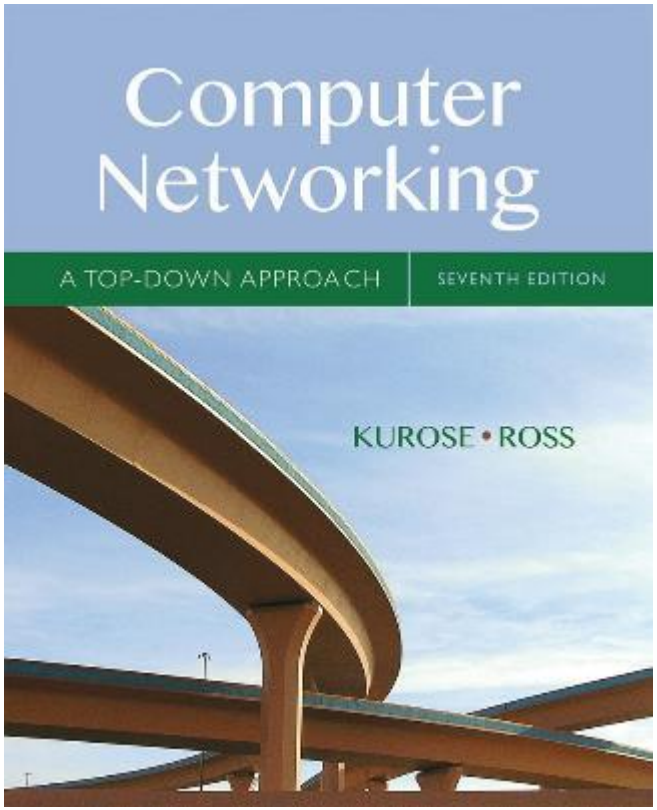
Chapter 6
The Link Layer and LANs

Supplementary material



Computer Networking: A Top Down Approach

7th edition
Jim Kurose, Keith Ross
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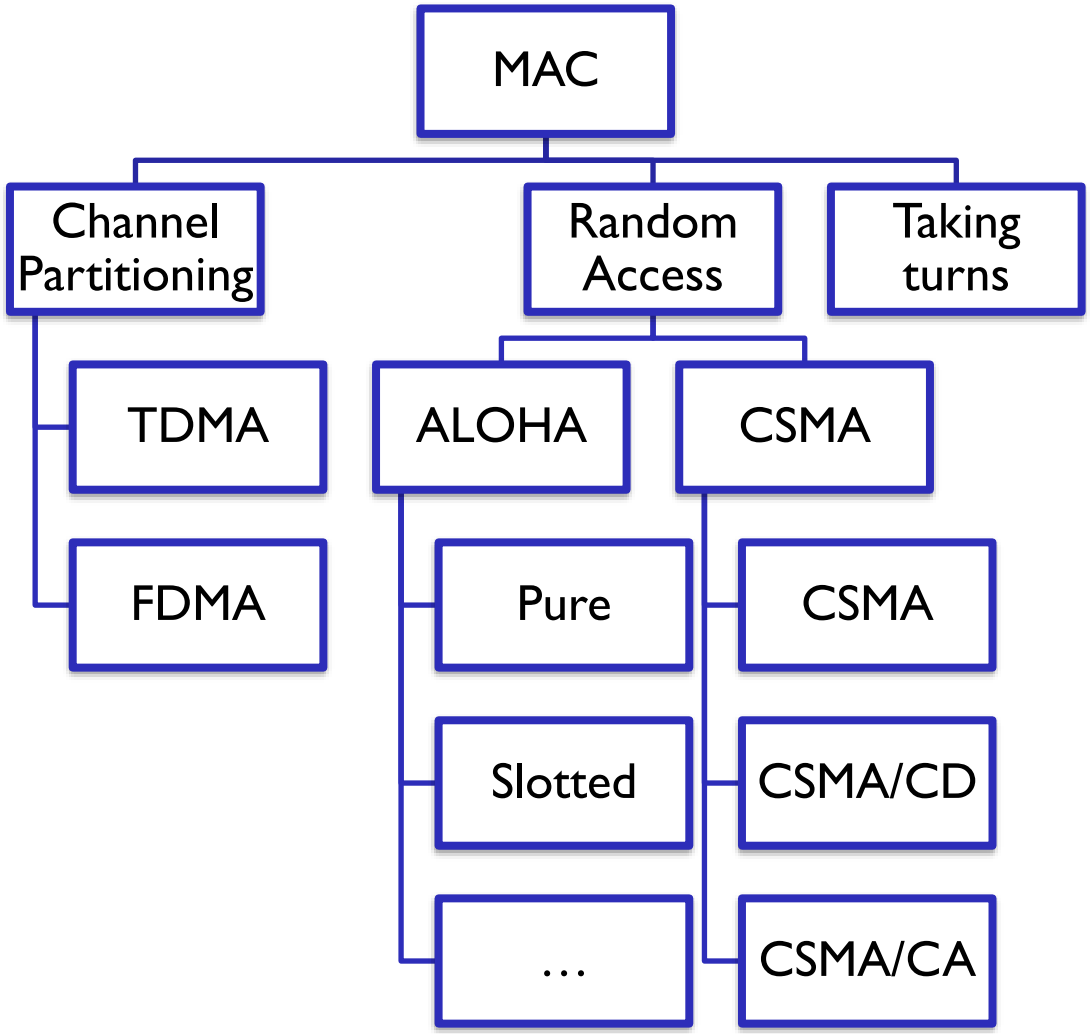
Medium access control (MAC):
three broad classes



Pure ALOHA

- Pure ALOHA technology was developed at the University of Hawaii to interconnect a packet radio network across multiple islands in Hawaii. The protocol has the following procedure:
  - (1) Frames are transmitted at will.
  - (2) The sending station listens for the time equal to the maximum possible round-trip delay.
  - (3) The station that receives the frame has to send an acknowledgment. If the acknowledgment is not received before the timer expires, the frame is retransmitted.
  - (4) The error is checked at the receiving station, which ignores all of erroneous frames.
- The successful transmission for Pure ALOHA is only 18%.

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Slotted ALOHA

- Improvement of Pure ALOHA led to the creation of Slotted ALOHA. The procedures of the algorithm are as follows:
  - (1) Time on the channel is organized into a uniform slot, and each slot size is equal to a frame transmission time.
  - (2) A frame is transmitted only at the beginning of the time slot
  - (3) If the frame does not go through, the frame is sent again after a random amount of time.
- The performance of the Slotted ALOHA is 37% empty slots, 37% success, and 26% collisions.
- This yields the successful transmission of 37%.

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ALOHA schemes: three problems and …

- Three problems
  1. the station not listening to the transmission medium before sending a packet.
  2. the station not listening to the transmission medium during the sending of the packet.
  3. the station not taking advantage of a much shorter propagation delay than the frame transmission time.
     - The shorter propagation delay provides a fast feedback for the state of the current transmission.
- Various versions of CSMA (to be introduced) to solve only the first problem.
  - The variants of CSMA schemes are dealing with what to do if the transmission medium is sensed to be busy. These CSMA schemes are described next.

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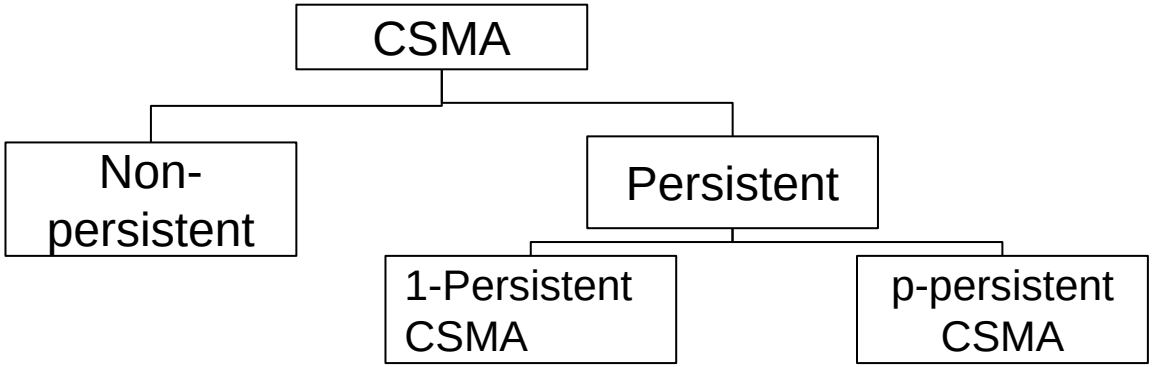
Carrier Sense Multiple Access (CSMA)

Determine when to initiate transmission onto the shared medium?



- In nonpersistent CSMA
  - **a non-aggressive transmission algorithm**
  - if a frame is waiting for transmission, a station checks if the medium is idle and transmits the frame right away if the medium is idle.
  - If the medium is busy, the station waits for a random amount of time and then repeats the same procedure to check if the medium is idle.
  - The algorithm can reduce the possibility collisions, but there is waste due to the idle time.

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Carrier Sense Multiple Access (CSMA)

- For **1-**persistent CSMA, the algorithm is used as part of the CSMA/CD. The procedure is as follows:
  - (1) A station checks if the transmission medium is idle, and then it transmits the frame if it is idle.
  - (2) If the medium is busy, the station continues to listen until the channel is idle, and then it transmits right away (immediately).
    - the message (a frame) unconditionally (**i.e. with probability=1**)
  - (3) If no acknowledgment is received, the station waits for a random amount of time and repeats the same procedure to check if the transmission medium is idle.
- The scheme would guarantee a collision if more than one station were waiting for transmitting frames.

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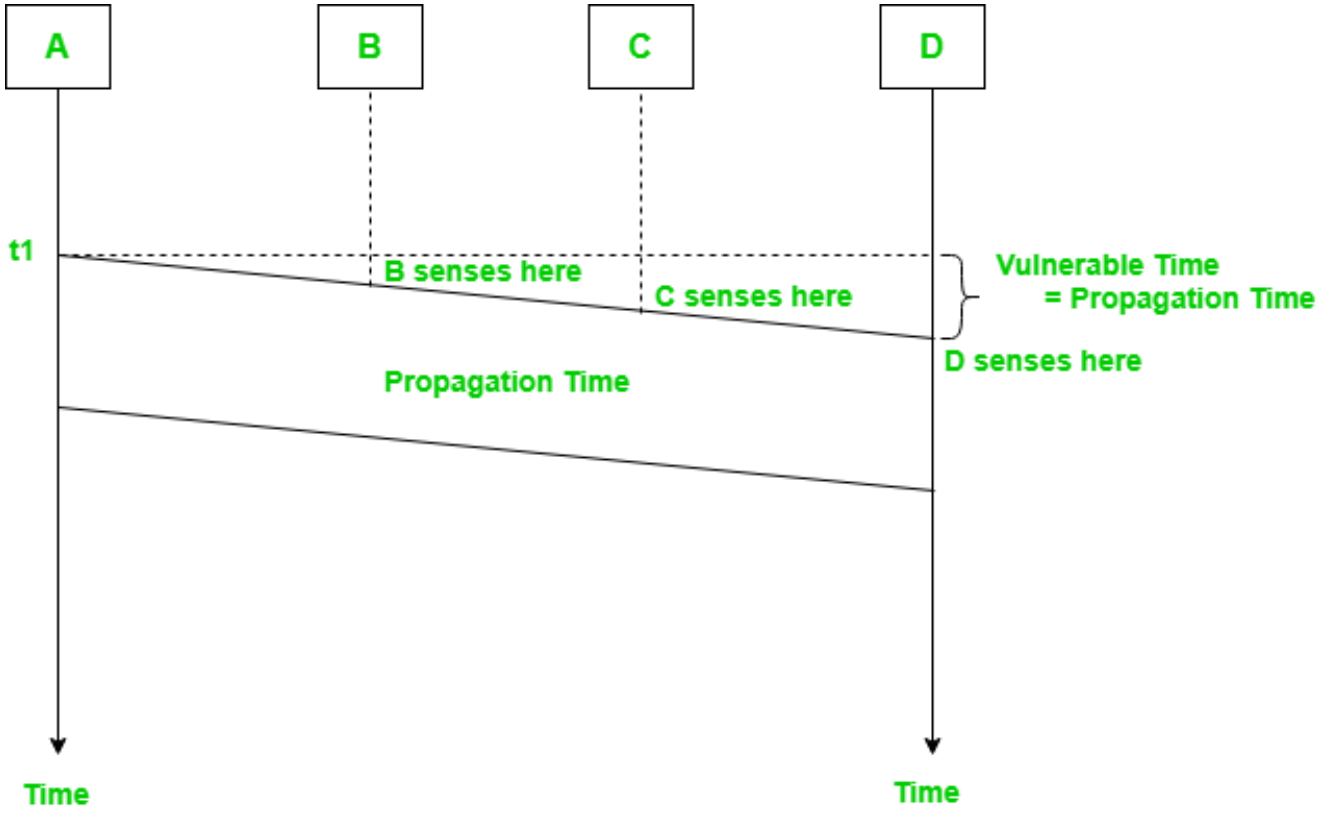
Carrier Sense Multiple Access (CSMA)

- The p-persistent CSMA algorithm takes a moderate approach between nonpersistent and 1-persistent CSMA.
  - It specifies a value; the probability of transmission after detecting the medium is idle.
  - The station first checks if the medium is idle, transmits a frame with the probability p if it is idle, and delays one time unit of maximum propagation delay with 1-p.
  - If the medium is busy, the station continues to listen until the channel is idle and repeats the same procedure when the medium is idle.
  - In general, at the heavier load, decreasing p would reduce the number of collisions.
  - At the lighter load, increasing p would avoid the delay and improve the utilization.
  - The value of p can be dynamically adjusted based on the traffic load of the network.

Carrier Sense Multiple Access (CSMA)

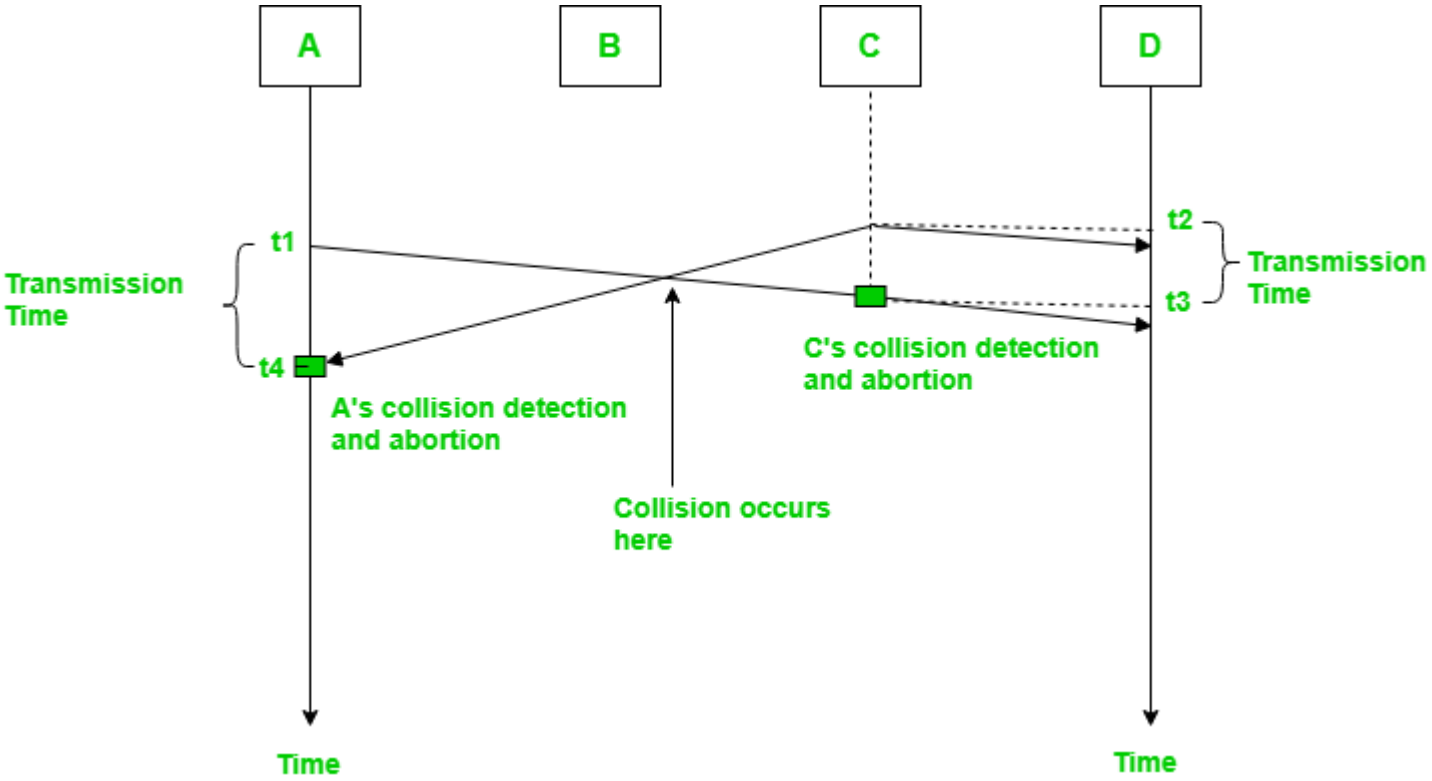
- The persistence methods can be applied to help the station take action when the channel is busy/idle.



https://www.geeksforgeeks.org/carrier-sense-multiple-access-csma/

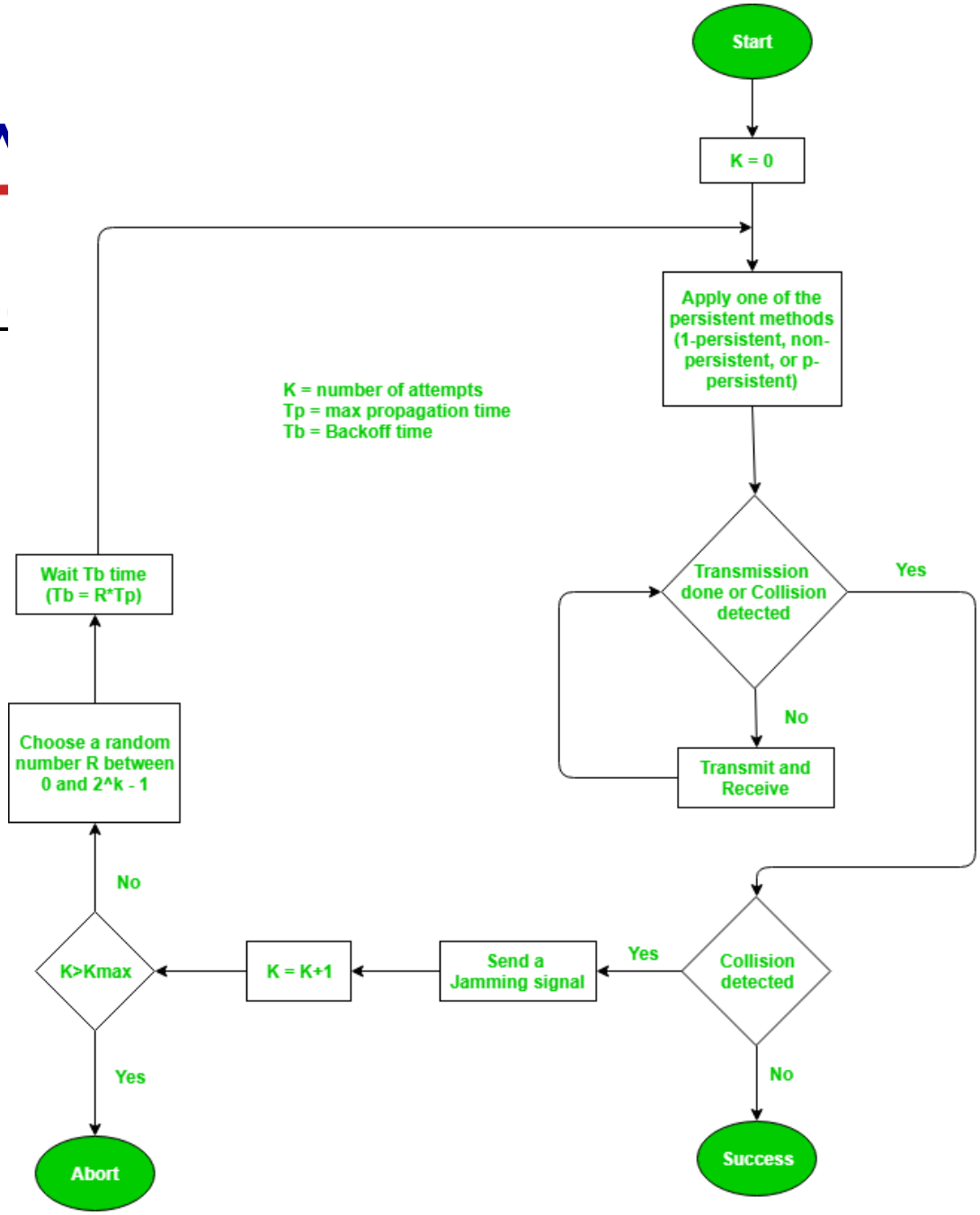
CSMA with Collision Detection (CSMA/CD)

- In this method, a station monitors the medium after it sends a frame to see if the transmission was successful. If successful, the station is finished, if not, the frame is sent again.



CSMA w /CD)

- **Process –** lained as follows:



CSMA with Collision Avoidance (CSMA/CA)

- The basic idea behind CSMA/CA is that the station should be able to receive while transmitting to detect a collision from different stations.
- In wired networks, if a collision has occurred then the energy of received signal almost doubles and the station can sense the possibility of collision.
- In case of wireless networks, most of the energy is used for transmission and the energy of received signal increases by only 5-10% if a collision occurs.
- It can't be used by the station to sense collision.
- Therefore **CSMA/CA has been specially designed for wireless networks**.

CSMA with Collision Avoidance (CSMA/CA)

- These are three types of strategies:
  - **InterFrame Space (IFS) –** When a station finds the channel busy, it waits for a period of time called IFS time. IFS can also be used to define the priority of a station or a frame. Higher the IFS lower is the priority.
  - **Contention Window –** It is the amount of time divided into slots. A station which is ready to send frames chooses random number of slots as **wait time**.
  - **Acknowledgements –** The positive acknowledgements and time-out timer can help guarantee a successful transmission of the frame.

CSMA/CD vs CSMA/CA

S.NO	CSMA/CD	CSMA/CA
1.	CSMA / CD is effective after a collision.	Whereas CSMA / CA is effective before a collision.
2.	CSMA / CD is used in wired networks.	Whereas CSMA / CA is commonly used in wireless networks.
3.	It only reduces the recovery time.	Whereas CSMA/ CA minimizes the possibility of collision.
4.	CSMA / CD resend the data frame whenever a conflict occurs.	Whereas CSMA / CA will first transmit the intent to send for data transmission.
5.	CSMA / CD is used in 802.3 standard.	While CSMA / CA is used in 802.11 standard.
6.	It is more efficient than simple CSMA(Carrier Sense Multiple Access).	While it is similar to simple CSMA(Carrier Sense Multiple Access).