CSMA/CD & CDMA/CA

Both CSMA/CA and CSMA/CD are network protocols for transmission that operate in the Medium Access Control Layer, however there are significant differences in the way they operate. Read through this article to find out more about CSMA/CA and CSMA/CD and how they are different from each other.

What is CSMA/CA?

CSMA/CA is a network protocol for carrier transmission that stands for Carrier Sense Multiple Access with Collision Avoidance. It works in the same media access control layer as CSMA/CD. This protocol is effective before the collision.

Algorithm of CSMA/CA

The algorithm of CSMA/CA is as follows −

- When a frame is ready, the transmitting station checks whether the channel is idle or busy.
- If the channel is not clear, the node starts to wait for a random amount of time before checking to see if it is clear. This waiting period of time is known as the "back off factor" which is counted down by a back off counter.
- If the channel is idle, the station waits for an Inter-frame gap (IFG) amount of time and then sends the frame.
- It sets a timer after sending the frame.
- The station then waits for acknowledgement from the receiver. If it receives the acknowledgement before expiry of timer, it marks a successful transmission.
- Otherwise, it waits for a back-off time period and restarts the algorithm.

CMSA/CA prevents collision. As it waits for acknowledgements, data is not lost unnecessarily and it avoids wasteful transmission. CSMA/CA is very much suited for wireless transmissions.

What is CSMA/CD?

CSMA/CD stands for Carrier Sense Multiple Access / Collision Detection. It is also a network protocol for transmission and operates in the Medium Access Control Layer.

It detects when the shared channel for broadcasting is busy and stops the broadcast till the channel becomes available. Collisions in CSMA/CD are identified via broadcast sensing from other stations.

In CSMA/CD, when a collision is recognized, the transmission is halted, and the stations send a "jam signal", after which the station waits for a random time context before retransmission.

After sending a frame, a station monitors the medium to determine if the transmission was successful. If the station is successful, it is completed; if not, the structure is sent again.

Algorithm of CSMA/CD

The CSMA/CD algorithm is as follows –

- The transmitting station examines if the channel is idle or busy when a frame is ready.
- If the channel is congested, the station will wait till it becomes available.
- If the channel is empty, the station begins transmitting and watches the channel for collisions
- The station initiates the collision resolution procedure if a collision is detected.

The station resets the retransmission counters and completes frame transmission.

Although CSMA/CS detects collisions, it does not have a mechanism to reduce the number of collisions. Hence, it is not appropriate for large networks, as the performance degrades exponentially when more stations are added.

Difference between CSMA/CA and CSMA/CD?

The following table highlights the major differences between CSMA/CA and CSMA/CD.

Key	CSMA/CA	CSMA/CD
Effectiveness	CSMA/CA is effective before a collision.	CSMA/CD is effective after a collision.
Network Type	CSMA/CA is generally used in wireless networks.	CSMA/CD is generally used in wired networks.
Recovery Time	CSMA/CA minimizes the risk of collision.	CSMA/CD reduces the recovery time.
Conflict Management	CSMA/CA initially transmits the intent to send the data. Once an acknowledgment is received, the sender sends the data.	CSMA/CD resends the data frame in case a conflict occurs during transmission.
IEEE Standards	CSMA/CA is part of the IEEE 802.11 standard.	CSMA/CD is part of the IEEE 802.3 standard.
Efficiency	CSMA/CA is similar in efficiency as CSMA.	CSMA/CD is more efficient than CSMA.

CSMA (Carrier Sense Multiple Access)

It is a **carrier sense multiple access** based on media access protocol to sense the traffic on a channel (idle or busy) before transmitting the data. It means that if the channel is idle, the station can send data to the channel. Otherwise, it must wait until the channel becomes idle. Hence, it reduces the chances of a collision on a transmission medium.

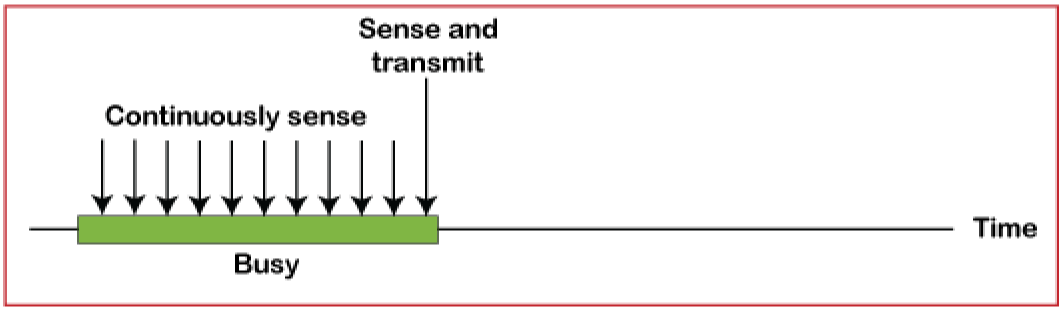
CSMA Access Modes

1-Persistent: In the 1-Persistent mode of CSMA that defines each node, first sense the shared channel and if the channel is idle, it immediately sends the data. Else it must wait and keep track of the status of the channel to be idle and broadcast the frame unconditionally as soon as the channel is idle.

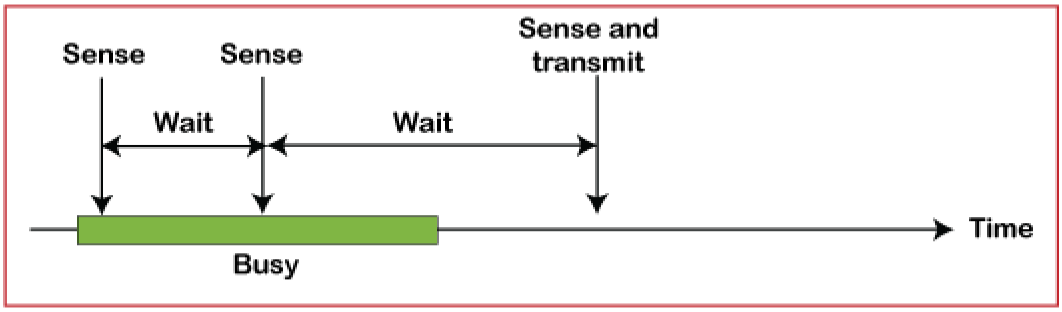
Non-Persistent: It is the access mode of CSMA that defines before transmitting the data, each node must sense the channel, and if the channel is inactive, it immediately sends the data. Otherwise, the station must wait for a random time (not continuously), and when the channel is found to be idle, it transmits the frames.

P-Persistent: It is the combination of 1-Persistent and Non-persistent modes. The P-Persistent mode defines that each node senses the channel, and if the channel is inactive, it sends a frame with a **P** probability. If the data is not transmitted, it waits for a (**q = 1-p probability**) random time and resumes the frame with the next time slot.

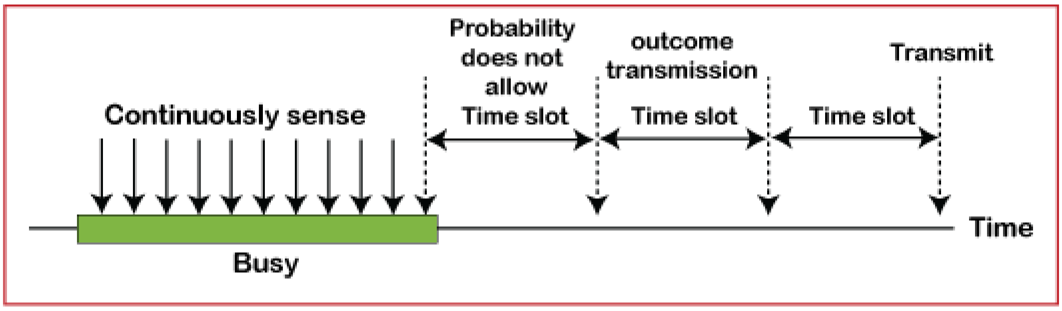
O- Persistent: It is an O-persistent method that defines the superiority of the station before the transmission of the frame on the shared channel. If it is found that the channel is inactive, each station waits for its turn to retransmit the data.



a. 1-persistent



b. Nonpersistent



c. p-persistent

CSMA/ CD

It is a **carrier sense multiple access/ collision detection** network protocol to transmit data frames. The CSMA/CD protocol works with a medium access control layer. Therefore, it first senses the shared channel before broadcasting the frames, and if the channel is idle, it transmits a frame to check whether the transmission was successful. If the frame is successfully received, the station sends another frame. If any collision is detected in the CSMA/CD, the station sends a jam/ stop signal to the shared channel to terminate data transmission. After that, it waits for a random time before sending a frame to a channel.

CSMA/ CA

It is a **carrier sense multiple access/collision avoidance** network protocol for carrier transmission of data frames. It is a protocol that works with a medium access control layer. When a data frame is sent to a channel, it receives an acknowledgment to check whether the channel is clear. If the station receives only a single (own) acknowledgments, that means the data frame has been successfully transmitted to the receiver. But if it gets two signals (its own and one more in which the collision of frames), a collision of the frame occurs in the shared channel. Detects the collision of the frame when a sender receives an acknowledgment signal.

Following are the methods used in the CSMA/ CA to avoid the collision:

Interframe space: In this method, the station waits for the channel to become idle, and if it gets the channel is idle, it does not immediately send the data. Instead of this, it waits for some time, and this time period is called the **Interframe** space or IFS. However, the IFS time is often used to define the priority of the station.

Contention window: In the Contention window, the total time is divided into different slots. When the station/ sender is ready to transmit the data frame, it chooses a random slot number of slots as **wait time**. If the channel is still busy, it does not restart the entire process, except that it restarts the timer only to send data packets when the channel is inactive.

Acknowledgment: In the acknowledgment method, the sender station sends the data frame to the shared channel if the acknowledgment is not received ahead of time.

B. Controlled Access Protocol

It is a method of reducing data frame collision on a shared channel. In the controlled access method, each station interacts and decides to send a data frame by a particular station approved by all other stations. It means that a single station cannot send the data frames unless all other stations are not approved. It has three types of controlled access: **Reservation, Polling**, and **Token Passing**.

C. Channelization Protocols

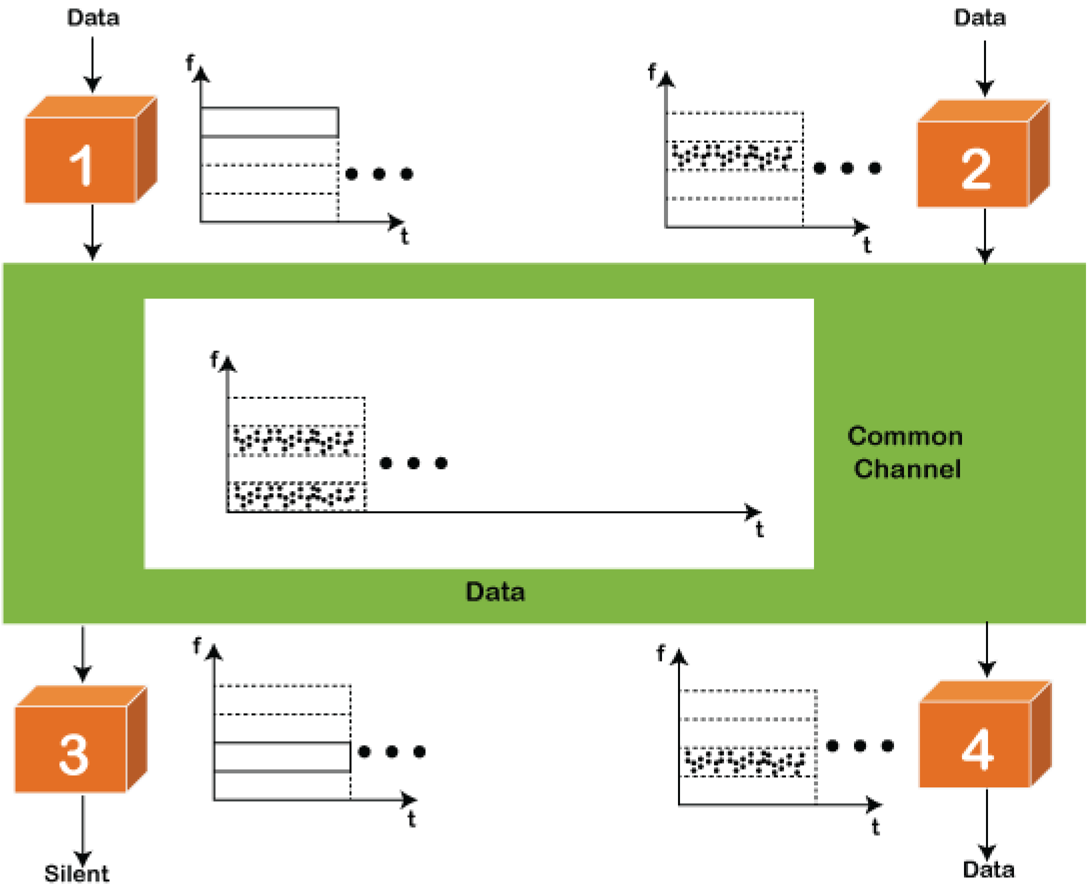
It is a channelization protocol that allows the total usable bandwidth in a shared channel to be shared across multiple stations based on their time, distance and codes. It can access all the stations at the same time to send the data frames to the channel.

Following are the various methods to access the channel based on their time, distance and codes:

1. FDMA (Frequency Division Multiple Access)
2. TDMA (Time Division Multiple Access)
3. CDMA (Code Division Multiple Access)

FDMA

It is a frequency division multiple access (**FDMA**) method used to divide the available bandwidth into equal bands so that multiple users can send data through a different frequency to the subchannel. Each station is reserved with a particular band to prevent the crosstalk between the channels and interferences of stations.



TDMA

Time Division Multiple Access (**TDMA**) is a channel access method. It allows the same frequency bandwidth to be shared across multiple stations. And to avoid collisions in the shared channel, it divides the channel into different frequency slots that allocate stations to transmit the data frames. The same **frequency** bandwidth into the shared channel by dividing the signal into various time slots to transmit it. However, TDMA has an overhead of synchronization that specifies each station's time slot by adding synchronization bits to each slot.

CDMA

The code division multiple access (CDMA) is a channel access method. In CDMA, all stations can simultaneously send the data over the same channel. It means that it allows each station to transmit the data frames with full frequency on the shared channel at all times. It does not require the division of bandwidth on a shared channel based on time slots. If multiple stations send data to a channel simultaneously, their data frames are separated by a unique code sequence. Each station has a different unique code for transmitting the data over a shared channel. For example, there are multiple users in a room that are continuously speaking. Data is received by the users if only two-person interact with each other using the same language. Similarly, in the network, if different stations communicate with each other simultaneously with different code language.