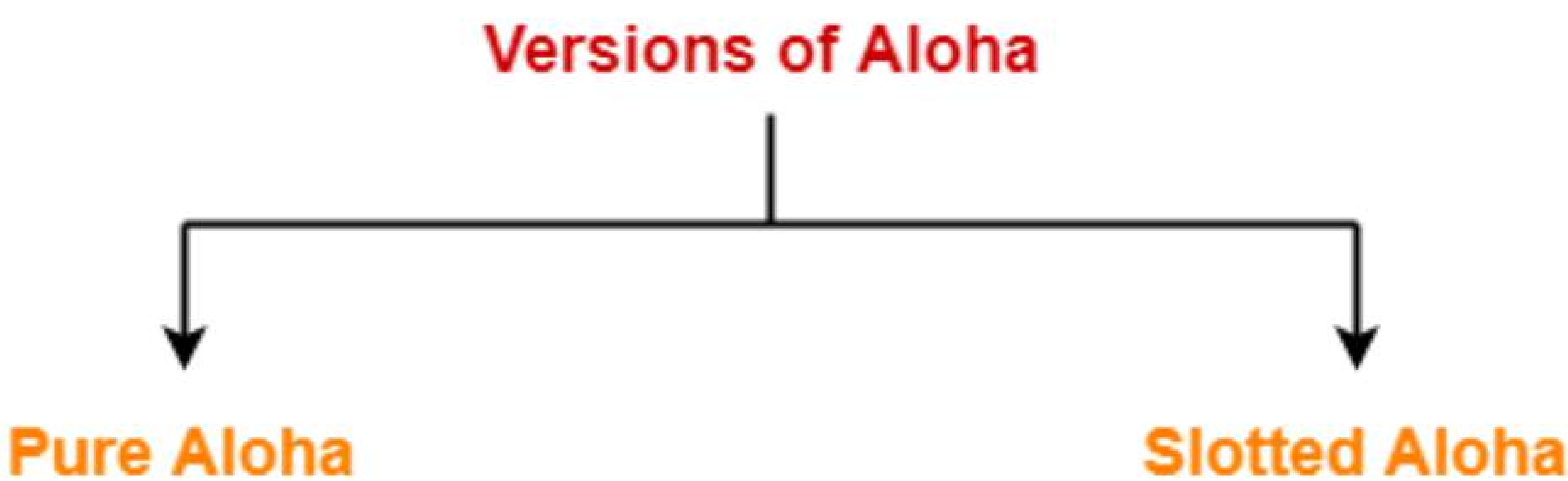
ALOHA Random Access Protocol

The ALOHA protocol or also known as the **ALOHA method** is a simple communication scheme in which every transmitting station or source in a network will send the data whenever a frame is available for transmission. If we succeed and the frame reaches its destination, then the next frame is lined-up for transmission. But remember, if the data frame is not received by the receiver (maybe due to collision) then the frame is sent again until it successfully reaches the receiver's end.

Aloha-

There are two different versions of Aloha-



1. Pure Aloha
2. Slotted Aloha

1. Pure Aloha-

- It allows the stations to transmit data at any time whenever they want.
- After transmitting the data packet, station waits for some time.

Then, following 2 cases are possible-

Case-01:

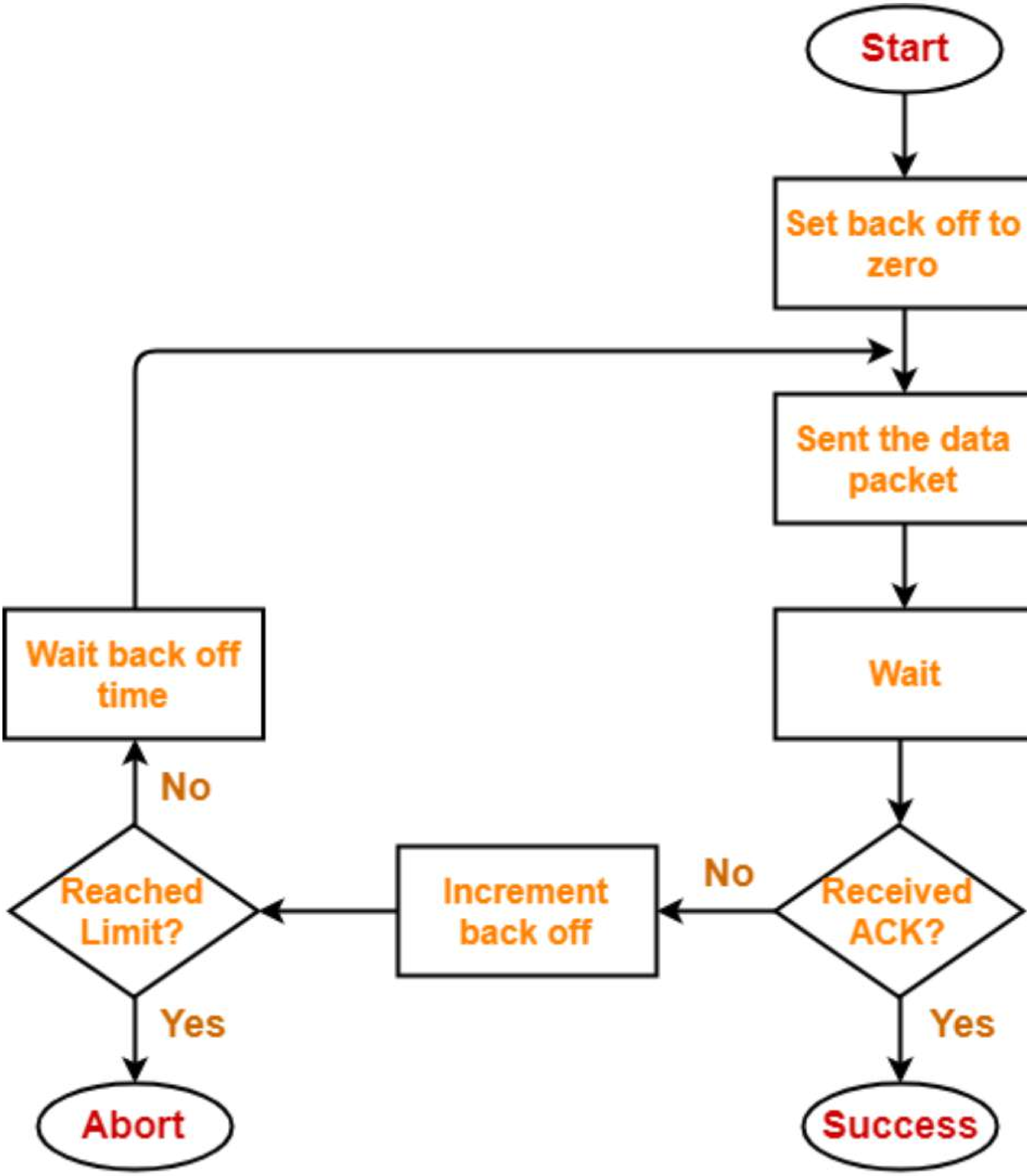
- Transmitting station receives an acknowledgement from the receiving station.
- In this case, transmitting station assumes that the transmission is successful.

Case-02:

- Transmitting station does not receive any acknowledgement within specified time from the receiving station.
- In this case, transmitting station assumes that the transmission is unsuccessful.

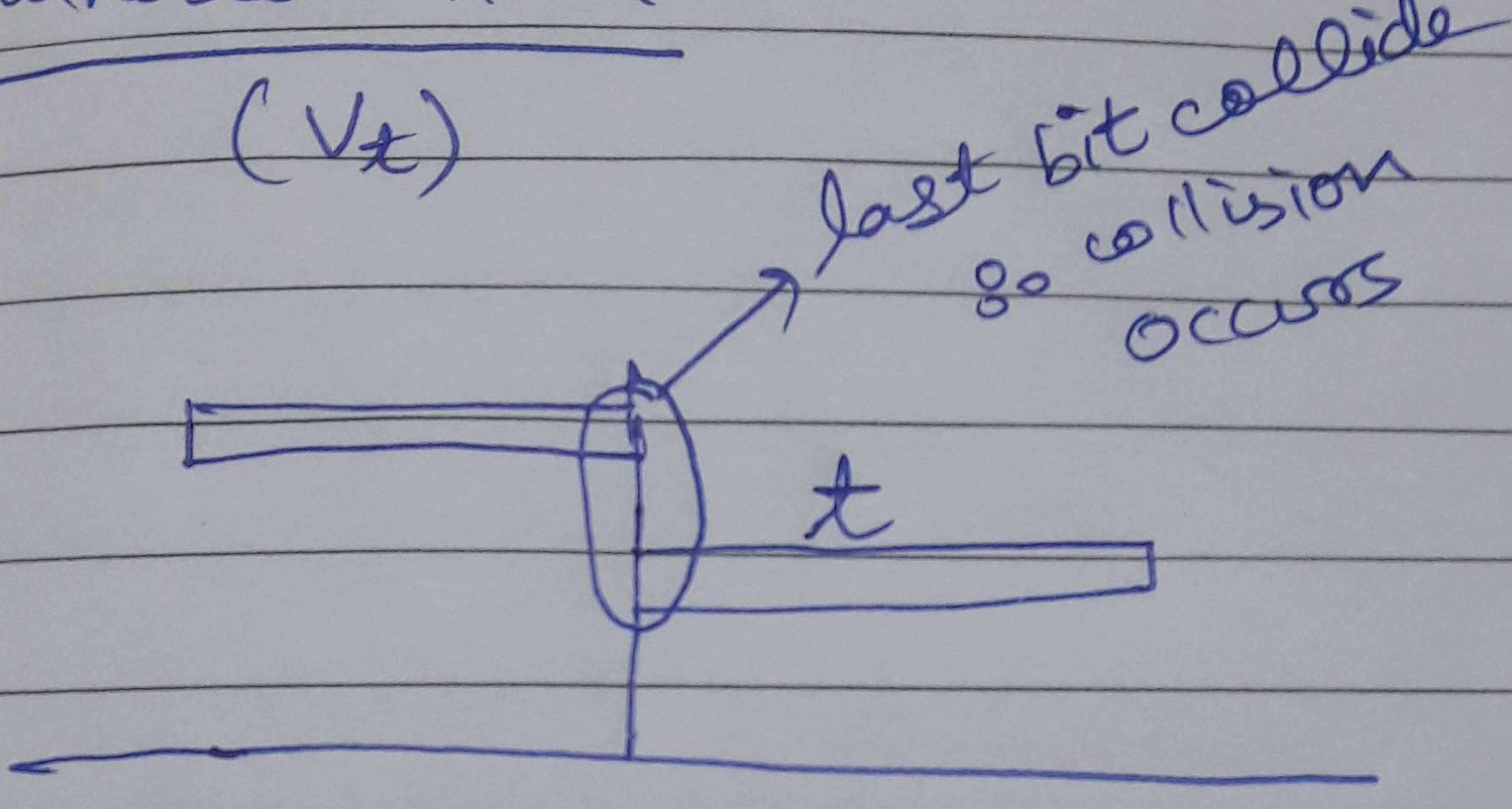
Then,

- Transmitting station uses a **Back Off Strategy** and waits for some random amount of time.
- After back off time, it transmits the data packet again.
- It keeps trying until the back off limit is reached after which it aborts the transmission.



Flowchart for Pure Aloha

Vulnerable time -
(Vt)



∴ $V_t = 2 * \text{transmission time}$

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Vulnerable Time = 2* Frame transmission

Throughput =  G exp{-2*G}

Maximum throughput = 0.184 for G=0.5
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Efficiency-

$$\text{Efficiency of Pure Aloha } (\eta) = G \times e^{-2G}$$

where G = Number of stations willing to transmit data

Maximum Efficiency-

For maximum efficiency,

- We put $d\eta / dG = 0$
- Maximum value of η occurs at $G = 1/2$
- Substituting $G = 1/2$ in the above expression, we get-

Maximum efficiency of Pure Aloha

$= 1/2 \times e^{-2 \times 1/2}$

$= 1 / 2e$

$= 0.184$

$= 18.4\%$

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In order to find max. efficiency, do differentiation

$$\eta = G \times e^{-2G}$$

$$\frac{\partial \eta}{\partial G} = G \times e^{-2G}(-2) + e^{-2G}(1) = 0$$

$$= e^{-2G}(-2G + 1) = 0$$

when, $-2G + 1 = 0$

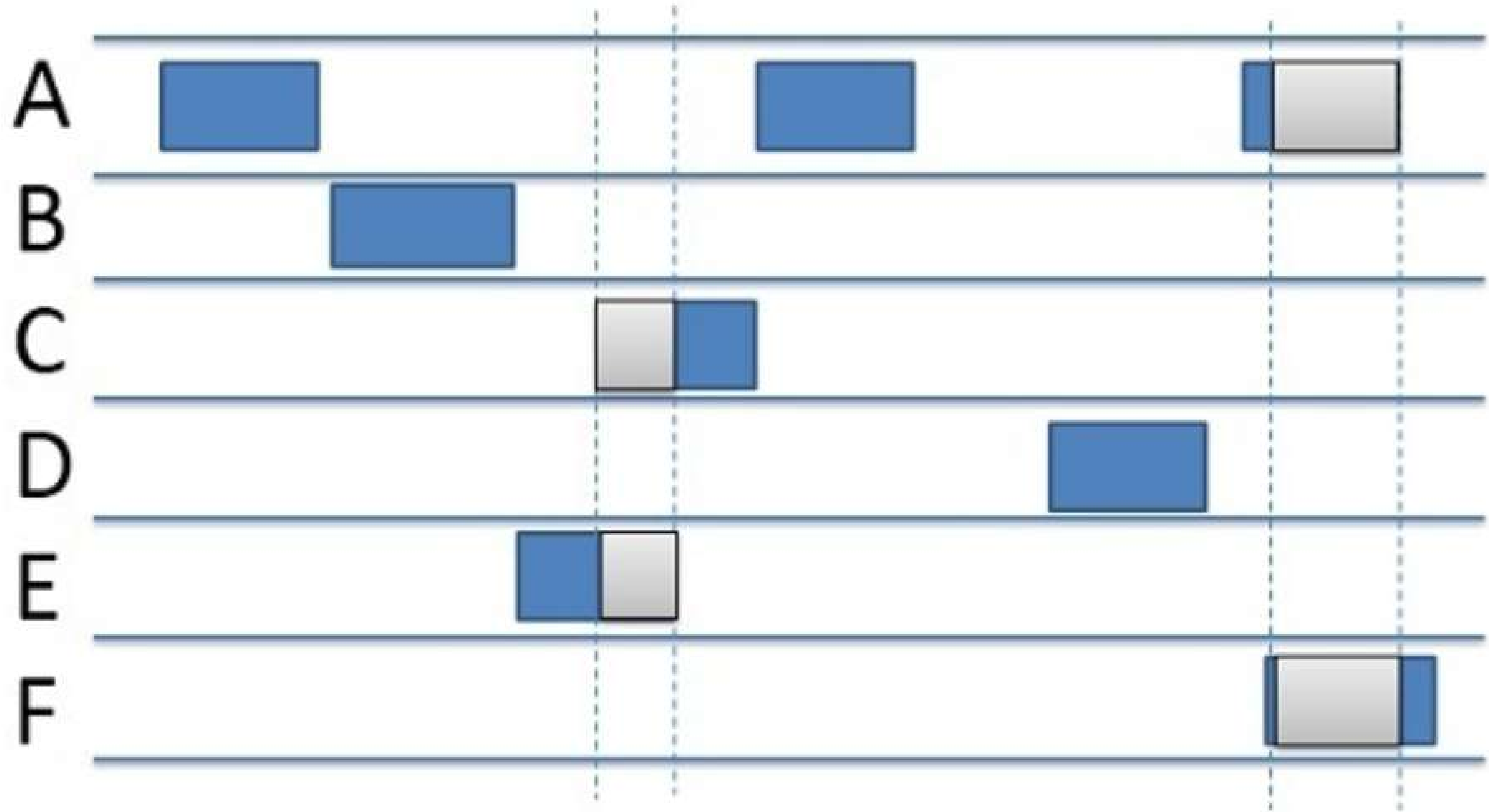
we get $G = 1/2$

So if we put $G = 1/2$, we get maximum efficiency.

Thus,

Maximum Efficiency of Pure Aloha (η) = 18.4%

The maximum efficiency of Pure Aloha is very less due to large number of collisions.



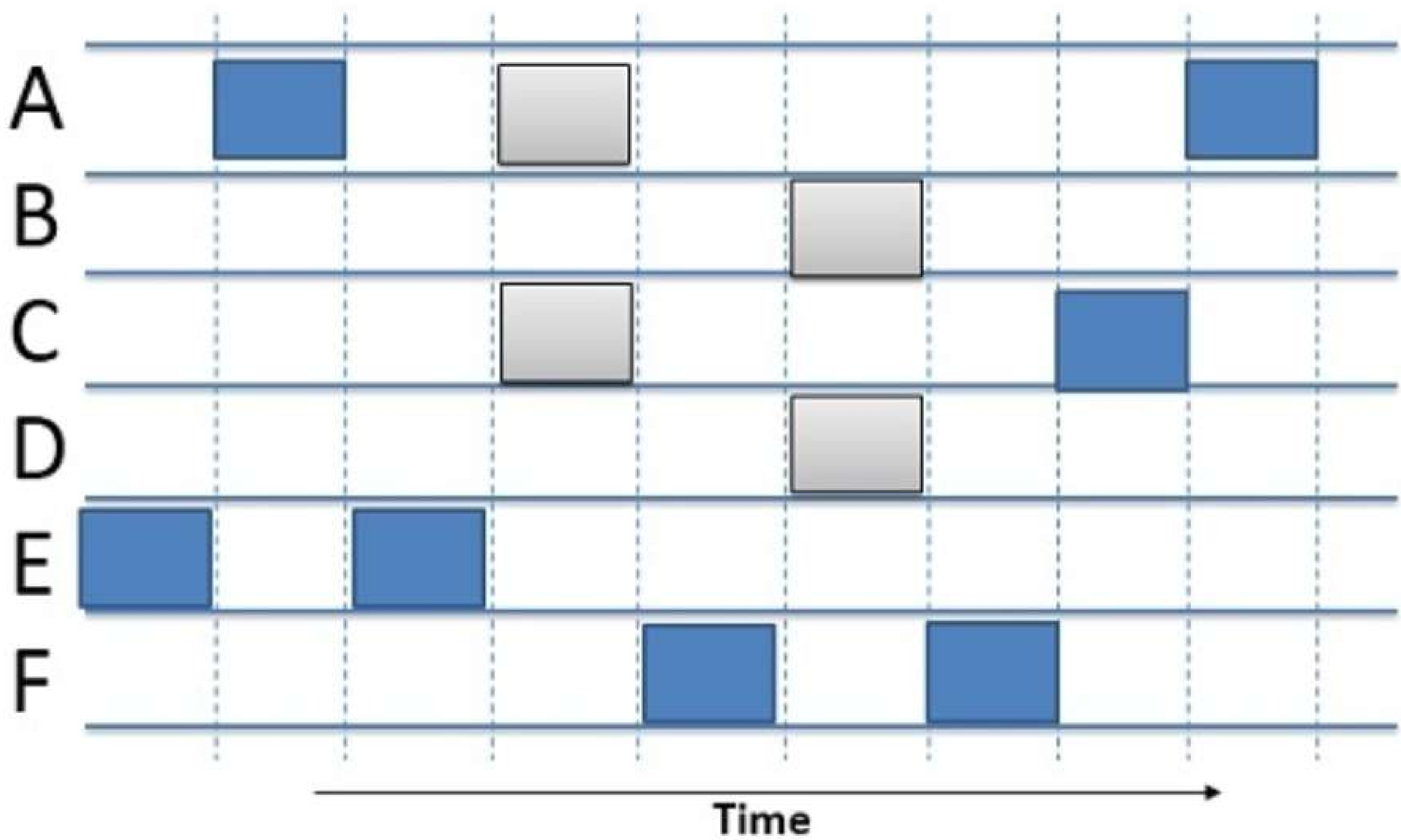
Pure ALOHA

2. Slotted Aloha-

- Slotted Aloha divides the time of shared channel into discrete intervals called as **time slots**.
- Any station can transmit its data in any time slot.
- The only condition is that station must start its transmission from the beginning of the time slot.
- If the beginning of the slot is missed, then station has to wait until the beginning of the next time slot.
- A collision may occur if two or more stations try to transmit data at the beginning of the same time slot.

In this method it was proposed that the time be divided up into discrete intervals (T) and each interval correspond to one frame .i.e the user should agree on the slot boundaries and require each station to begin each transmission at the beginning of a slot.

Even if station is ready to send in middle of a slot, it must wait until the beginning of the next one.



Slotted ALOHA

Efficiency-

$$\text{Efficiency of Slotted Aloha } (\eta) = G \times e^{-G}$$

where G = Number of stations willing to transmit data at the beginning of the same time slot

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Vulnerable Time =  Frame transmission t

Throughput =  G exp{-*G}

Maximum throughput = 0.368 for G=1
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Maximum Efficiency-

For maximum efficiency,

- We put $d\eta / dG = 0$
- Maximum value of η occurs at $G = 1$
- Substituting $G = 1$ in the above expression, we get-

Maximum efficiency of Slotted Aloha

$= 1 \times e^{-1}$

$= 1 / e$

$= 0.368$

$= 36.8\%$

Thus,

Maximum Efficiency of Slotted Aloha (η) = 36.8%

The maximum efficiency of Slotted Aloha is high due to less number of collisions.

Pure Aloha	Slotted Aloha
Any station can transmit the data at any time.	Any station can transmit the data at the beginning of any time slot.
The time is continuous and not globally synchronized.	The time is discrete and globally synchronized.
Vulnerable time in which collision may occur $= 2 \times T_t$	Vulnerable time in which collision may occur $= T_t$
Probability of successful transmission of data packet $= G \times e^{-2G}$	Probability of successful transmission of data packet $= G \times e^{-G}$

Maximum efficiency = 18.4% (Occurs at G = 1/2)	Maximum efficiency = 36.8% (Occurs at G = 1)
The main advantage of pure aloha is its simplicity in implementation.	The main advantage of slotted aloha is that it reduces the number of collisions to half and doubles the efficiency of pure aloha.

Carrier Sense Multiple Access (CSMA)

CSMA works on the principle that only one device can transmit signals on the network, otherwise a collision will occur resulting in the loss of data packets or frames. CSMA works when a device needs to initiate or transfer data over the network. Before transferring, each CSMA must check or listen to the network for any other transmissions that may be in progress. If it senses a transmission, the device will wait for it to end. Once the transmission is completed, the waiting device can transmit its data/signals. However, if multiple devices access it simultaneously and a collision occurs, they both have to wait for a specific time before reinitiating the transmission process.

This method was developed to decrease the chances of collisions when two or more stations start sending their signals over the datalink layer. Carrier Sense multiple access requires that each station **first check the state of the medium** before sending.

Vulnerable Time –

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Vulnerable time = Propagation time (Tp)
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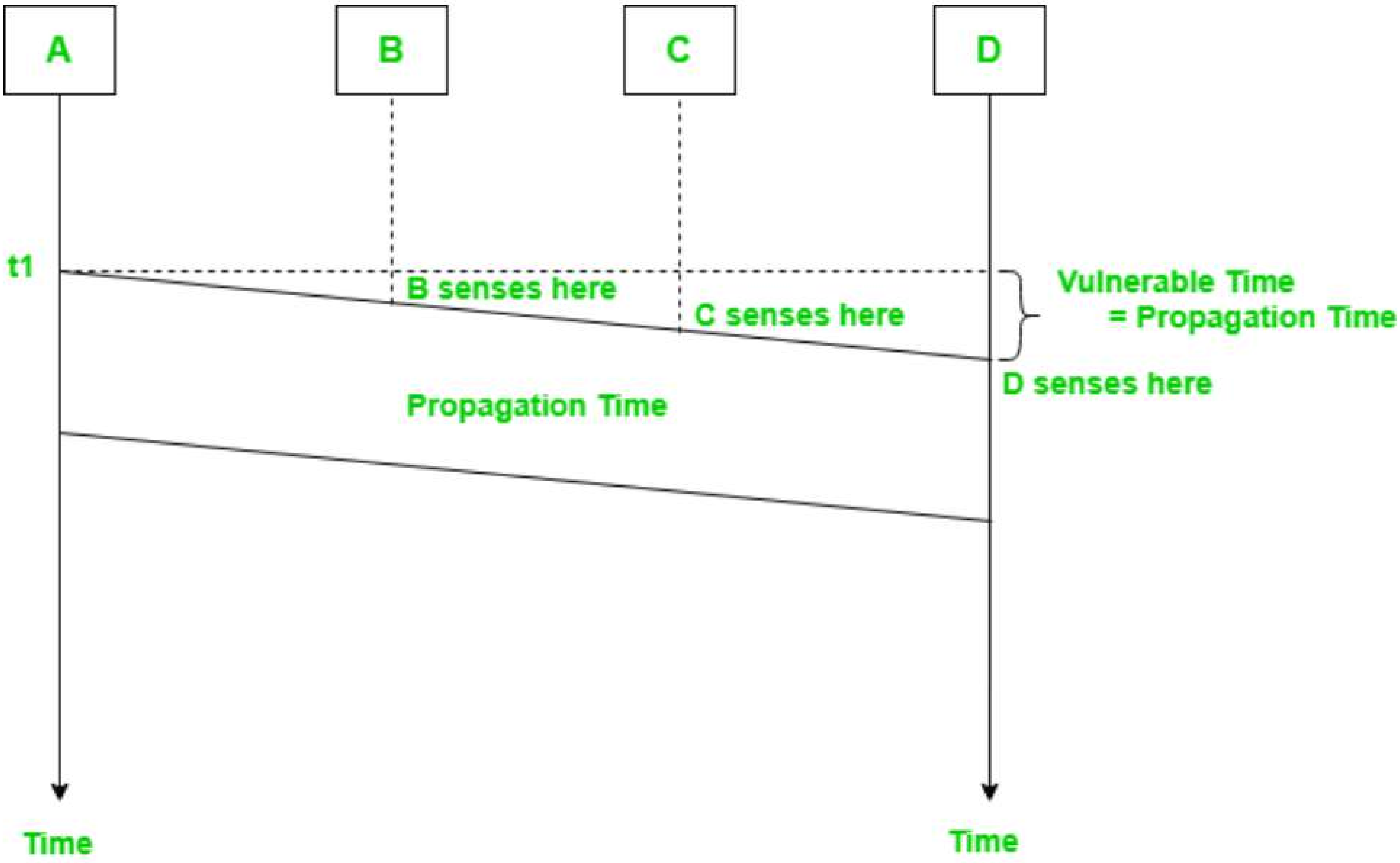

The persistence methods can be applied to help the station take action when the channel is busy/idle.

1. 1-persistent CSMA :

In 1-persistent CSMA, station continuously senses channel to check its state i.e. idle or busy so that it can transfer data. In case when channel is busy, station will wait for channel to become idle. When station finds an idle channel, it transmits frame to channel without any delay with probability 1. Due to probability 1, it is called 1-persistent CSMA. The problem with this method is that there is a huge chance of collision, as two or more stations can find channel in idle state and transmit frames at the same time. At the time when a collision occurs station has to wait for random time for channel to be idle and to start all again.

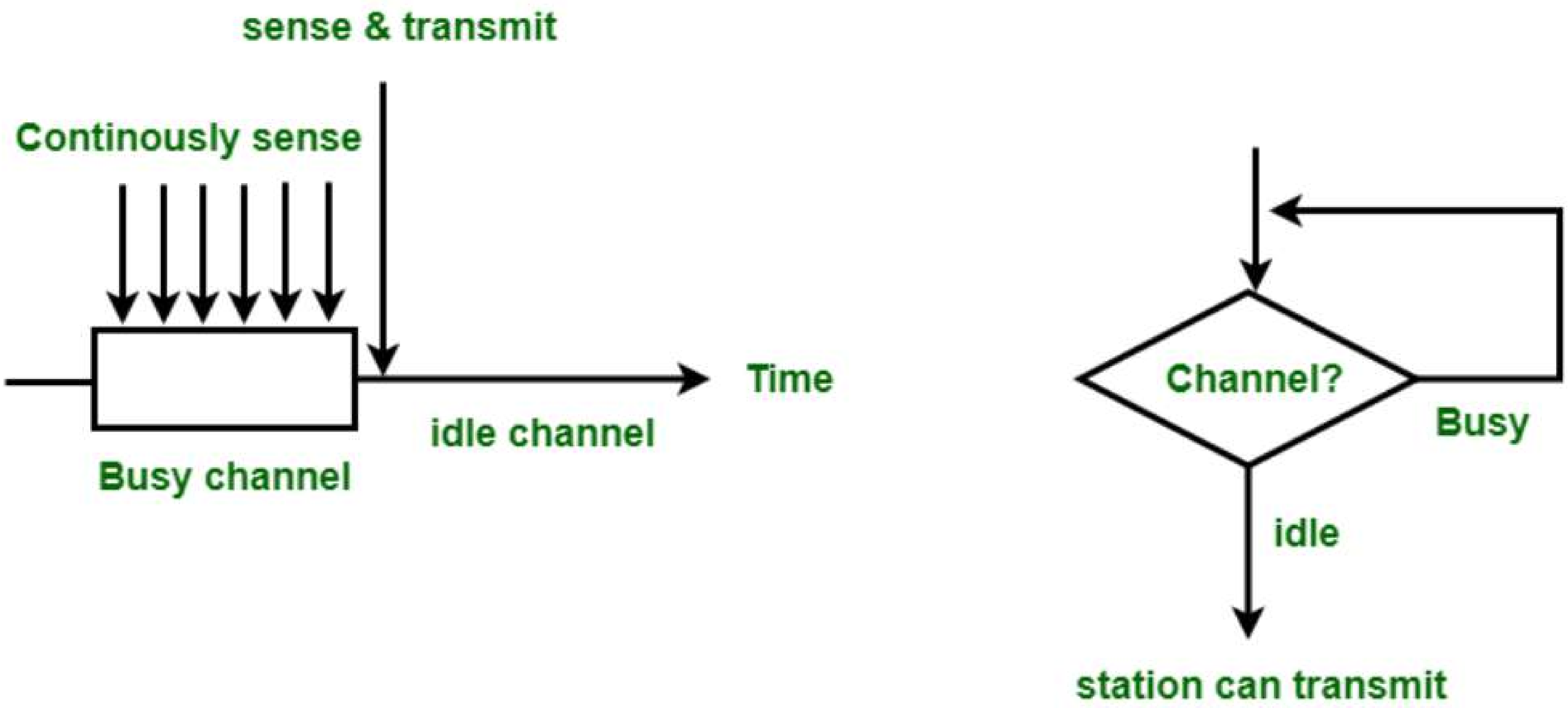

Figure – 1-persistent CSMA