# Function of OSI and TCP/IP Layers Part-5

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# Functions of OSI and TCP/IP Part-5

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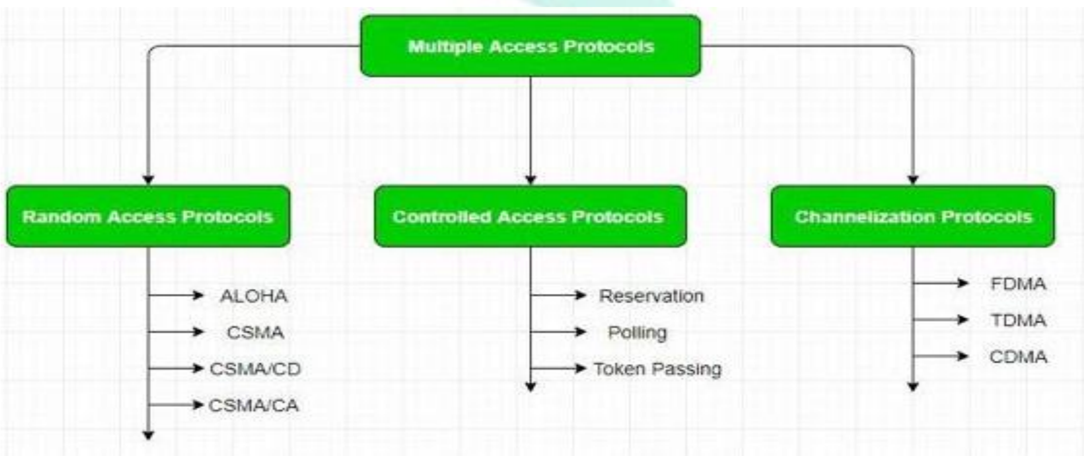
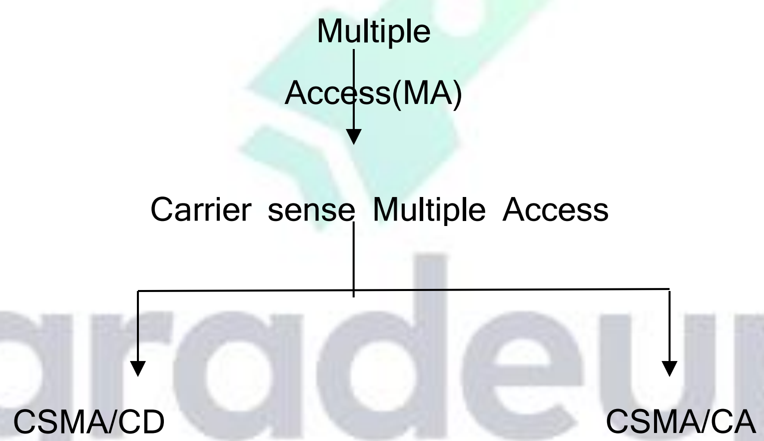



**Multiple Access**

- When a number of stations(users) use a common link of communication system we have to use a multiple access protocol in order to coordinate the access protocol in order to coordinate the access to the common link
- The three techniques used to deal with the multiple access problem as follows:
  1. Random Access
  2. Controlled Access
  3. Channelization

**Random Access**

- In the random access there is no control
- Each station will have the right to use common medium without any control over it
- With increase in number of stations , there is an increased probability of collision or access conflict
- The collisions will occur when more than one user tries to access the common medium simultaneously
- As a result of such collisions , we have to set up a procedure
- The evolution of the random access method is shown below .




**Multiple Access (Aloha System)**

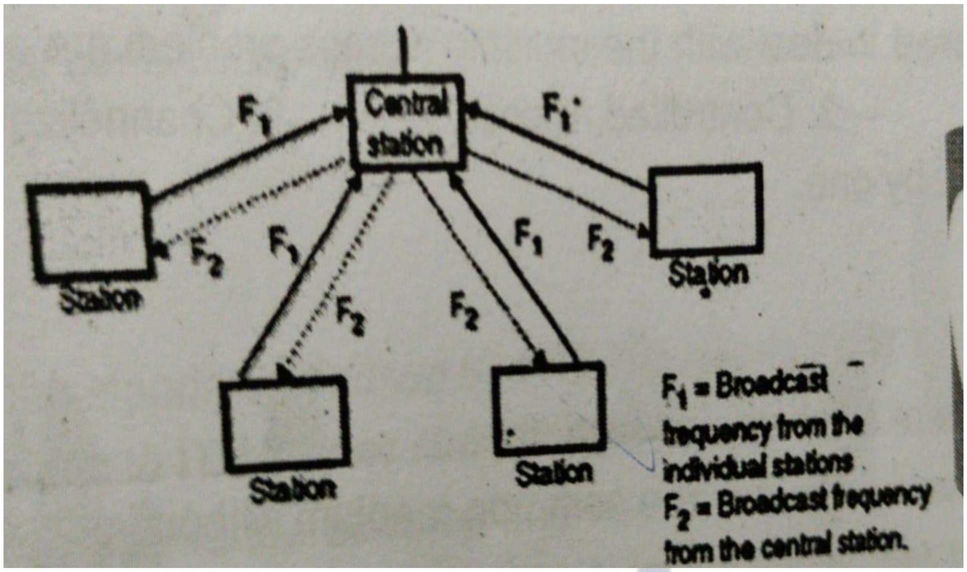
Aloha System: System in which multiple user share a common channel in a way that can lead to conflicts are widely known as contention systems . The Aloha System is contention protocol which is developed at the university of Hawaii in the early 1970’s by Norman Abramson and his colleagues.

**The Aloha system has two version:**

1. Pure aloha : does not require global time synchronization
2. Slotted Aloha : requires time synchronization

**Pure Aloha :**

- In works on a very simple principle . Essentially it allows for any station to broadcast at any time . If two signals collide , each station simply waits a random time and try again
- Collision are easily detected . As shown below , when the central station receives a frame it sends an acknowledgement on a different frequency .




- If a user station receives an acknowledgement it assumes that transmitted frame was successfully received and if does get an acknowledgement it assumes that collision had occurred and is ready to retransmit
- The advantage of pure Aloha is the simplicity in implementation but it's performance becomes worse as the data traffic on the channel increases

**Efficiency of an Aloha Channel :**

**Frame Time :**

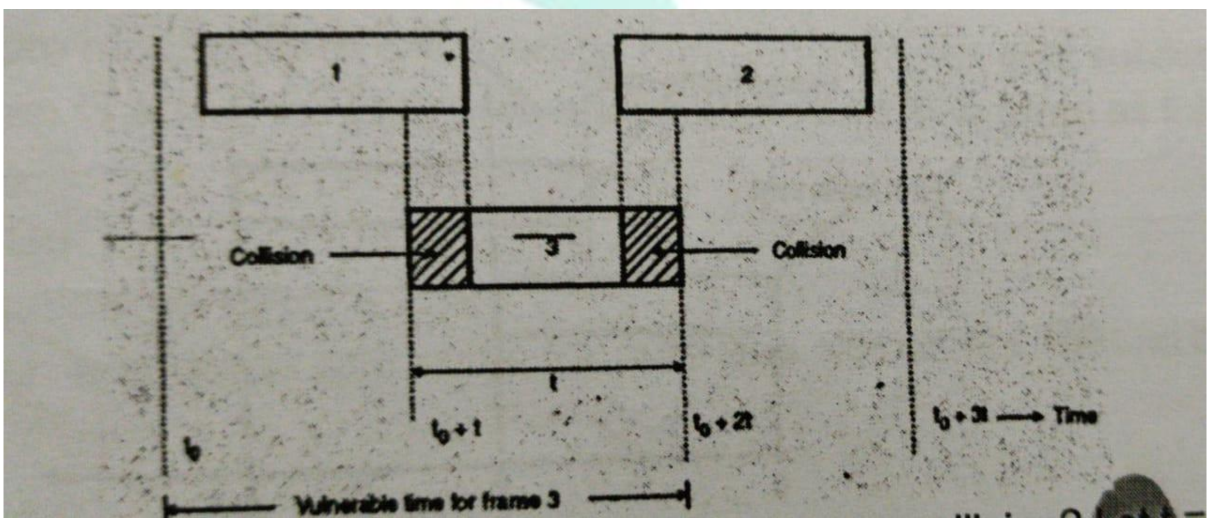
- Let the frame time denote the amount of time required to transmit the standard the fixed length frame. Note that :

frame time = frame time / bit rate

- We assume that ∞ number of users generate new frames according to the Poisson's distribution with mean N frame per frame time
- If N >1 , then users are generating frames at a rate higher than that can be handled by the channel . So every frame will face collision . Hence 0<N<1
- Let there be k transmission attempt (including retransmissions) per frame time
- The probability of -k transmission per frame time is also Poisson . Let the mean of number of transmissions be G per frame time . So G>=N .
- At low load N = 0 there will be less number of collisions so less number of retransmission and G =N .
- With increase in load there are many collisions so G>N for all the loads the throughput is given by

$$S = GP_0$$

$P_0$ = Probability that a frame does not suffer a collision




- What is the condition for frame 3 in above diagram to arrive collision ? Let t = time required to send a frame . If frame 1 is generated any wherebetween $t_0$ to $(t_0 + 1)$ then it will collide with frame 3. Similarly any frame (2) generated between $(t_0 + 1)$ and $(t_0 + 2t)$ also collide with frame 3
- The probability that k frames are generated during a given frame time is given by the poisson's distribution

$$P[k] = G^k e^{-G} / k!$$

- So the probability of zero frames i.e. k =0

  $$P_0 = G^0 e^{-G} / 0! = e^{-G}$$

- If an interval is two frame time long , the mean number of frame generated is 2G
- The probability that no other frame is transmitted during the vulnerable period is

  $$P_0 = e^{-2G}$$

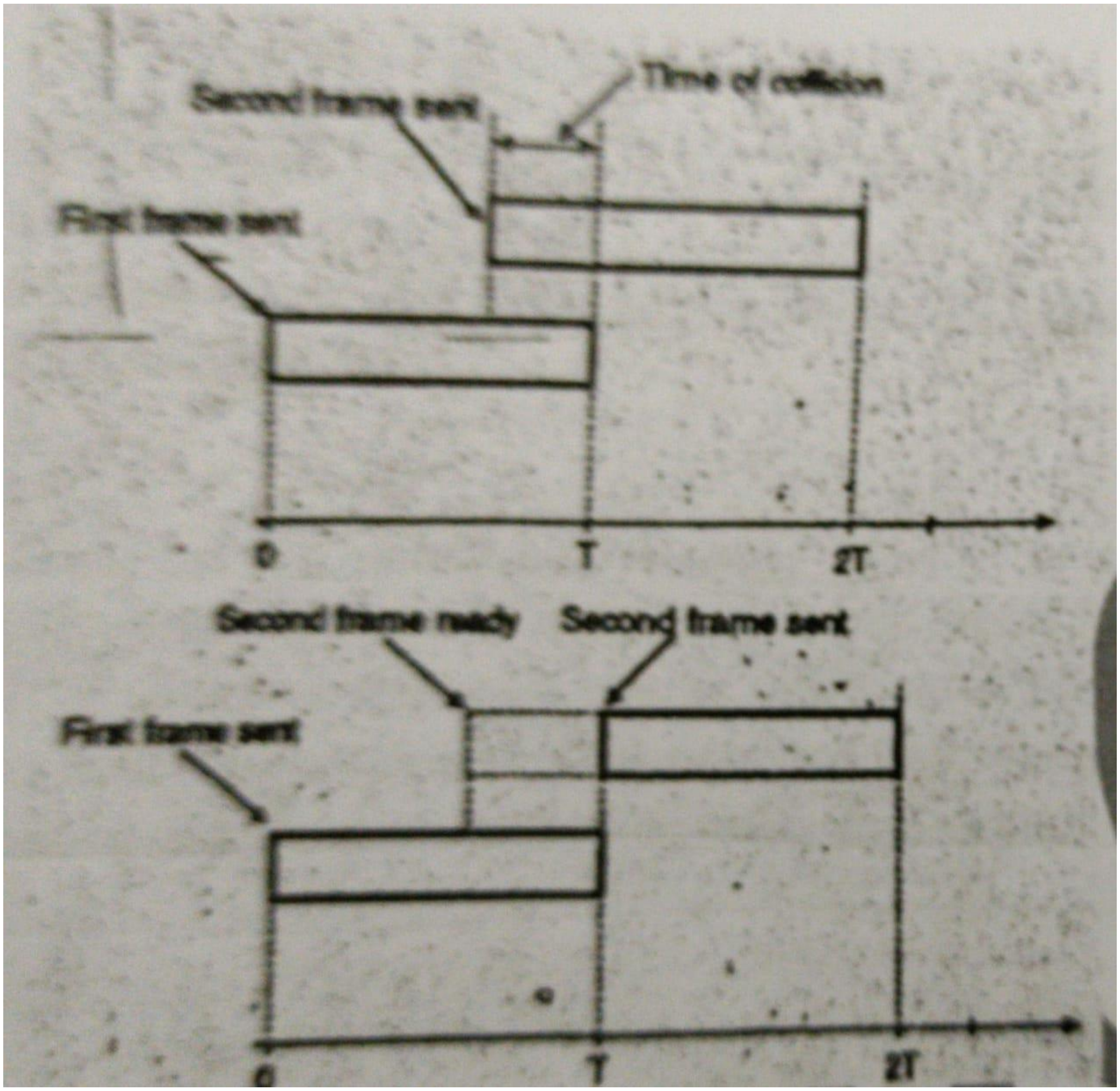
- But throughput $S = GP_0$

  i.e. $S = G e^{-2G}$

- $G = 0.5$ and $S_{max} = 0.184$ . so the best possible channel utilization is on 18.4 percent

**Slotted Aloha :**

- To overcome the disadvantages of the pure aloha system Robert published a method for doubling the capacity of traffic on the channel
- In this method time is divided up into discrete intervals ,each intervals corresponding to one frame
- This method required the users to agree on slot boundaries. In this method for synchronization one special station emits a pip at the start of each interval , like a clock
- Collision occurs if any part of two transmission overlaps . Suppose that T is time required for one transmission and that two stations must transmit
- The total time required for both stations to do successfully is 2T as shown below . In case of pure aloha allowing a station to transmit at arbitrary times can waste time upto 2T




- As an alternative , in the slotted ALOHA method the time is divided into intervals (slots) of T units each and required each station to being each transaction at the beginning of a slot
- In other words , even if station is ready to send in the middle of a slot , it must wait until the start of the next one as shown in diagram
- In this method a collision occurs when both stations become ready in the same slot

- Slotted aloha is thus a discrete time system whereas pure aloha , the throughput for slotted is

$$S = Ge^{-G}$$

- The maximum throughput corresponds to G =1 and it is given by $S_{max} = 1/e = 0.368$ as shown below . So far a slotted aloha with G = 1 the probability of success is 37% . The probability of empty slot is ,

$$P[k] = G^k e^{-G} /k!$$

For G = 1 and K =0 we put p(k=0) = 0.368

- And the probability of collision is 24 %
- The probability of transmission requiring exactly k attempts (i.e. k-1 collisions followed by one success ) is given by

$$P_k = e^{-G} (1-e^{-G})^{k-1}$$

- And the expected number of transmission E per carriage return typed is :

**Conclusion:**As E depends exponentially on G , with a small increase in G , there is a large increase in E and drastic fall in performance

**Comparison of Pure and Slotted Aloha :**

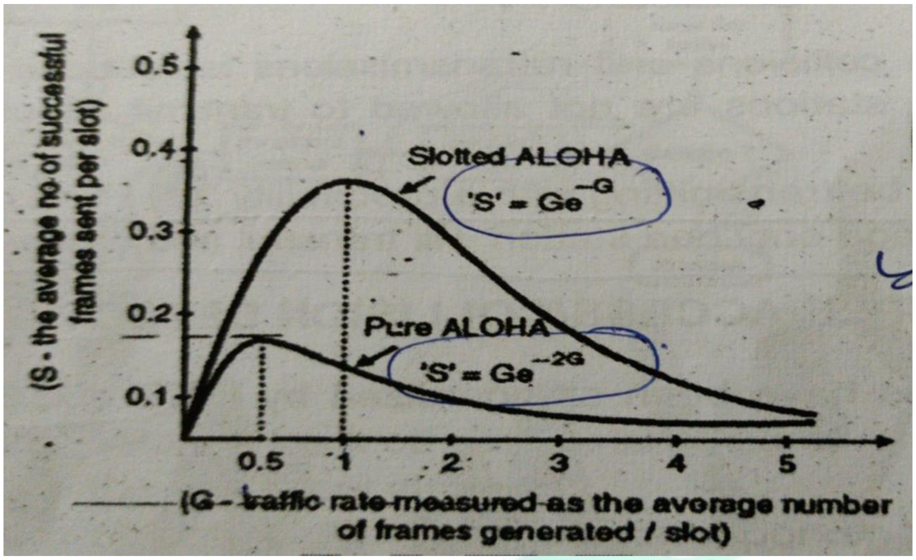
- A mathematical model can be created for the relationship between the number of frames transmitted and the number of frames transmitted successfully.
- Let G represent the traffic measured as the average number of frames generated by slot.
- Let Sbe the success rate measured as the average number frames sent successfully per slot
- The relationship between G and S for both pure and slotted aloha is given as follows :

  Pure aloha → $S = G e^{-2G}$

  Slotted aloha → $S = G e^{-G}$

  Whereas is the mathematical constant = 2.718

- From the above equation a success rate curve for pure and slotted aloha can be plotted as shown below




- As seen in above diagram both graphs have same shape. If G is small so is S, which means that if few frames are generated few frames will transmitted successfully
- As G increases so does S but upto a certain point . As G continues to increase S approaches to 0 which means that if more frames are generated there will be more collision and success rate will fall to 0 .
- Similarly for pure aloha the maximum occurs at G = 0.5 for which S = 1/2e = 0.184 which means the rate of successful transmissions is approximately by 18.4 % . As seen from the graph the maximum for slotted aloha occurs at G =1 for which S = 1/e = 0.368 in other words the rate of successful transmissions is approximately 0.368 frames per slot time or 37 % of the time will be spent on successful transmission. Hence the slotted aloha has a double through put efficiency that the pure aloha system
- The maximum utilization achievable using CSMA can be reducing in the propagation time the utilization gets improved

**Carriers Sense Multiple Access(CSMA)**

The CSMA protocol operates on the principle of carrier sensing . In this protocol , a station listens to see the presence of transmission (carrier ) on the cable and decides to act according .

**Non-Persistent CSMA :**

- In this scheme , if a station wants to transmit a frame and it finds that the channel is busy (some other station is transmitting ) then it will wait for fixed interval of time
- After this time, it again checks the status of the channel and if the channel is free it will transmit

**1-Persistent CSMA :**

- In this scheme the station which wants to transmit , continuously monitors the channel until it is idle and then transmits immediately
- The disadvantages of this strategy is that if two stations are waiting then they will transmit simultaneously and collision will take place . This will then require retransmission

**P-Persistent CSMA :**

- The possibility of such collisions and retransmissions is reduced in the P-Persistent CSMA . In this scheme all the waiting stations are not allowed to transmit simultaneously as soon as the channel become idle
- A station is assumed to be transmitting with a probability "p" . For example if p =1/6 and if 6 stations are waiting then on an average only one station will transmit and other will wait

**Carrier Sense Multiple Access/ Collision Detection(CSMA/CD) :**

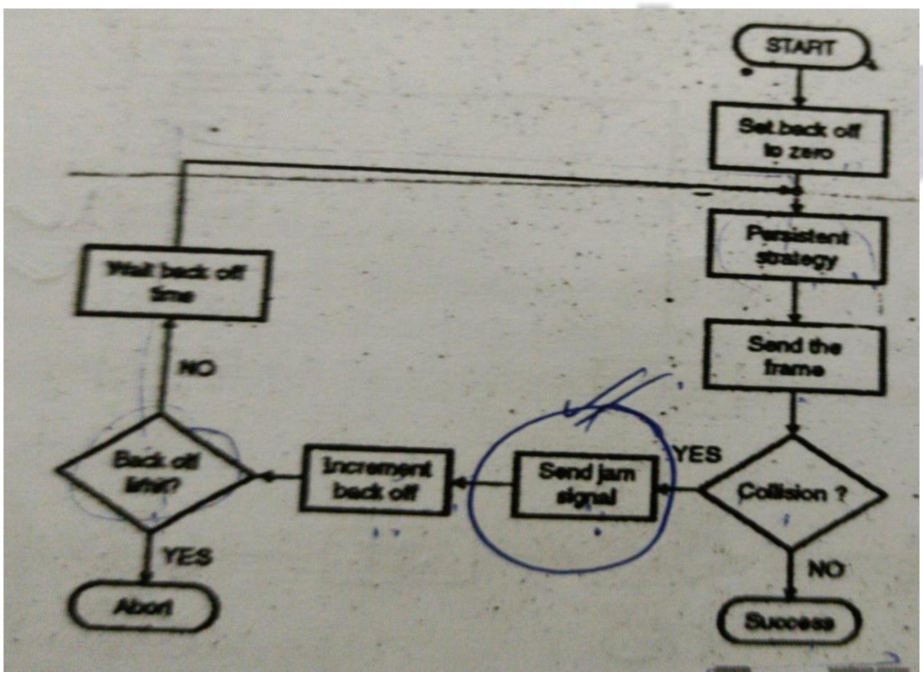
The CSMA/CD specifications have been standardized by IEEE 802.3 standard . It is widely used iin MAC

**Media ACCESS CONTROL:**

- The problem in CSMA explained earlier is that transmitting station continues to transmit its frame even through a collision occurs
- The channel time is unnecessarily wasted due to this. In CSMA/CD if a station receives other transmissions when it is transmitting , then a collision can be detected as soon as it occurs and then transmission time can be saved
- As soon as a collision is detected , the transmitting stations release a jam signal
- The jam signal will alert the other stations . The stations then not supposed to transmit immediately after the collision has occurred
- Otherwise there is a possibility that the same frames would collide again
- After some "back off" delay time the station =s will retry the transmission . If again the collision take place then the back off time is increased progressively

**CSMA/CD :**

Below figure shows a flow chart for the CSMA/CD protocol

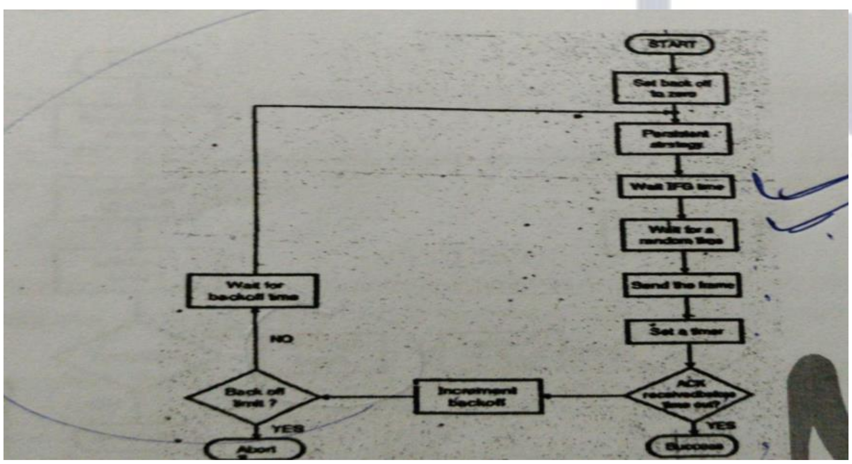


**Explanation :**

- The station that has a ready frame sets the back off parameter zero
- Then it sense the line using one of the persistent strategies
- If then sends the frame . if there is no collision for a period corresponding to one complete frame , then the transmission is successful
- Otherwise, the station sends the jam signal to inform the other stations about the collision
- The station the increments the back off time and sends the frame again
- If the back off has reached its limit then the station aborts the transmission
- CSMA/CD is used for the traditional Ethernet
- CSMA/CD is an important protocol . IEEE 802.3(Ethernet ) is an example of CSMA/CD. It is an international standard
- The MAC sub layer protocol does not guarantee reliable delivery. Even in absence of collision the receiver may not have copied the frame correctly

**CSMA/CA :**

Below figure shows the flow chart of CSMA/CA protocol :




- The station ready to transmit, senses the line by using one of the persistent strategies
- As soon as it find the line to be idle , the station waits for an IFG (inter frame gap) amount of time

- If then waits for some random time and sends the frame
- After sending the frame , it sets a timer and waits for the acknowledgement from the receiver
- If the acknowledgement is received before expiry of the timer , then the transmission is successful
- But if the transmitting station does not receive the expected acknowledgement before the timer expiry then it increments the back off parameter , waits for the back off time and recesses the line .

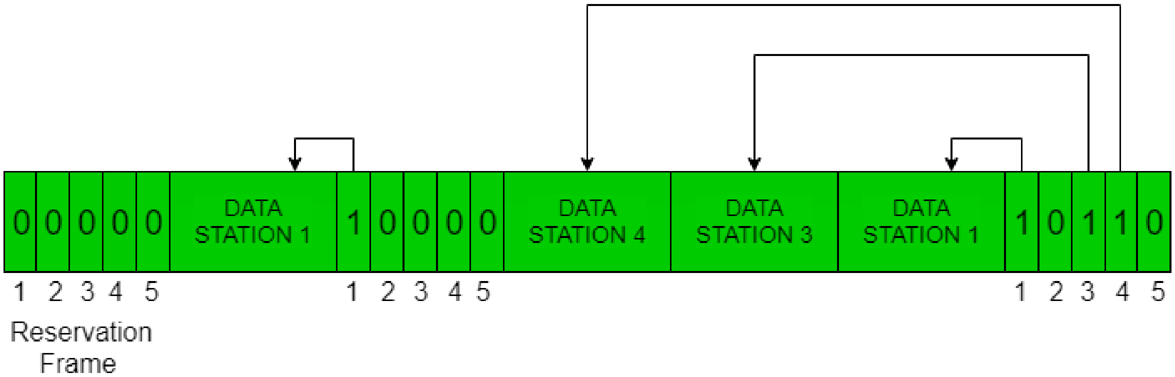
**Reservation**

- In this method, a station needs to make a reservation before sending the data.
- Time line has two kinds of periods:

1. Reservation interval of fixed time length
2. Data transmission period of variable frames.

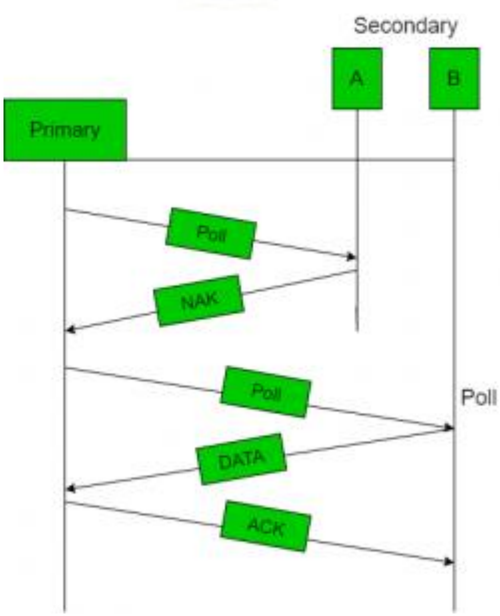
- If there are N stations, the reservation interval is divided into N slots, and each station has one slot.
- Suppose that if station 1 has a frame to send, then it transmits 1 bit during the slot 1. No other station is allowed to transmit during this slot.
- In general, $j^{th}$ station may announce that it has a frame to send by inserting a 1 bit into $j^{th}$ slot. After all M slots have been checked, each station knows which stations wish to transmit.
- Stations which have reserved their slots transfer their frames in that order.
- After the data transmission period, the next reservation interval begins.
- Since everyone agrees on who to goes next, then there will never be any collisions.

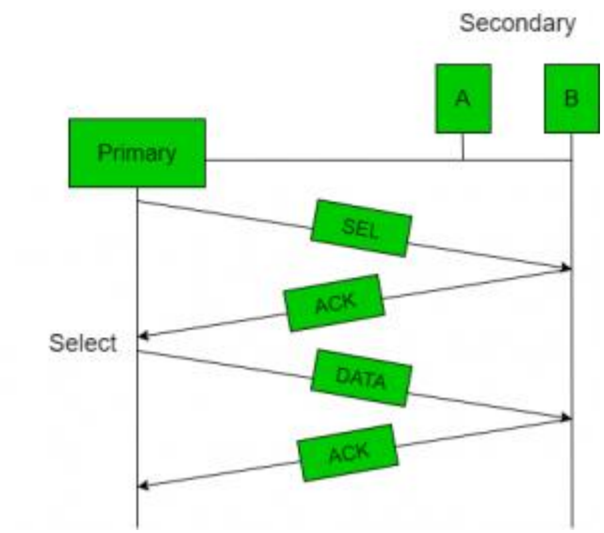
The following diagram shows the situation with five stations and a five slot reservation frame. In first interval, only stations 1, 3, and 4 have made reservations. In the second interval, only station 1 has made a reservation




**Polling:**

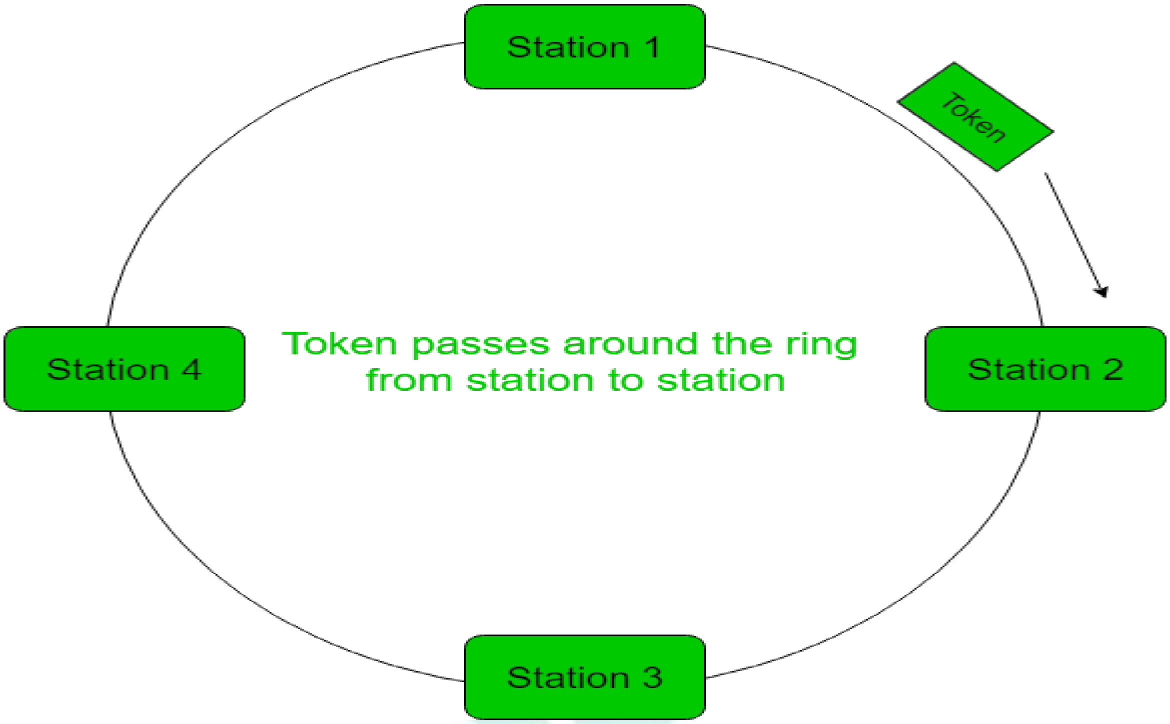
- The process of Polling similar to the roll-call performed in the class. Just like teacher, a controller sends a message to each node in turn.
- In this process, one acts as a primary station(controller) and all the others are secondary stations. All exchange of data must be made through the controller.
- The message sent by controller contains the address of the node being selected for granting the access.
- Although all the nodes receive the message but the addressed one responds to it and sends the data, if any. If there is no data, usually a "poll reject"(NAK) message is then sent back.
- Problems include very high overhead of the polling messages and high dependence on the reliability of the controller.






**Token Passing:**

- In token passing scheme, stations are connected logically to each other in the form of ring and access of stations is governed by tokens.
- A token is a small message or a special bit pattern, which circulate from one station to next in the some predefined order.
- In Token ring, token is passed from one station to the another adjacent station in ring whereas in case of Token bus, each station uses bus to send the token to the next station in some predefined order.
- In both the cases, token represents the permission to send. If a station has a frame queued for transmission when it receives a token, it can send that frame before it passes the token to the next station. If it has no queued frame, it passes token simply.
- After sending a frame, each station must wait for all N stations (including itself) to send token to their neighbours and the other N - 1 stations to send frame, if they have one.
- There exists problems like duplication of the token or token is lost orremoval of a station, insertion of new station, which need be tackled for correct and reliable operation of this scheme.




**Code Division Multiple Access (CDMA) -**

In CDMA, one channel carries all transmissions simultaneously. There is neither the division of bandwidth nor the division of time. For example, if there are many people in room all speaking at the same time, then also perfect reception of data is possible if and only if two person speak the same language. Similarly the data from different stations can be transmitted simultaneously in different code languages.