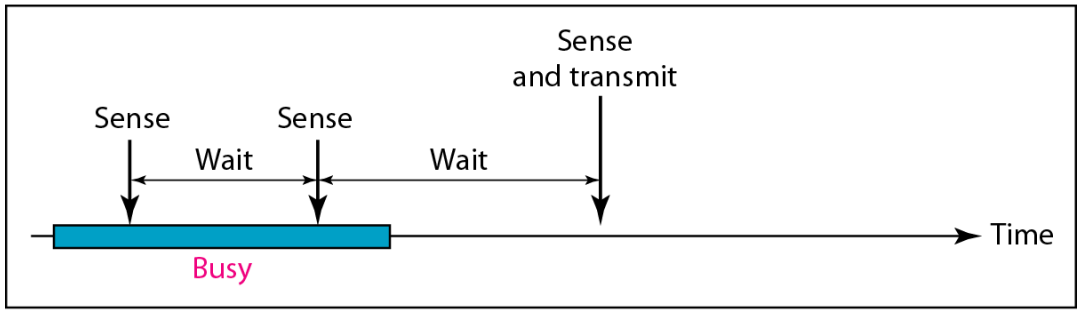


MAC sub layer: CSMA/CD/CA

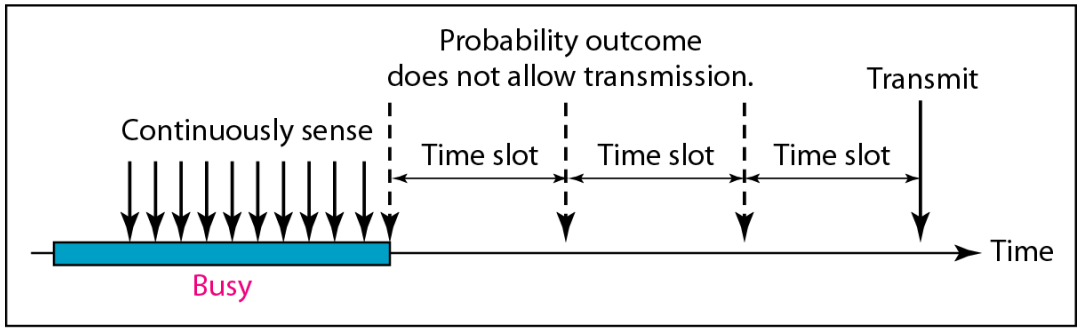
- The solution



a. 1-persistent

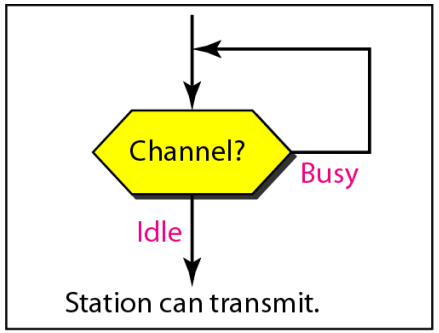


b. Nonpersistent

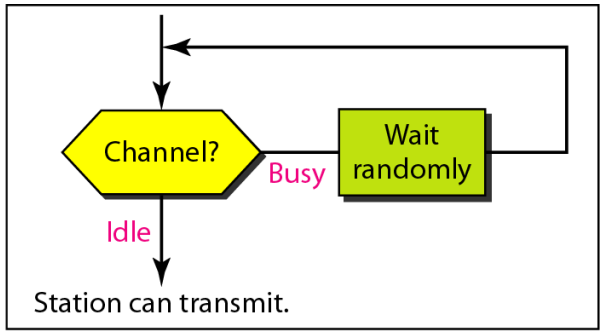


c. p-persistent

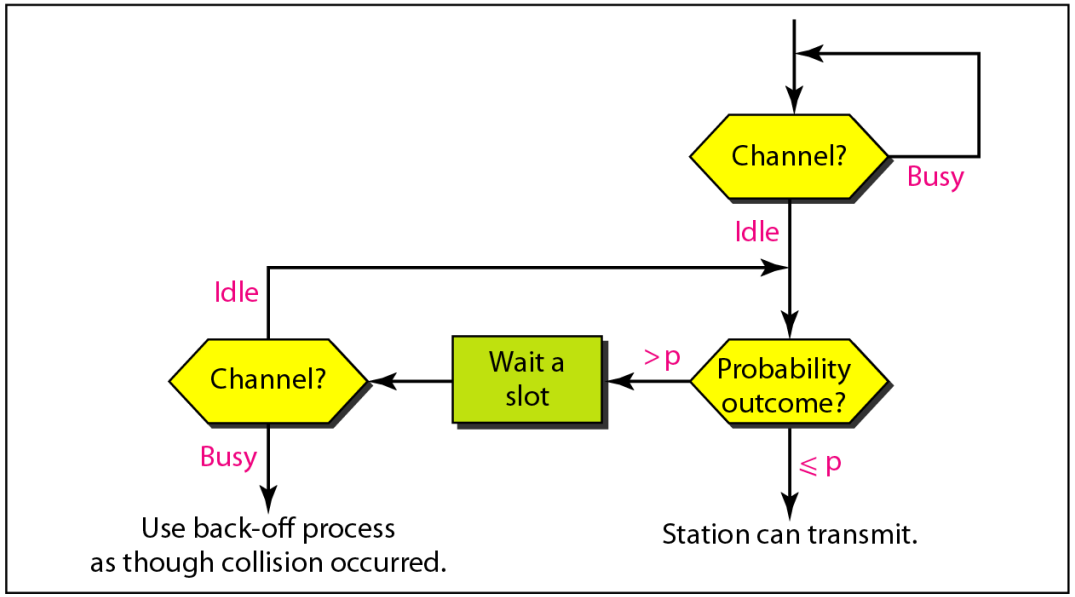
MAC sub layer: CSMA/CD/CA



a. 1-persistent



b. Nonpersistent

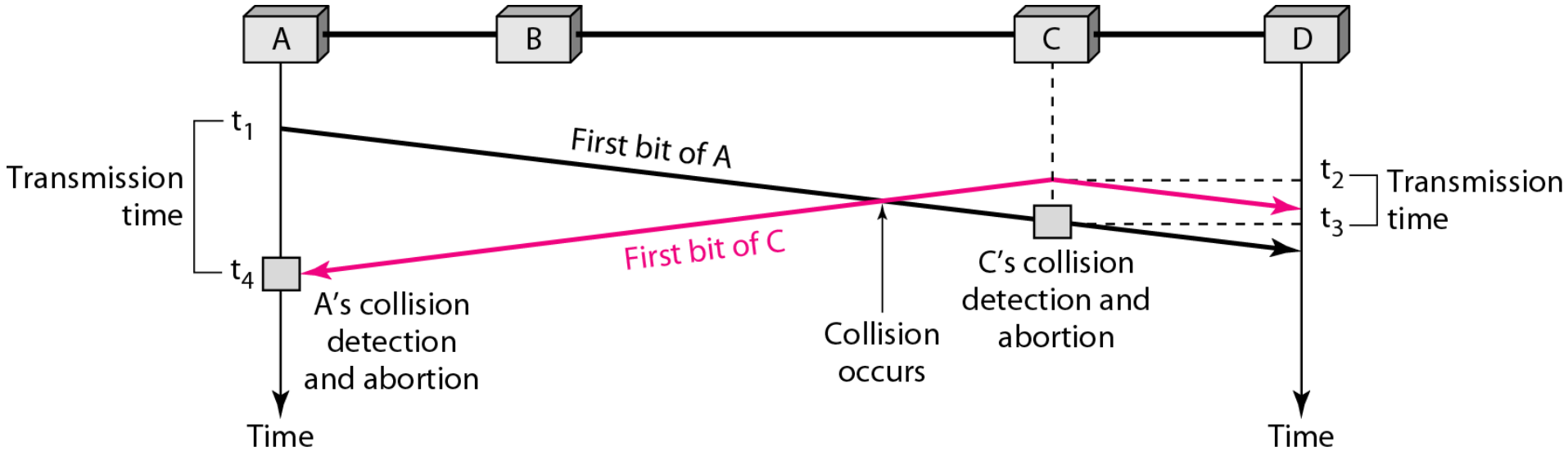


c. p-persistent

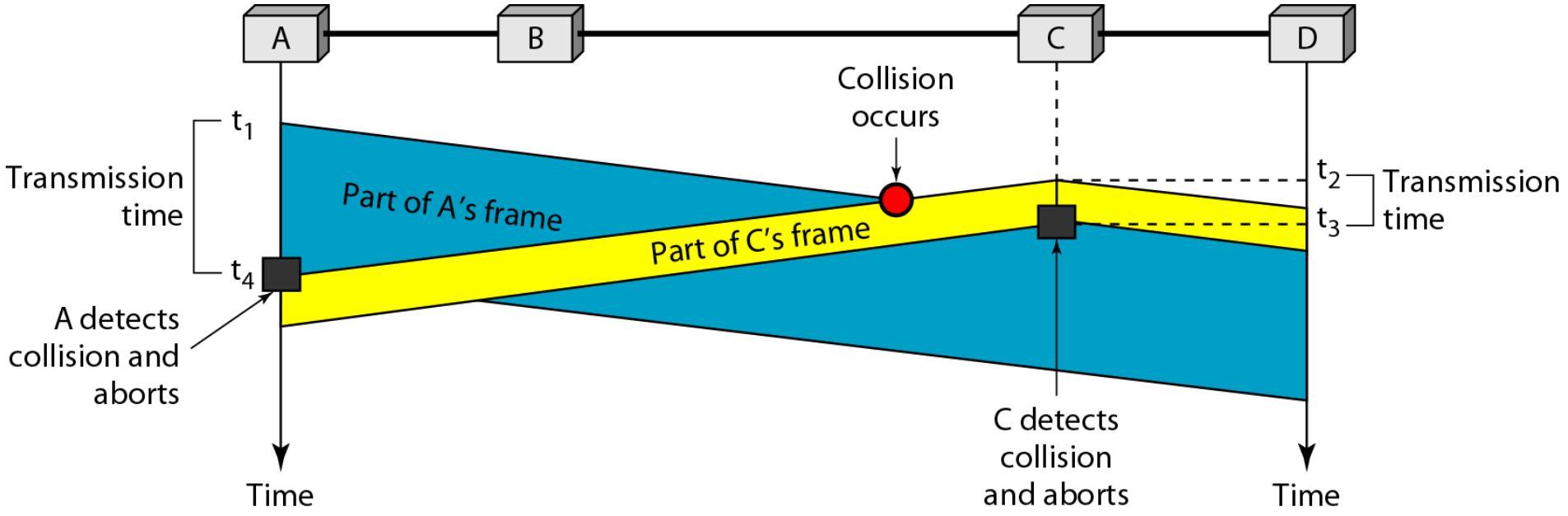
MAC sub layer: CSMA/CD/CA

- CSMA method does not specify the procedure following collision.
- CSMA/CD – Collision Detection augments the algorithm to handle the collision.
- In this method, a station monitors the medium after it sends a frame to see if the transmission was successful.
- If so, the station is finished.
- If, however, there is a collision, the frame is sent again.

MAC sub layer: CSMA/CD/CA



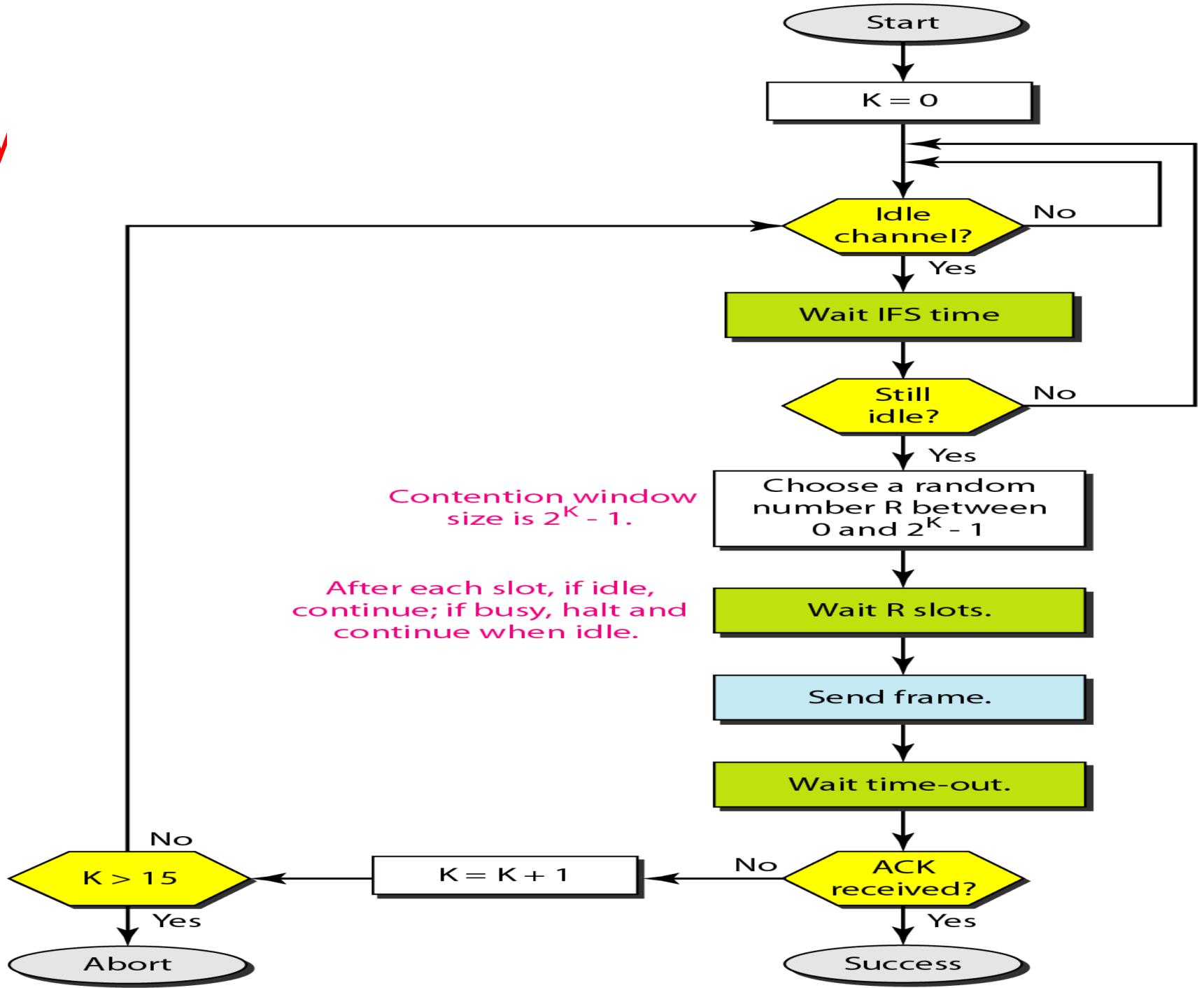
MAC sub layer: CSMA/CD/CA



MAC sub layer: CSMA/CD/CA

- CSMA – CA collision avoidance was invented for wireless networks.
- Collisions are avoided through the use of CSMA/CA's three strategies:
  - The interframe space (IFS)
  - Contestation window
  - Acknowledgement

MAC sub lay

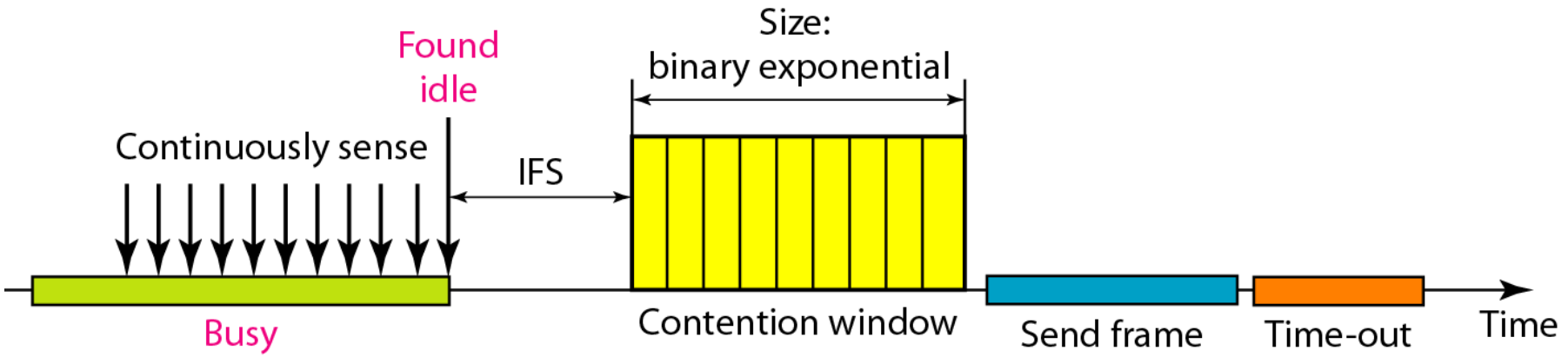

Start
K = 0
Idle channel?
No
Yes
Wait IFS time
Still idle?
No
Yes
Choose a random number R between 0 and 2^K - 1
Contention window size is 2^K - 1.
After each slot, if idle, continue; if busy, halt and continue when idle.
Wait R slots.
Send frame.
Wait time-out.
ACK received?
No
Yes
Success
K = K + 1
K > 15
No
Yes
Abort

MAC sub layer: CSMA/CD/CA

- Interframe Space
  - When an ideal channel is found, the station does not send immediately.
  - It waits for a period of time called the interframe space/IFS.
  - Even though the channel may appear ideal when it is sensed, a distant station may have already started transmitting.
  - The distant station’s signal has not yet reached this station.
  - IFS time allows the front of the transmitted signal by the distant station to reach this station.
  - After waiting an IFS time, if the channel is idle, the station can send, but it still needs to wait a time equal the contention window.

MAC sub layer: CSMA/CD/CA

- Contention Window
  - An amount of time divided into slots.
  - A station that is ready to send choose a random of slots as its wait time.



MAC sub layer: CSMA/CD/CA

- Acknowledgement
  - With all these precautions, there still may be collision resulting in destroyed data.
  - In addition, the data may be corrupted during the transmission.
  - The positive acknowledgement and the time-out time can help guarantee the receiver has received the frame.

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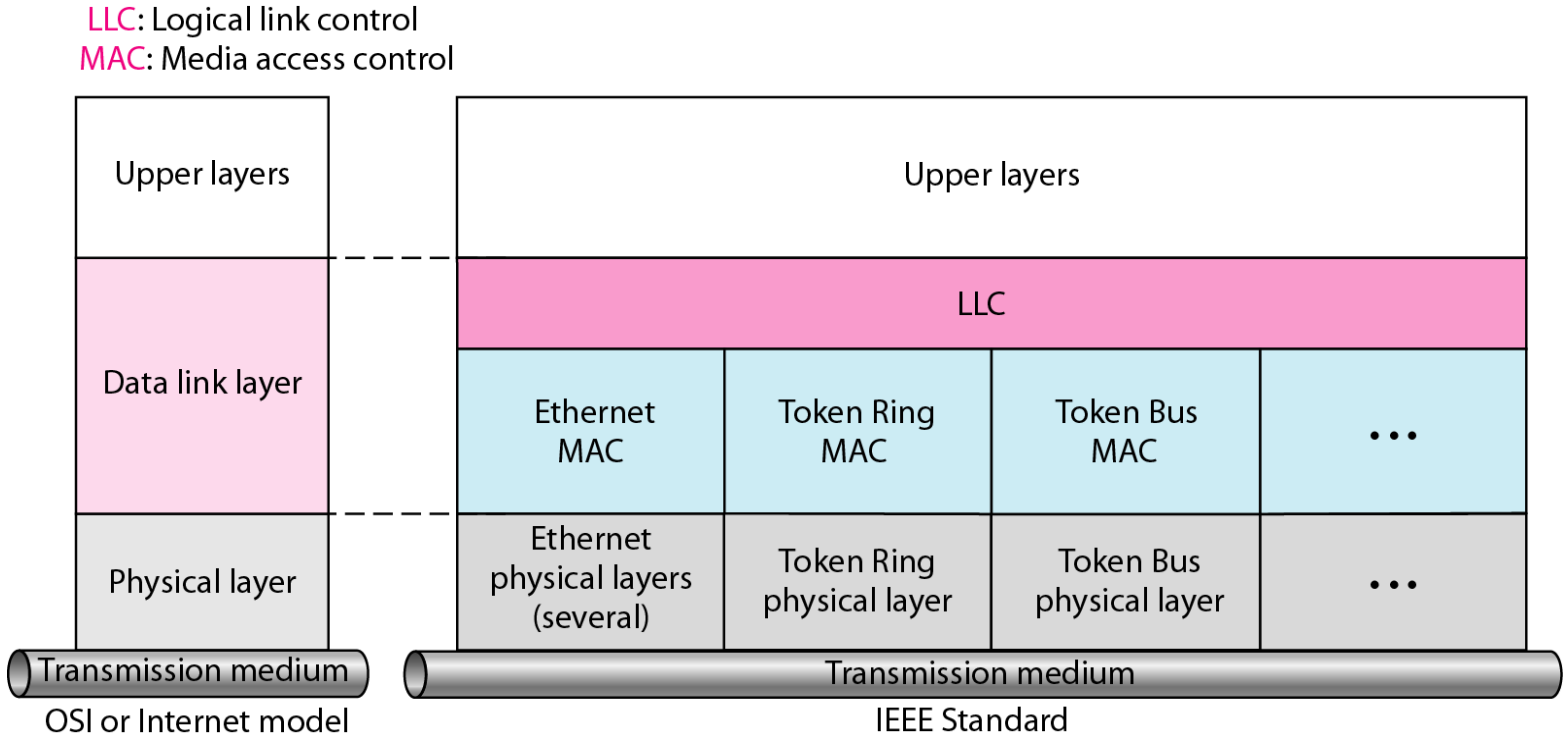
- IEEE 802.3 Ethernet
  - In 1985, the computer society of IEEE started a project, called project 802, to set standards to enable intercommunication among equipment from a variety of manufacturers.



IEEE standards (IEEE802.3 Ethernet IEEE 802.4 Token Bus, IEEE 802.5 Token Ring)

- IEEE 802.3 Ethernet
- The original Ethernet was created in 1976 at Xerox's Palo Alto Research Center (PARC). Since then, it has gone through four generations.