CSMA (Carrier Sense Multiple Access)

1. **CS –** It stands for Carrier Sensing. It implies that before sending data, a station first senses the carrier. If the carrier is found free, then the station transmits data else it refrains.
2. **MA –** Stands for Multiple Access i.e. if there's a channel, then there are many stations that are trying to access it.

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.

Principle of CSMA

The principle of operation of CSMA is based on:

Sense before Transmit

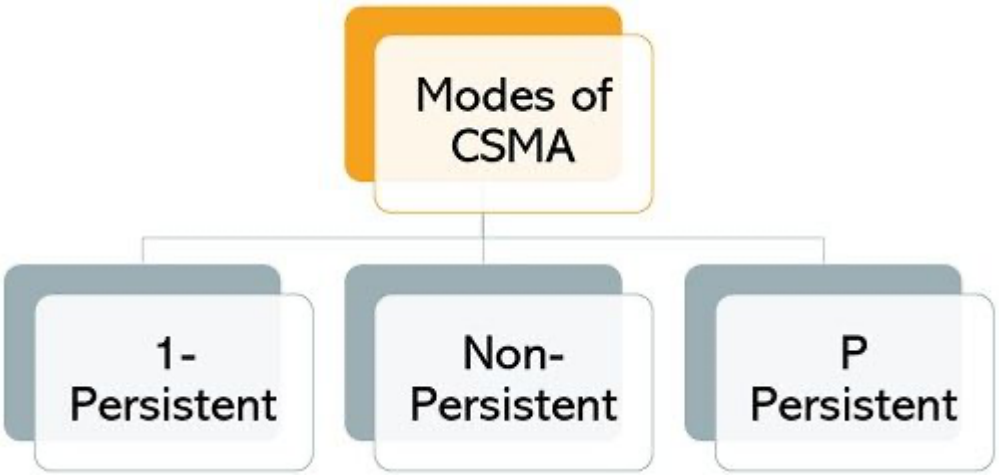
The name of this scheme, itself indicates that here the carrier is sensed first and then transmission takes place. From the word carrier here, we mean channel or medium through which the transmission is taking place. So, in CSMA, first, the channel over which the data is to be transmitted is checked by the user/station to see if it is free to transmit or not. This checking before actually sending the data enables us to reduce the chances of collision.

Basically, whenever a carrier is sensed then two possibilities mainly exist:

- **Busy Carrier**: This corresponds to the condition when there is an ongoing transmission that is already taking place over the channel. This means that the moment a user sensed the channel, any other user within the network is utilizing the channel.
- **Idle Carrier**: Idle carrier state shows that the channel is free and no other node of the network is transmitting at that instant. When this idle carrier state is noticed by a user who is willing to transmit then only it begins the transmission otherwise wait for some random time.

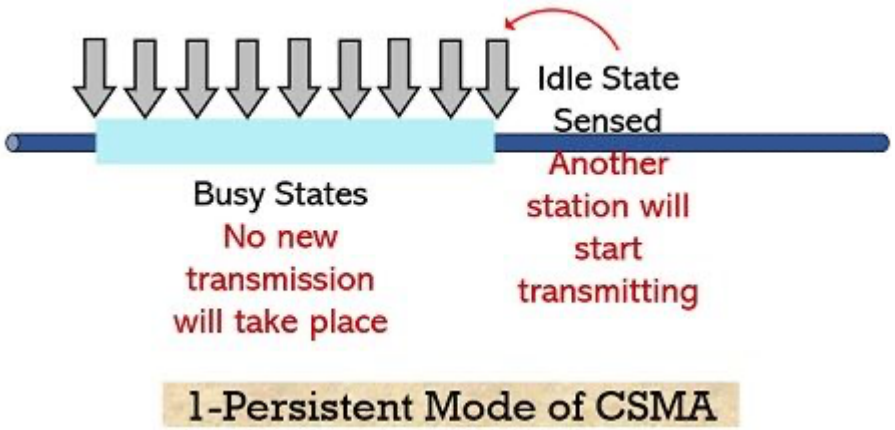
Modes of CSMA

As this technique is built upon the way of sensing the carrier so this can be done in three ways.



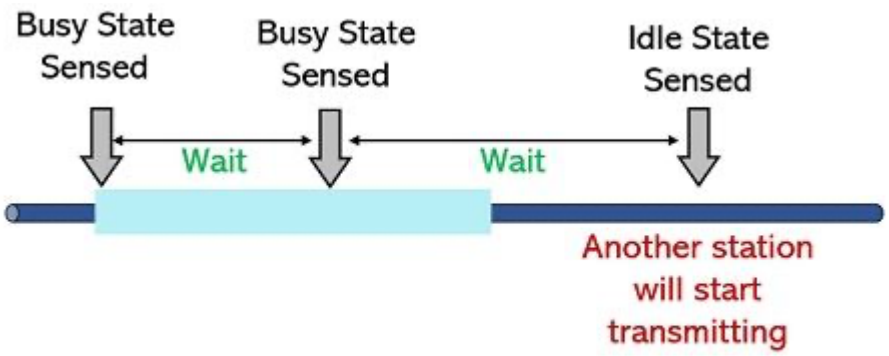
1. 1-persistent CSMA: The word persistent corresponds to something continuous or constant in nature. In this mode of CSMA, the node which is willing to transmit the data packet checks for the availability of a free carrier.

However, if it finds the channel busy, then it continuously checks for the availability of a free channel. As soon as the medium gets free, the new station immediately begins transmission. But still, this mode is not collision-free because there exists a worst case.



In this case, the collision of data packets may happen, when two nodes continuously sense the channel and the instant when the channel gets free, both the nodes begin transmission immediately. **Ethernet** uses 1-persistent technique.

2. Non-Persistent: It is sometimes known as **0-Persistent**. In this mode of CSMA, the channel is sensed by the station and if it is free then the host begins to transmit. However, if a busy channel is sensed then the station that is willing to transmit will wait for a random period of time and once this random duration will get over then it checks for availability again.



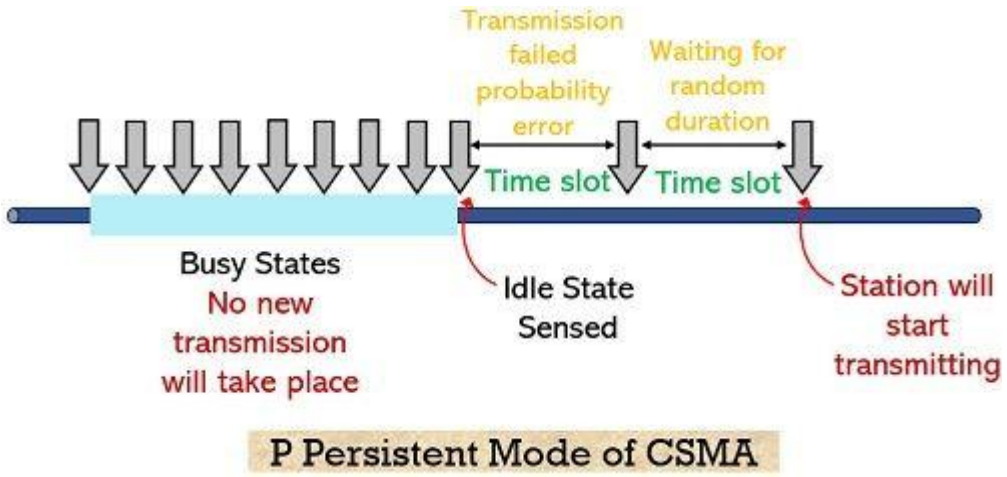
Non-Persistent Mode of CSMA

This means here, continuous sensing will not take place for immediately seizing the channel once the previous transmission gets completed. But once the random tenure gets over, then again it will sense the channel and if finds free then begin the transmission. Here the channel is utilized in a better way than the previous mode and also the worst-case collision occurring there was not taking place here. So, the chances of collision will be less.

But in this case, the worst-case is that if the channel gets free before the completion of the random time, then it will remain unutilized in that time. This is so because the node will check again only once the random period gets over.

3. P-Persistent: This technique is a combination of the 1-persistent and non-persistent mode of CSMA. Here, similar to the 1-persistent scheme, the station willing to transmit senses the channel constantly to check it is free or not. If it finds the channel free, then the station sends the data frame with probability P.

However, if the data fails to get transmitted i.e. if collision has occurred and the sender has not received the acknowledgment i.e., failing of P probability. Then it retransmits the data packet after a random period of time in the next time slot by considering probability Q = 1-P. However, even after the random time slot, if the channel is sensed busy then the algorithm is repeated in the same way.



P Persistent Mode of CSMA

What Is CSMA/CD

CSMA/CD procedure can be understood as a group discussion, where if the participants speak all at once then it will be very confusing and the communication will not happen.

Instead, for good communication, it is required that the participants speak one after another so that we can clearly understand the contribution of each participant in the discussion.

Once a participant has finished talking, we should wait for a certain time period to see if any other participant is speaking or not. One should start speaking only when no other participant has spoken. If another participant also speaks at the same time, then we should stop, wait, and try again after some time.

Similar is the process of CSMA/CD, where the data packet transmission is only done when the data transmission medium is free. When various network devices try to share a data channel simultaneously, then it will encounter a **data collision**.

The medium is continuously monitored to detect any data collision. When the medium is detected as free, the station should wait for a certain time period before sending the data packet to avoid any chances of data collision.

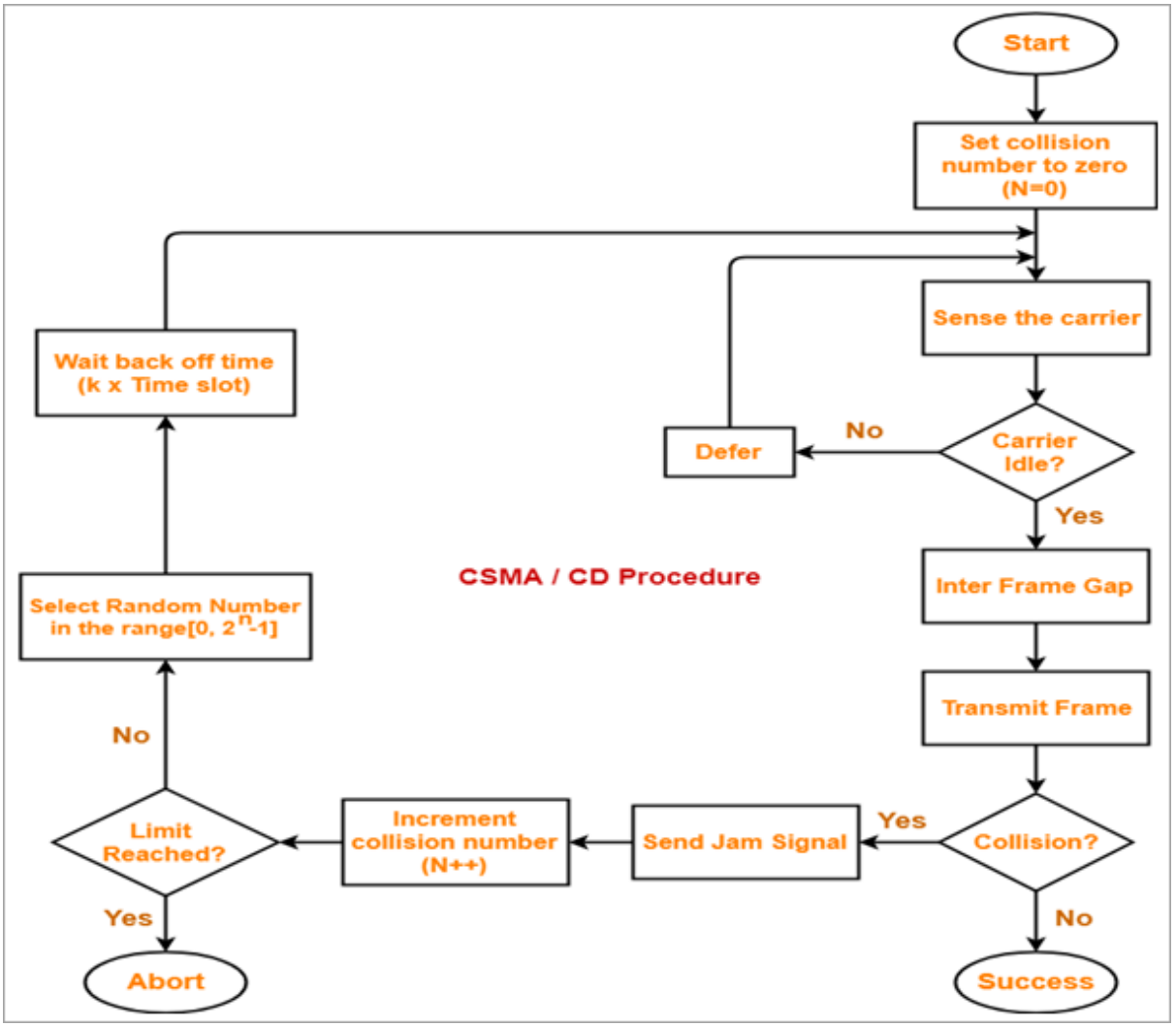
When no other station tries to send the data and there is no data collision detected, then the transmission of data is said to be successful.

Algorithm

The algorithm steps include:

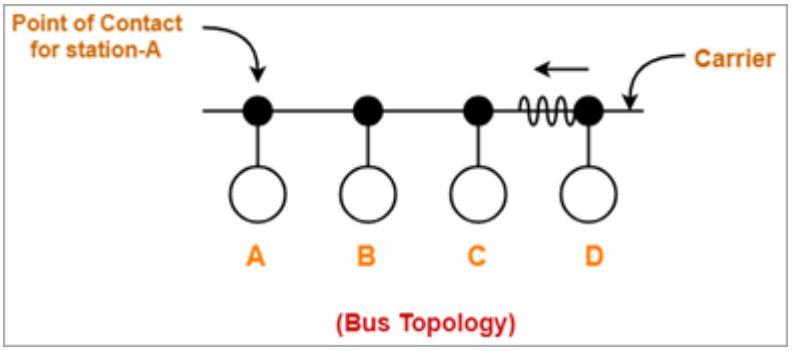
- First, the station that wants to transmit the data senses the carrier as to whether it is busy or idle. If a carrier is found idle, then the transmission is carried out.
- The transmission station detects a collision, if any, using the condition: **Tt >= 2 * Tp** where Tt is the transmission delay and Tp is the propagation delay.
- The station releases the jam signal as soon as it detects a collision.
- After collision has occurred, the transmitting station stops transmitting and waits for some random amount of time called the '**back-off time'.** After this time, the station retransmits again.

CSMA/CD Flow Chart



How Does CSMA/CD Work

To understand the working of CSMA/CD, let's consider the following scenario.



- Suppose there are two stations A and B. If station A wants to send some data to station B, then it has to sense the carrier first. The data is being sent only if the carrier is free.
- But by standing at one point, it cannot sense the entire carrier, it can only sense the point of contact. According to the protocol, any station can send data at any time, but the only condition is to first sense the carrier as if its idle or busy.
- In case A and B together start transmitting their data, then it's fairly possible that the data of both the stations will collide. So, both the stations will receive inaccurate collided data.

How will the stations know that their data got collided?

The answer to this question is, if the colloidal signal comes back during the process of transmission, then it indicates that the collision has occurred.

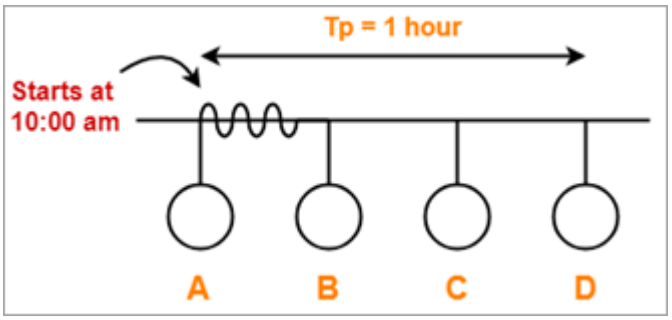
For this, the stations need to keep on transmitting. Only then they can be sure that it's their own data that got collided/corrupted.

If in case, the packet is large enough, which means by the time the collision signal comes back to the transmitting station, the station is still transmitting the left part of data. Then it can recognize that its own data got lost in the collision.

Understanding Collision Detection

In order to detect a collision, it is important that the station keeps on transmitting the data until the transmitting station gets back the collision signal if any.

Let's take an example where the first bits transmitted by the station is involved in the collision. Consider we have four stations A, B, C and D. Let the propagation delay from station A to station D be 1 hour i.e. if the data packet bit starts to move at 10 a.m., then it will reach D at 11 a.m.

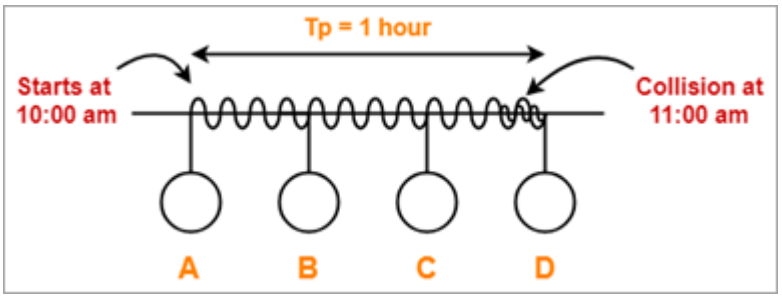


- At 10 a.m. both the stations, A and D sense the carrier as free and start their transmission.
- If the total propagation delay is 1 hour, then after half an hour both the station's first bits will reach halfway and will soon experience a collision.
- So, exactly at 10:30 a.m., there will be a collision which will produce collision signals.
- At 11 a.m. the collision signals will reach stations A and D i.e. exactly after one hour the stations receive the collision signal.

Therefore, for the respective stations to detect that it's their own data that got collided the transmission time for both the stations should be greater than their propagation time. ***i.e. Tt>Tp***

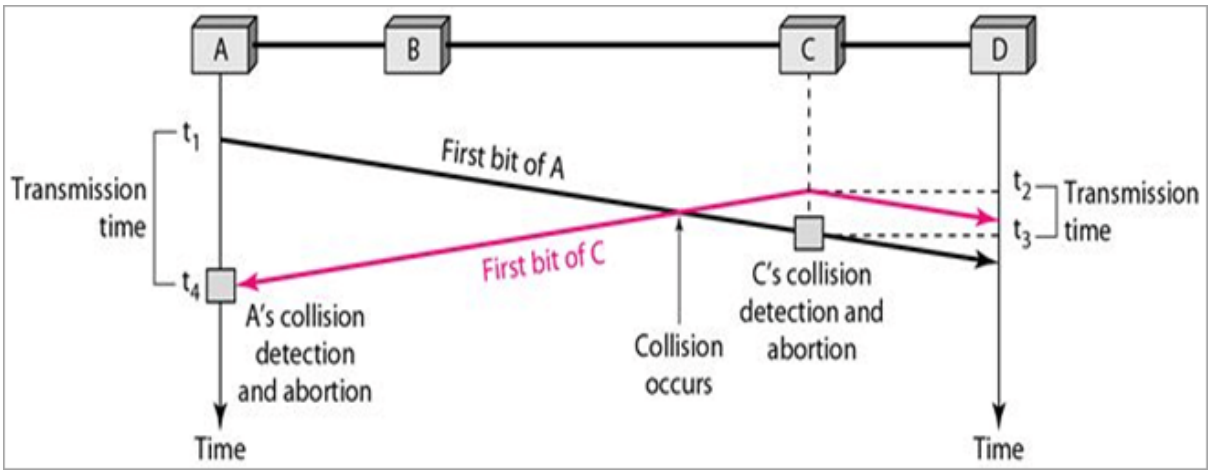
Where Tt is the transmission time and Tp is the propagation time.

Let's see the worst-case situation now.



- Station A started the transmission at 10 a.m. and is about to reach station D at 10:59:59 a.m.
- At this time, station D started its transmission after sensing the carrier as free.
- So here the first bit of data packet sent from station D will face collision with the data packet of station A.
- After collision occurred, the carrier starts sending a colloidal signal.
- Station A will receive the collision signal after 1 hour.

The below diagram explains the Collision of first bits in CSMA/CD:

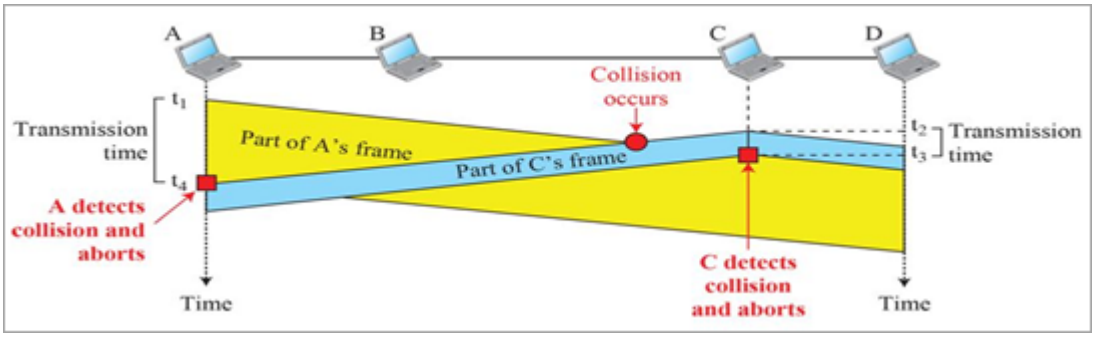


Station A,B,C, D are connected through Ethernet wire. Any station can send its data packet for transmission after sensing the signal as idle. Here the data packets are sent in bits which take time to travel. Due to this, there are chances of a collision.

In the above diagram, at time t1 station A starts transmitting the first bit of data after sensing the carrier as free. At time t2, station C also senses the carrier as free and starts transmitting the data. At t3, the collision occurs between bits sent by stations A and C.

Thus, the transmission time for station C becomes t3-t2. After the collision, the carrier will send back the colloidal signal to station A which will reach at time t4. This means, while sending the data, the collision can also be detected.

Having seen the time durations for the two transmissions, refer to the below figure for a complete understanding.



Efficiency Of CSMA/CD

The efficiency of CSMA/CD is better than Pure ALOHA however there are some points that need to be kept in mind while measuring the efficiency of CSMA/CD.

These include:

- If the distance increases, then the efficiency of CSMA/CD decreases.
- For Local Area Network (LAN), CSMA/CD works optimally but for long-distance networks like WAN, it's not advisable to use CSMA/CD.
- If the length of the packet is bigger, then the efficiency increases but then again there is a limitation. The maximum limit for the length of the packets is 1500 bytes.

Advantages & Disadvantages Of CSMA/CD

Advantages

- Overhead is less in CSMA/CD.
- Whenever possible, it utilizes all the bandwidth.
- It detects collision within a very short span of time.
- Its efficiency is better than simple CSMA.
- It mostly avoids any kind of wasteful transmission.

Disadvantages

- Not suitable for large distance networks.
- Distance limitation is 2500 meters. Collision can't be detected after this limit.
- Assignment of priorities cannot be done to certain nodes.

- As devices are added, the performance disrupts exponentially.

Applications

CSMA/CD was used in shared media Ethernet variants(10BASE2,10BASE5) and in the early versions of twisted pair Ethernet that used repeater hubs.

But nowadays, modern Ethernet networks are built with switches and full-duplex connections so that CSMA/CD is no longer used.