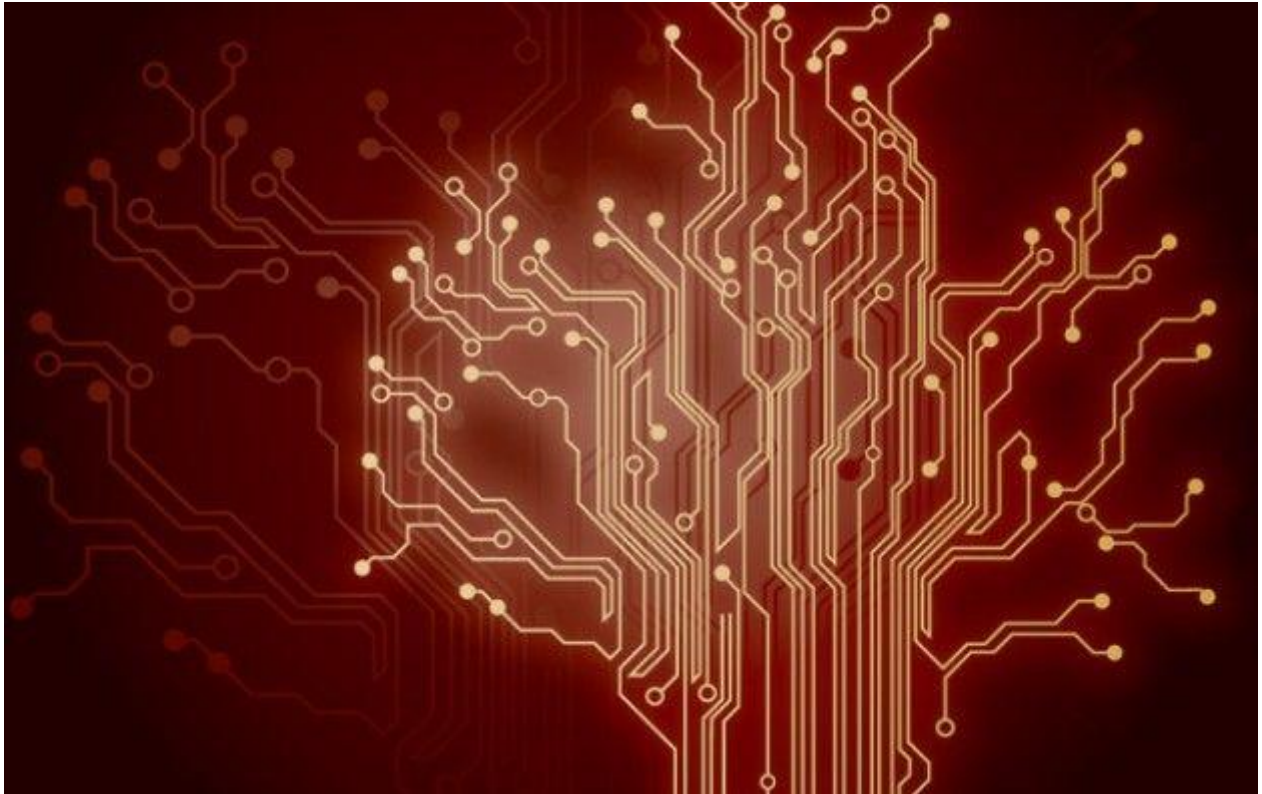# NETWORK LAB REPORT

CO3: Implement 1-persistent, non-persistent and p-persistent CSMA techniques.

Atanu Ghosh

BCSE-III (2019-2023) 5th sem, Section: A-1,

Roll: **001910501005**, Date: 20/09/2021

ASSIGNMENT-2

Implement 1-persistent, non-persistent and p-persistent CSMA techniques.

PROBLEM STATEMENT

In this assignment, you have to implement 1-persistent, non-persistent and p-persistent CSMA techniques. Measure the performance parameters like throughput (i.e., average amount of data bits successfully transmitted per unit time) and forwarding delay (i.e., average end-to-end delay, including the queuing delay and the transmission delay) experienced by the CSMA frames (IEEE 802.3). Plot the comparison graphs for throughput and forwarding delay by varying p. State your observations on the impact of performance of different CSMA techniques.

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DESIGN

One-persistent CSMA:

In 1-persistent CSMA, the station continuously senses the channel to check its state i.e. idle or busy so that it can transfer data or not. In case when the channel is busy, the station will wait for the channel to become idle. When a station finds an idle channel, it transmits the frame to the channel without any delay. It transmits the frame with probability 1. Due to probability 1, it is called 1-persistent CSMA.

The problem with this method is that there are a large number of chances for the collision because there is a chance when two or more stations found a channel in an idle state and the transmit frames at the same time. At the time when a collision occurs, the station has to wait for the random time for the channel to be idle and to start all again.
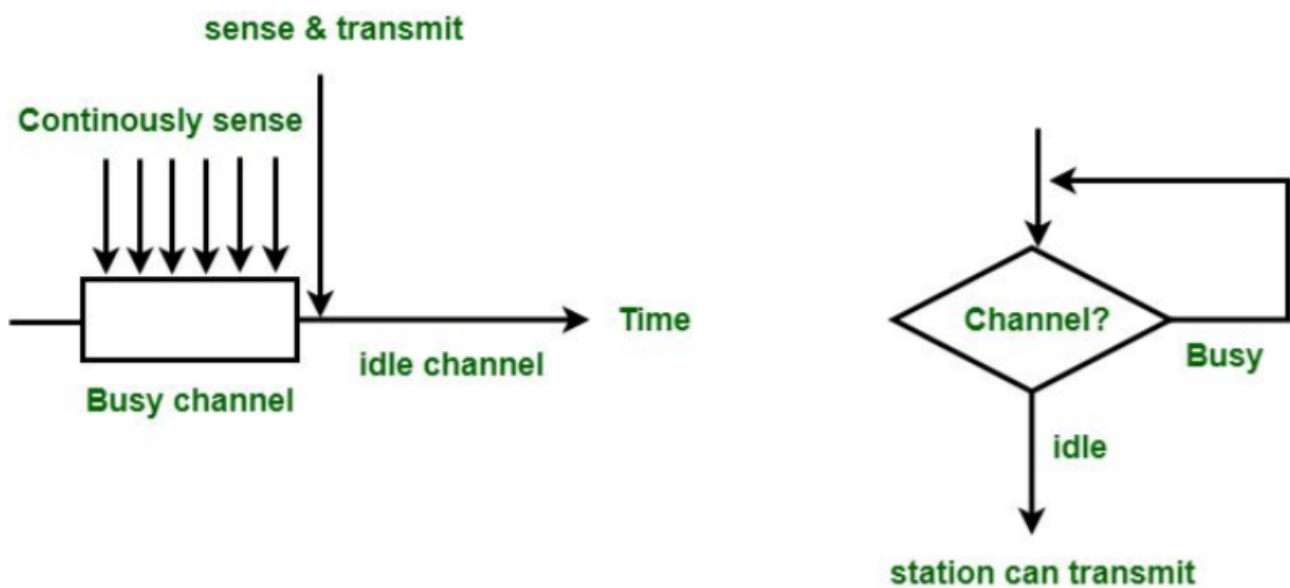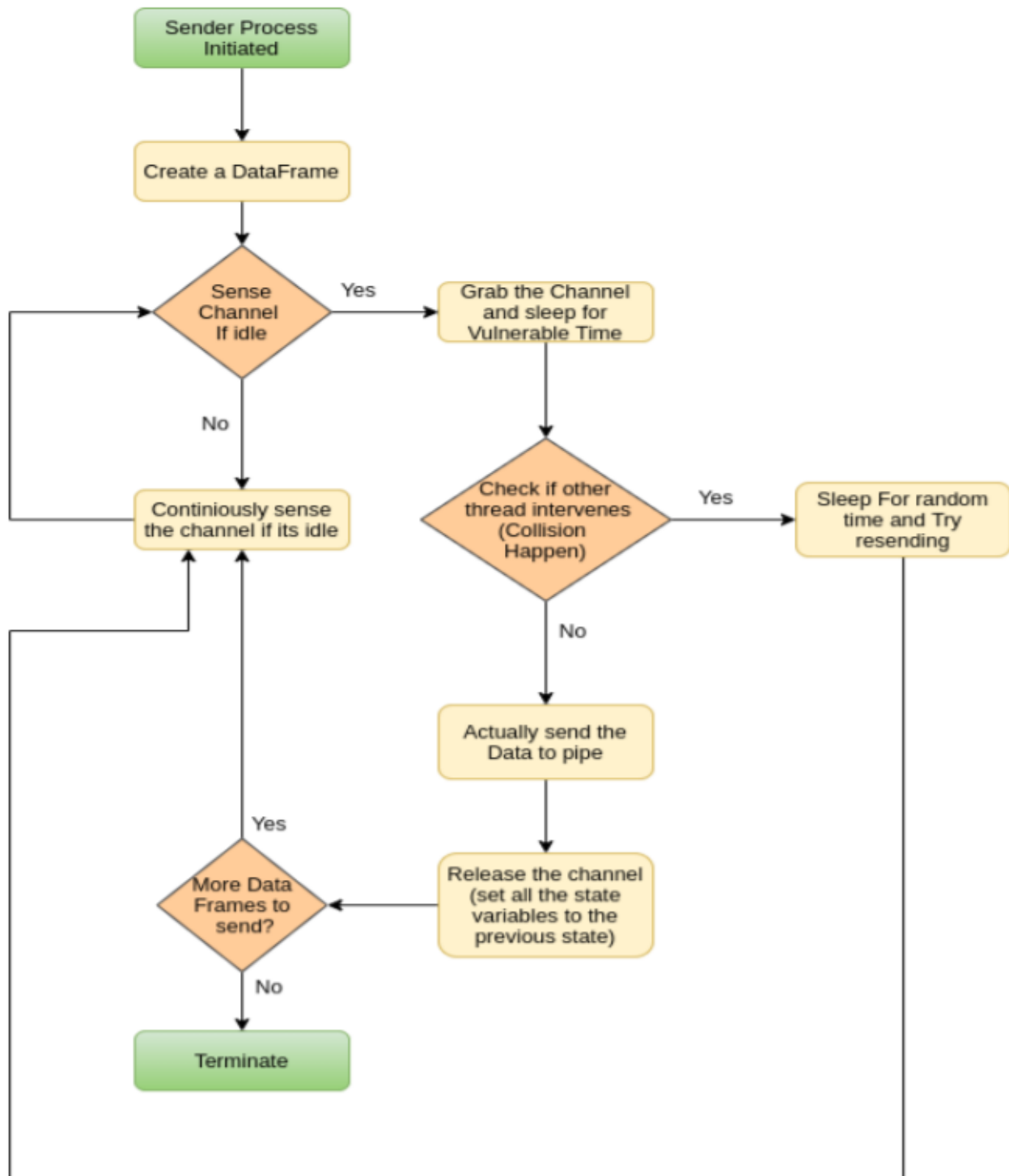

FIg : One persistent CSMA

FLOWCHART :

Fig : Implementation of One-persistent CSMA

Non-persistent CSMA:

In this method, the station which has frames to send, only that station senses for the channel. In case of an idle channel, it will send a frame immediately to that channel. In case when the channel is found busy, it will wait for the random time and again sense for the state of the station whether idle or busy. In this method, the station does not immediately sense the channel for only the purpose of capturing it when it detects the end of the previous transmission. The main advantage of using this method is that it reduces the chances of collision. The problem with this is that it reduces the efficiency of the network.
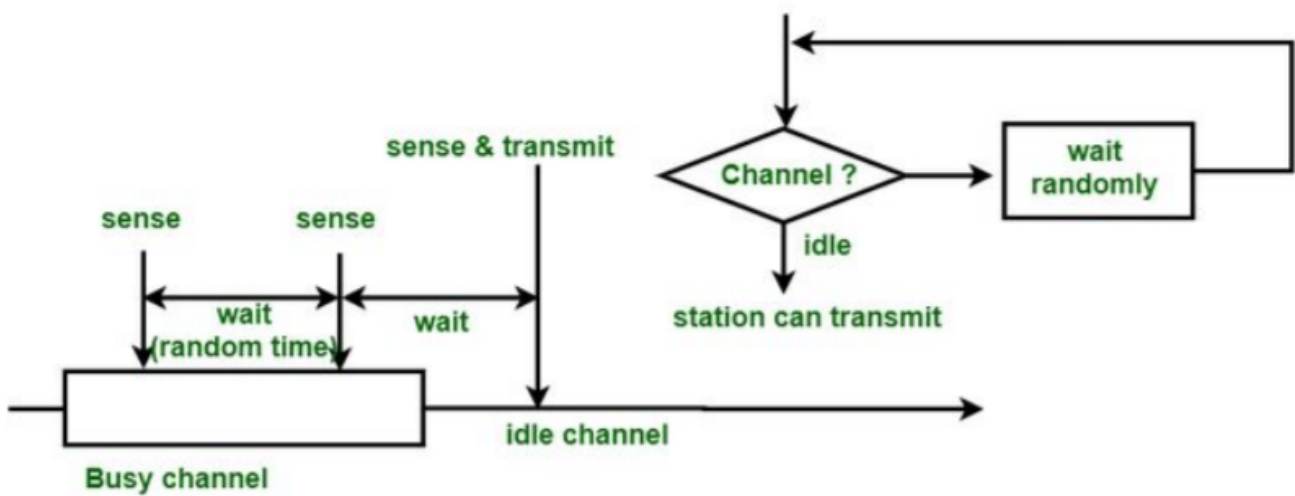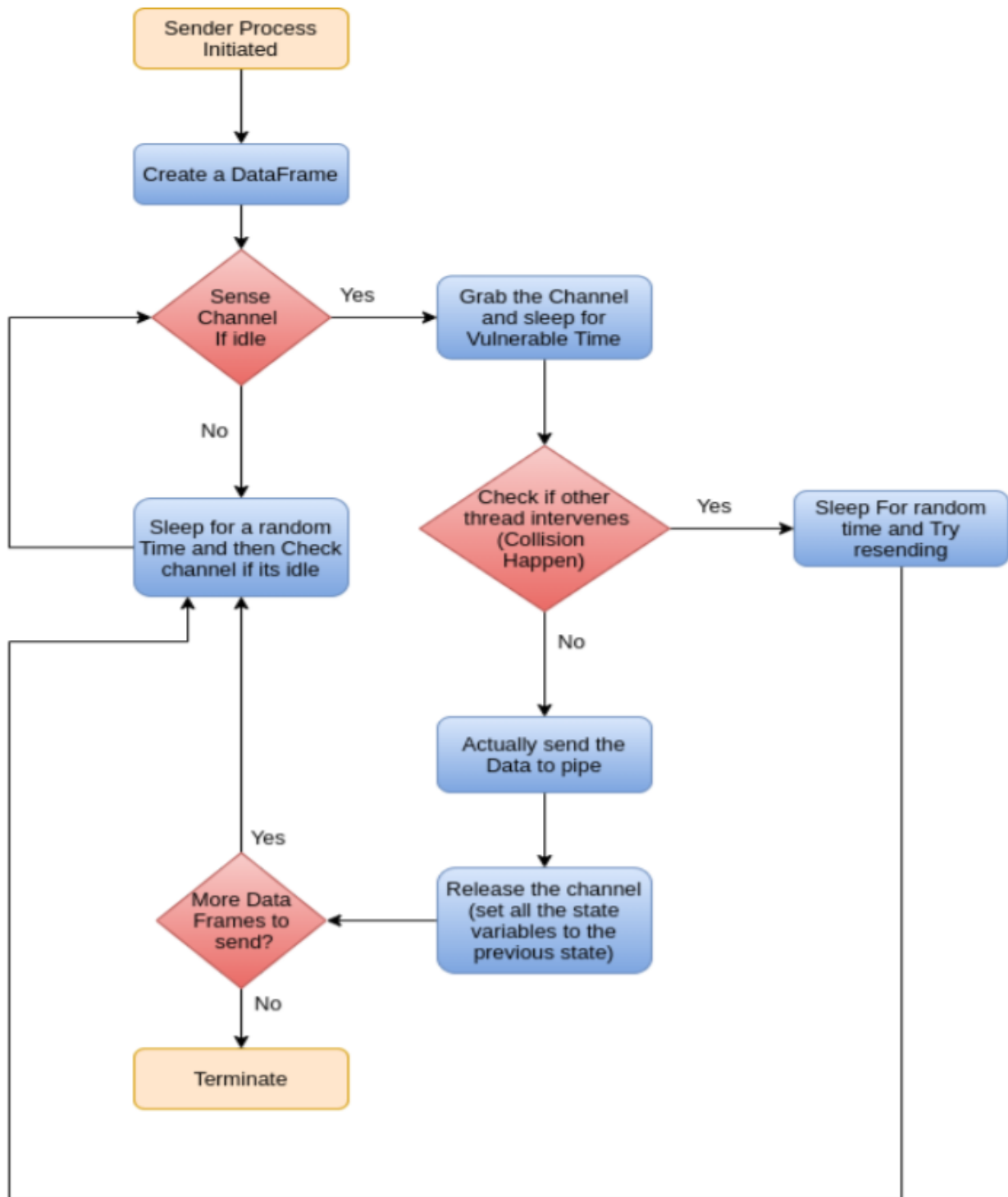
FIg : Non persistent CSMA

FLOWCHART :

Fig : Implementation of Non-persistent CSMA

P (1/n) -persistent CSMA:

This is the method that is used when the channel has time-slots and that time-slot duration is equal to or greater than the maximum propagation delay time. When the station is ready to send the frames, it will sense the channel. If the channel is found to be busy, the channel will wait for the next slot. If the channel is found to be idle, it transmits the frame with probability p, thus for the left probability i.e. q which is equal to 1-p the station will wait for the beginning of the next time slot. In case, when the next slot is also found idle it will transmit or wait again with the probabilities p and q. This process is repeated until either the frame gets transmitted or another station has started transmitting.
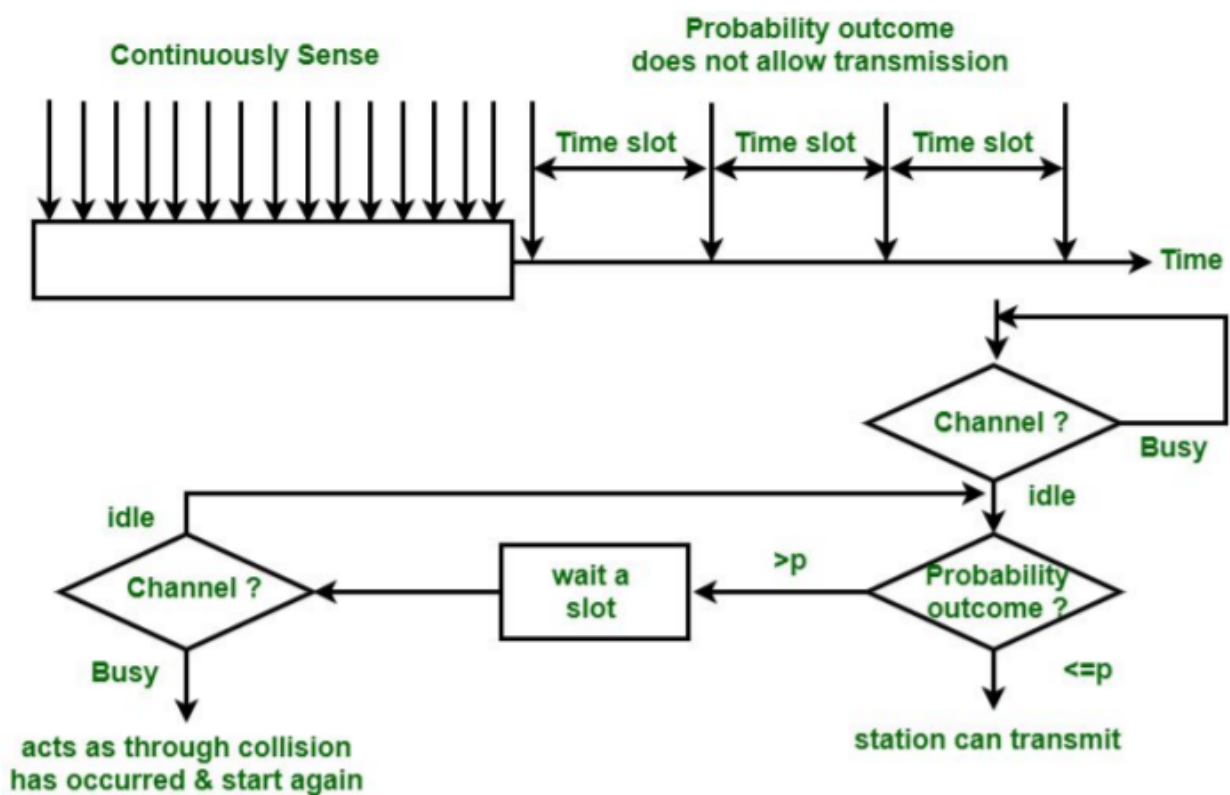
FIg : P persistent CSMA

FLOWCHART :
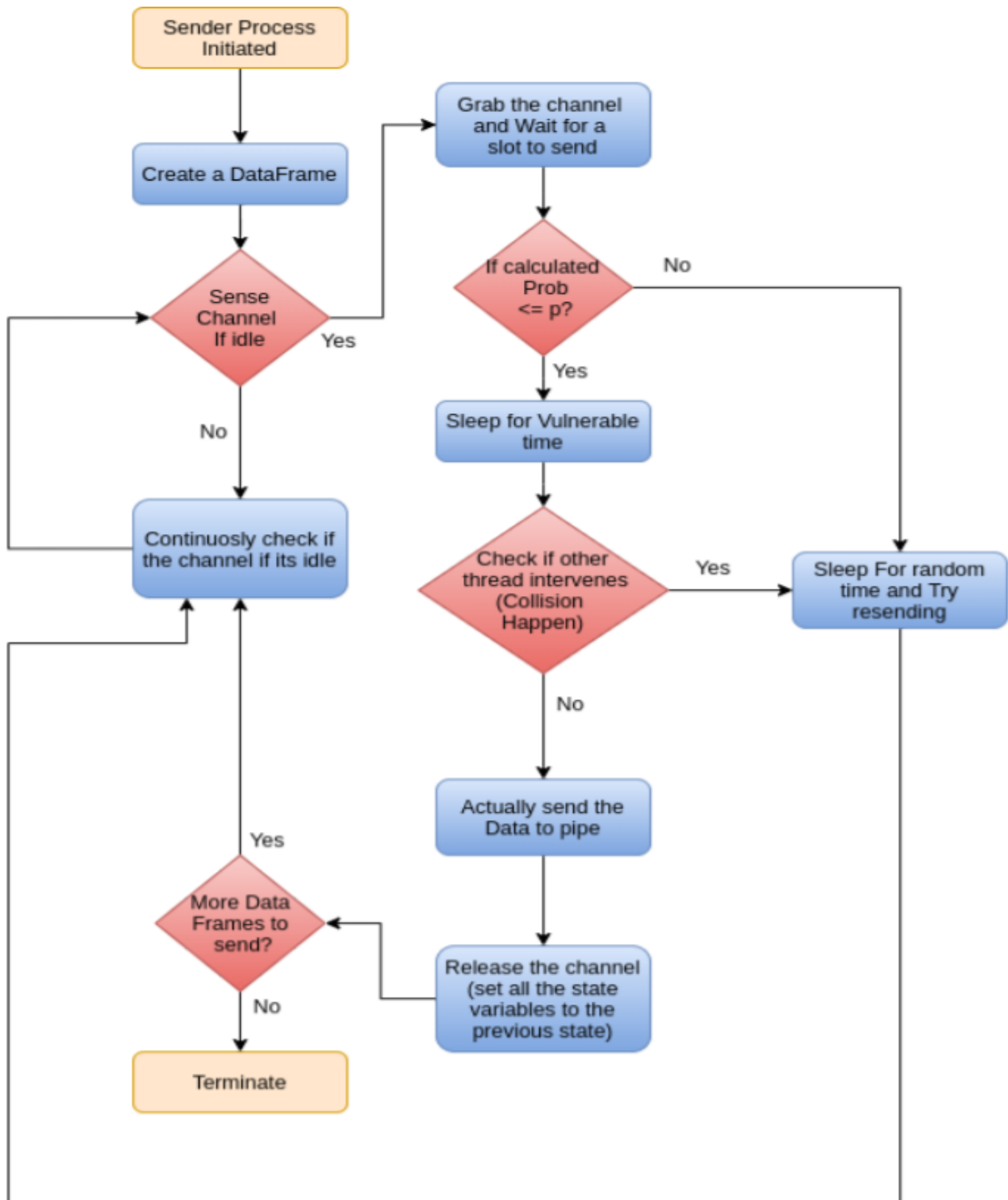
Fig : Implementation of P-persistent CSMA

SCHEMATIC DIAGRAM (as a part of DESIGN)
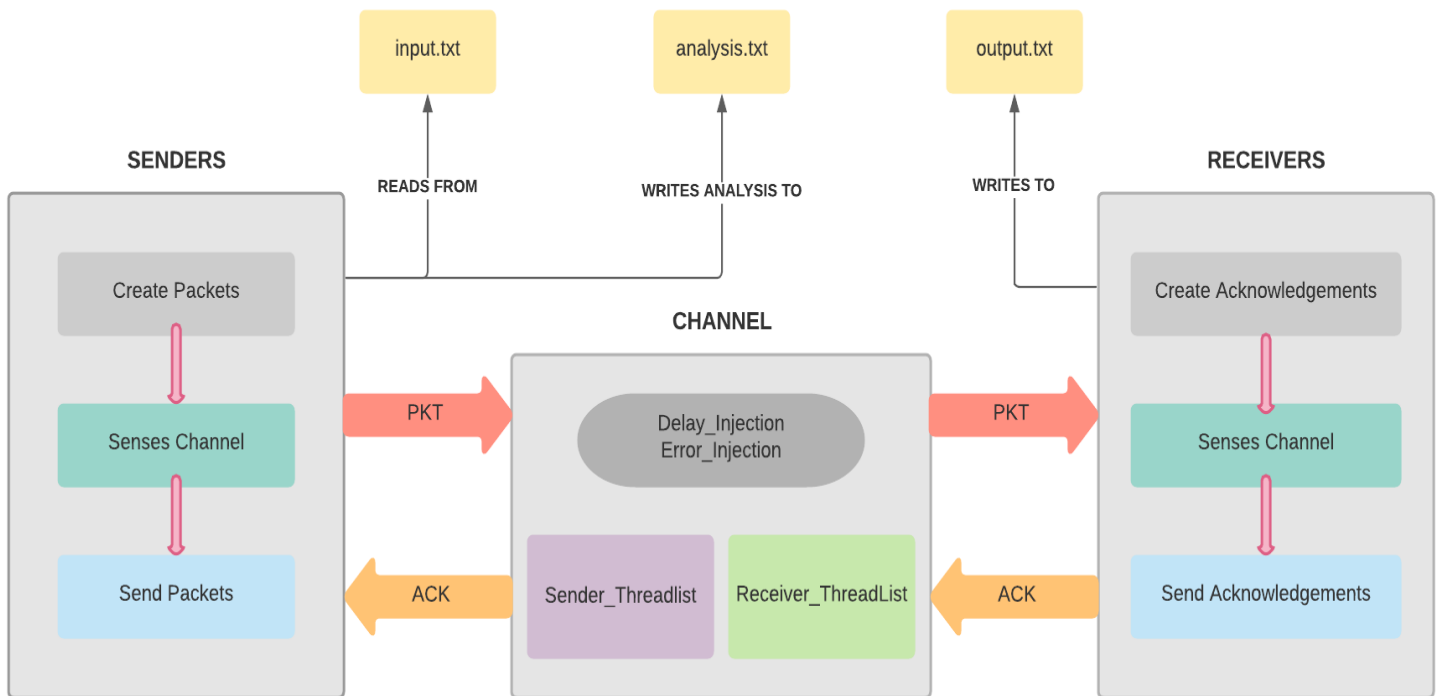
Fig : Schematic diagram to understand the flow of code for CSMA

IMPLEMENTATION

A. Packet Structure:

Here for better generalization and uniformity, **IEEE 802.3** frame format has been used throughout the communication. The fields are `Preamble + SFD + DEST_MAC + SRC_MAC + Node_Info (custom addition) + DATA + CheckSum` (**7** + **1** + **6** + **6** + **2** +**46** + **4** = 72 **Bytes**)**.** Each data packet is encoded with **CheckSum-32** for detecting transmission error.
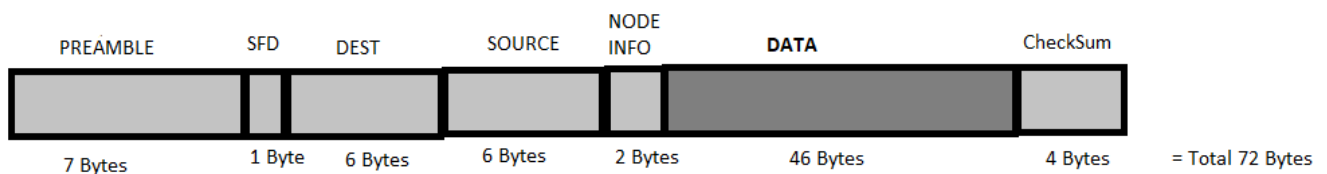
Fig : IEEE 802.3 Frame Format

B. <u>Algorithm for Sender:</u>

```
select_receiver( )

make_packets_to_send_by_one/non/P-persistent( )

sense_signal_to_check_if_busy_or_not( )

start_sending_packets( )

receive_confirmation_from_reciver( )

generate_report_for_performance_analysis( )
```

C. <u>Algorithm for Channel:</u>

```
channelize_packets_from_sender_to_receiver( )

channelize_response_from_receiver_to_sender( )

start_the_threads_for_data_sending_and_response_receiving( )
```

D. <u>Algorithm for Receiver:</u>

```
decode_which_sender_the_packet_is_coming_from( )

receive_the_packet( )

send_packet_reception_confirmation_to_specific_address( )
```

SOURCE CODE STRUCTURE

The Source-Code folder (`src`) contains -

- `const.py:`

  All the constants (number of threads, time-out, packet-size and etc) are defined here.

- `checker.py:`

  Contains functions for CheckSum generation and ErrorChecking.

- `gen_packet.py:`

  Packet class containing methods for generating packets maintaining IEEE 802.3 format, extracting the original data from the generated packets, decode the source and destination mac addresses, checking errors by CheckSum algorithm, etc.

- `sender.py`:

  Sender Class containing methods for selecting a receiver, reading data from the input file(s), selecting the sending method (one/non/p-persistent), adding the packets into stream/channel after sensing whether the channel is busy or not, etc.

- `channel.py`:

  Channel Class for channelizing packets from sender, channelizing response from the receiver, starting the sender and receiving threads one by one in queued manner.

- `receiver.py`:

  Receiver Class for extracting the data from the receiver packet, writing the confirmation into the output file, etc.

- `main.py`:

  Contains support for adding the sender and receiver connections to separate lists one by one, adding the sender and receiver threads to separate lists one by one, and start the sending of packets based on the chosen option and generating a performance report.

- `/textfiles` :

  Folder containing input and output files, and the report file (written number of packets sent, received and total delay and calculated throughput).

OUTPUT & SCREENSHOTS

```
--------------------------------------------------------------
    ###### CHOSEN CSMA TECHNIQUE IS : ONE PERSISTENT METHOD ######

20/09/2021 20:08:55 CHANNEL has been initialised

20/09/2021 20:08:55 SENDER-1    ||   PACKET 1 SENT TO CHANNEL
20/09/2021 20:08:55 SENDER-2    ||   PACKET 1 SENT TO CHANNEL

20/09/2021 20:08:56 RECEIVER-1  ||   PACKET RECEIVED

20/09/2021 20:08:56 SENDER-1    ||   FOUND CHANNEL BUSY
20/09/2021 20:08:56 SENDER-2    ||   FOUND CHANNEL BUSY
20/09/2021 20:08:57 SENDER-2    ||   FOUND CHANNEL BUSY
20/09/2021 20:08:57 SENDER-1    ||   FOUND CHANNEL BUSY

20/09/2021 20:08:57 RECEIVER-2  ||   PACKET RECEIVED

20/09/2021 20:08:57 SENDER-2    ||   PACKET 2 SENT TO CHANNEL
20/09/2021 20:08:57 SENDER-1    ||   COLLISION
20/09/2021 20:08:58 SENDER-1    ||   PACKET 2 SENT TO CHANNEL

20/09/2021 20:08:58 RECEIVER-2  ||   PACKET RECEIVED

20/09/2021 20:08:59 SENDER-2    ||   FOUND CHANNEL BUSY
20/09/2021 20:08:59 SENDER-1    ||   FOUND CHANNEL BUSY
20/09/2021 20:08:59 SENDER-2    ||   FOUND CHANNEL BUSY

20/09/2021 20:08:59 RECEIVER-1  ||   PACKET RECEIVED

20/09/2021 20:08:59 SENDER-1    ||   FOUND CHANNEL BUSY
20/09/2021 20:09:00 SENDER-2    ||   PACKET 3 SENT TO CHANNEL
20/09/2021 20:09:00 SENDER-1    ||   PACKET 3 SENT TO CHANNEL

20/09/2021 20:09:00 RECEIVER-2  ||   PACKET RECEIVED

20/09/2021 20:09:01 SENDER-2    ||   FOUND CHANNEL BUSY
20/09/2021 20:09:01 SENDER-1    ||   FOUND CHANNEL BUSY
20/09/2021 20:09:01 SENDER-2    ||   FOUND CHANNEL BUSY

20/09/2021 20:09:01 RECEIVER-1  ||   PACKET RECEIVED

20/09/2021 20:09:01 SENDER-1    ||   FOUND CHANNEL BUSY
20/09/2021 20:09:02 SENDER-2    ||   PACKET 4 SENT TO CHANNEL
20/09/2021 20:09:02 SENDER-1    ||   PACKET 4 SENT TO CHANNEL

20/09/2021 20:09:03 RECEIVER-2  ||   PACKET RECEIVED

20/09/2021 20:09:03 SENDER-2    ||   FOUND CHANNEL BUSY
20/09/2021 20:09:03 SENDER-1    ||   FOUND CHANNEL BUSY
20/09/2021 20:09:03 SENDER-2    ||   FOUND CHANNEL BUSY
```

```
53    20/09/2021 20:09:03 RECEIVER-1  ||  PACKET RECEIVED
54
55    20/09/2021 20:09:03 SENDER-1    ||  FOUND CHANNEL BUSY
56    20/09/2021 20:09:04 SENDER-2    ||  PACKET 5 SENT TO CHANNEL
57    20/09/2021 20:09:04 SENDER-1    ||  PACKET 5 SENT TO CHANNEL
58
59    20/09/2021 20:09:05 RECEIVER-2  ||  PACKET RECEIVED
60
61    20/09/2021 20:09:05 SENDER-2    ||  FOUND CHANNEL BUSY
62    20/09/2021 20:09:05 SENDER-1    ||  FOUND CHANNEL BUSY
63    20/09/2021 20:09:05 SENDER-2    ||  FOUND CHANNEL BUSY
64
65    20/09/2021 20:09:06 RECEIVER-1  ||  PACKET RECEIVED
66
67    20/09/2021 20:09:06 SENDER-1    ||  FOUND CHANNEL BUSY
68    20/09/2021 20:09:06 SENDER-2    ||  PACKET 6 SENT TO CHANNEL
69    20/09/2021 20:09:06 SENDER-1    ||  PACKET 6 SENT TO CHANNEL
70
71    20/09/2021 20:09:07 RECEIVER-2  ||  PACKET RECEIVED
72
73    20/09/2021 20:09:07 SENDER-2    ||  FOUND CHANNEL BUSY
74    20/09/2021 20:09:07 SENDER-1    ||  FOUND CHANNEL BUSY
75    20/09/2021 20:09:08 SENDER-2    ||  FOUND CHANNEL BUSY
76
77    20/09/2021 20:09:08 RECEIVER-1  ||  PACKET RECEIVED
78
79    20/09/2021 20:09:08 SENDER-1    ||  FOUND CHANNEL BUSY
80    20/09/2021 20:09:08 SENDER-2    ||  PACKET 7 SENT TO CHANNEL
81    20/09/2021 20:09:08 SENDER-1    ||  PACKET 7 SENT TO CHANNEL
82
83    20/09/2021 20:09:09 RECEIVER-2  ||  PACKET RECEIVED
84
85    20/09/2021 20:09:09 SENDER-2    ||  FOUND CHANNEL BUSY
86    20/09/2021 20:09:09 SENDER-1    ||  FOUND CHANNEL BUSY
87    20/09/2021 20:09:10 SENDER-2    ||  FOUND CHANNEL BUSY
88
89    20/09/2021 20:09:10 RECEIVER-1  ||  PACKET RECEIVED
90
91    20/09/2021 20:09:10 SENDER-1    ||  FOUND CHANNEL BUSY
92    20/09/2021 20:09:10 SENDER-2    ||  PACKET 8 SENT TO CHANNEL
93    20/09/2021 20:09:10 SENDER-1    ||  PACKET 8 SENT TO CHANNEL
94
95    20/09/2021 20:09:11 RECEIVER-2  ||  PACKET RECEIVED
96
97
98
99    ********** 20/09/2021 20:09:11 SENDER-2 STATS **********
100   *    Total packets: 8
101   *    Total Delay: 16.11 secs
102   *    Total collisions: 0
103   *    Throughput: 1.0
104   *******************************************************
```

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```
108
109    ********** 20/09/2021 20:09:11 SENDER-1 STATS **********
110    *    Total packets: 8
111    *    Total Delay: 16.25 secs
112    *    Total collisions: 1
113    *    Throughput: 0.889
114    ********************************************************
115
116
117
118    20/09/2021 20:09:12 RECEIVER-1  ||  PACKET RECEIVED
119
120
121    -------------------------------------------------------------------------------
122    |     ###### CHOSEN CSMA TECHNIQUE IS : NON PERSISTENT METHOD ######
123
124    20/09/2021 20:09:40 CHANNEL has been initialised
125
126    20/09/2021 20:09:40 SENDER-1     ||   PACKET 1 SENT TO CHANNEL
127    20/09/2021 20:09:40 SENDER-2     ||   PACKET 1 SENT TO CHANNEL
128
129    20/09/2021 20:09:41 RECEIVER-1  ||  PACKET RECEIVED
130
131    20/09/2021 20:09:41 SENDER-2     ||   FOUND CHANNEL BUSY
132    20/09/2021 20:09:41 SENDER-1     ||   FOUND CHANNEL BUSY
133
134    20/09/2021 20:09:42 RECEIVER-2  ||  PACKET RECEIVED
135
136    20/09/2021 20:09:42 SENDER-1     ||   PACKET 2 SENT TO CHANNEL
137    20/09/2021 20:09:42 SENDER-2     ||   PACKET 2 SENT TO CHANNEL
138
139    20/09/2021 20:09:43 RECEIVER-1  ||  PACKET RECEIVED
140
141    20/09/2021 20:09:43 SENDER-1     ||   FOUND CHANNEL BUSY
142    20/09/2021 20:09:43 SENDER-2     ||   FOUND CHANNEL BUSY
143
144    20/09/2021 20:09:44 RECEIVER-2  ||  PACKET RECEIVED
145
146    20/09/2021 20:09:44 SENDER-1     ||   PACKET 3 SENT TO CHANNEL
147    20/09/2021 20:09:44 SENDER-2     ||   PACKET 3 SENT TO CHANNEL
148
149    20/09/2021 20:09:45 RECEIVER-1  ||  PACKET RECEIVED
150
151    20/09/2021 20:09:45 SENDER-1     ||   FOUND CHANNEL BUSY
152    20/09/2021 20:09:45 SENDER-2     ||   FOUND CHANNEL BUSY
153
154    20/09/2021 20:09:46 RECEIVER-2  ||  PACKET RECEIVED
155
156    20/09/2021 20:09:46 SENDER-1     ||   PACKET 4 SENT TO CHANNEL
157    20/09/2021 20:09:46 SENDER-2     ||   PACKET 4 SENT TO CHANNEL
158
```

```
159    20/09/2021 20:09:47 RECEIVER-1  ||  PACKET RECEIVED
160
161    20/09/2021 20:09:48 SENDER-1    ||  FOUND CHANNEL BUSY
162    20/09/2021 20:09:48 SENDER-2    ||  FOUND CHANNEL BUSY
163
164    20/09/2021 20:09:48 RECEIVER-2  ||  PACKET RECEIVED
165
166    20/09/2021 20:09:49 SENDER-2    ||  PACKET 5 SENT TO CHANNEL
167    20/09/2021 20:09:49 SENDER-1    ||  PACKET 5 SENT TO CHANNEL
168
169    20/09/2021 20:09:49 RECEIVER-2  ||  PACKET RECEIVED
170
171    20/09/2021 20:09:50 SENDER-1    ||  FOUND CHANNEL BUSY
172    20/09/2021 20:09:50 SENDER-2    ||  FOUND CHANNEL BUSY
173
174    20/09/2021 20:09:50 RECEIVER-1  ||  PACKET RECEIVED
175
176    20/09/2021 20:09:51 SENDER-2    ||  PACKET 6 SENT TO CHANNEL
177    20/09/2021 20:09:51 SENDER-1    ||  PACKET 6 SENT TO CHANNEL
178
179    20/09/2021 20:09:52 RECEIVER-2  ||  PACKET RECEIVED
180
181    20/09/2021 20:09:52 SENDER-1    ||  FOUND CHANNEL BUSY
182    20/09/2021 20:09:52 SENDER-2    ||  FOUND CHANNEL BUSY
183
184    20/09/2021 20:09:52 RECEIVER-1  ||  PACKET RECEIVED
185
186    20/09/2021 20:09:53 SENDER-2    ||  PACKET 7 SENT TO CHANNEL
187    20/09/2021 20:09:53 SENDER-1    ||  PACKET 7 SENT TO CHANNEL
188
189    20/09/2021 20:09:54 RECEIVER-1  ||  PACKET RECEIVED
190
191    20/09/2021 20:09:54 SENDER-1    ||  FOUND CHANNEL BUSY
192    20/09/2021 20:09:54 SENDER-2    ||  FOUND CHANNEL BUSY
193
194    20/09/2021 20:09:55 RECEIVER-2  ||  PACKET RECEIVED
195
196    20/09/2021 20:09:55 SENDER-1    ||  PACKET 8 SENT TO CHANNEL
197    20/09/2021 20:09:55 SENDER-2    ||  PACKET 8 SENT TO CHANNEL
198
199    20/09/2021 20:09:56 RECEIVER-1  ||  PACKET RECEIVED
200
201
202
203    ********** 20/09/2021 20:09:56 SENDER-1 STATS **********
204    *    Total packets: 8
205    *    Total Delay: 16.06 secs
206    *    Total collisions: 0
207    *    Throughput: 1.0
208    ****************************************************
209
```

14

```
213     ********** 20/09/2021 20:09:56 SENDER-2 STATS **********
214     *    Total packets: 8
215     *    Total Delay: 16.07 secs
216     *    Total collisions: 0
217     *    Throughput: 1.0
218     ***********************************************************
219
220
221
222     20/09/2021 20:09:57 RECEIVER-2  ||  PACKET RECEIVED
223
224
225     ---------------------------------------------------------------------------
226         ###### CHOSEN CSMA TECHNIQUE IS : P PERSISTENT METHOD ######
227
228     20/09/2021 20:10:12 CHANNEL has been initialised
229
230     20/09/2021 20:10:12 SENDER-2    ||  PACKET 1 SENT TO CHANNEL
231     20/09/2021 20:10:12 SENDER-1    ||  PACKET 1 SENT TO CHANNEL
232
233     20/09/2021 20:10:13 RECEIVER-1  ||  PACKET RECEIVED
234
235     20/09/2021 20:10:13 SENDER-1    ||  FOUND CHANNEL BUSY
236     20/09/2021 20:10:13 SENDER-2    ||  FOUND CHANNEL BUSY
237     20/09/2021 20:10:13 SENDER-1    ||  FOUND CHANNEL BUSY
238
239     20/09/2021 20:10:13 RECEIVER-2  ||  PACKET RECEIVED
240
241     20/09/2021 20:10:14 SENDER-2    ||  WAITING
242     20/09/2021 20:10:14 SENDER-1    ||  WAITING
243     20/09/2021 20:10:14 SENDER-2    ||  PACKET 2 SENT TO CHANNEL
244     20/09/2021 20:10:14 SENDER-1    ||  COLLISION OCCURED
245     20/09/2021 20:10:14 SENDER-1    ||  PACKET 2 SENT TO CHANNEL
246
247     20/09/2021 20:10:15 RECEIVER-2  ||  PACKET RECEIVED
248
249     20/09/2021 20:10:15 SENDER-2    ||  FOUND CHANNEL BUSY
250     20/09/2021 20:10:15 SENDER-1    ||  FOUND CHANNEL BUSY
251     20/09/2021 20:10:16 SENDER-2    ||  FOUND CHANNEL BUSY
252
253     20/09/2021 20:10:16 RECEIVER-1  ||  PACKET RECEIVED
254
255     20/09/2021 20:10:16 SENDER-1    ||  FOUND CHANNEL BUSY
256     20/09/2021 20:10:16 SENDER-2    ||  PACKET 3 SENT TO CHANNEL
257     20/09/2021 20:10:16 SENDER-1    ||  WAITING
258     20/09/2021 20:10:17 SENDER-1    ||  FOUND CHANNEL BUSY
259     20/09/2021 20:10:17 SENDER-1    ||  FOUND CHANNEL BUSY
260
261     20/09/2021 20:10:17 RECEIVER-2  ||  PACKET RECEIVED
262
263     20/09/2021 20:10:17 SENDER-2    ||  PACKET 4 SENT TO CHANNEL
264     20/09/2021 20:10:18 SENDER-1    ||  FOUND CHANNEL BUSY
265     20/09/2021 20:10:18 SENDER-1    ||  FOUND CHANNEL BUSY
```

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```
263    20/09/2021 20:10:17 SENDER-2    ||  PACKET 4 SENT TO CHANNEL
264    20/09/2021 20:10:18 SENDER-1    ||  FOUND CHANNEL BUSY
265    20/09/2021 20:10:18 SENDER-1    ||  FOUND CHANNEL BUSY
266
267    20/09/2021 20:10:18 RECEIVER-2  ||  PACKET RECEIVED
268
269    20/09/2021 20:10:18 SENDER-2    ||  PACKET 5 SENT TO CHANNEL
270    20/09/2021 20:10:19 SENDER-1    ||  WAITING
271    20/09/2021 20:10:19 SENDER-1    ||  FOUND CHANNEL BUSY
272
273    20/09/2021 20:10:19 RECEIVER-2  ||  PACKET RECEIVED
274
275    20/09/2021 20:10:19 SENDER-1    ||  FOUND CHANNEL BUSY
276    20/09/2021 20:10:20 SENDER-2    ||  WAITING
277    20/09/2021 20:10:20 SENDER-2    ||  WAITING
278    20/09/2021 20:10:20 SENDER-1    ||  PACKET 3 SENT TO CHANNEL
279    20/09/2021 20:10:20 SENDER-2    ||  FOUND CHANNEL BUSY
280    20/09/2021 20:10:21 SENDER-2    ||  FOUND CHANNEL BUSY
281
282    20/09/2021 20:10:21 RECEIVER-1  ||  PACKET RECEIVED
283
284    20/09/2021 20:10:21 SENDER-1    ||  WAITING
285    20/09/2021 20:10:21 SENDER-2    ||  PACKET 6 SENT TO CHANNEL
286    20/09/2021 20:10:21 SENDER-1    ||  PACKET 4 SENT TO CHANNEL
287
288    20/09/2021 20:10:22 RECEIVER-2  ||  PACKET RECEIVED
289
290    20/09/2021 20:10:22 SENDER-2    ||  FOUND CHANNEL BUSY
291    20/09/2021 20:10:22 SENDER-1    ||  FOUND CHANNEL BUSY
292    20/09/2021 20:10:23 SENDER-2    ||  FOUND CHANNEL BUSY
293
294    20/09/2021 20:10:23 RECEIVER-1  ||  PACKET RECEIVED
295
296    20/09/2021 20:10:23 SENDER-1    ||  PACKET 5 SENT TO CHANNEL
297    20/09/2021 20:10:23 SENDER-2    ||  FOUND CHANNEL BUSY
298    20/09/2021 20:10:24 SENDER-2    ||  FOUND CHANNEL BUSY
299
300    20/09/2021 20:10:24 RECEIVER-1  ||  PACKET RECEIVED
301
302    20/09/2021 20:10:24 SENDER-1    ||  PACKET 6 SENT TO CHANNEL
303    20/09/2021 20:10:24 SENDER-2    ||  FOUND CHANNEL BUSY
304    20/09/2021 20:10:25 SENDER-2    ||  FOUND CHANNEL BUSY
305
306    20/09/2021 20:10:25 RECEIVER-1  ||  PACKET RECEIVED
307
308    20/09/2021 20:10:25 SENDER-1    ||  WAITING
309    20/09/2021 20:10:25 SENDER-2    ||  PACKET 7 SENT TO CHANNEL
310    20/09/2021 20:10:25 SENDER-1    ||  WAITING
311    20/09/2021 20:10:26 SENDER-1    ||  FOUND CHANNEL BUSY
312    20/09/2021 20:10:26 SENDER-1    ||  FOUND CHANNEL BUSY
313
314    20/09/2021 20:10:26 RECEIVER-2  ||  PACKET RECEIVED
315
```

```
299
300    20/09/2021 20:10:24 RECEIVER-1  ||  PACKET RECEIVED
301
302    20/09/2021 20:10:24 SENDER-1    ||  PACKET 6 SENT TO CHANNEL
303    20/09/2021 20:10:24 SENDER-2    ||  FOUND CHANNEL BUSY
304    20/09/2021 20:10:25 SENDER-2    ||  FOUND CHANNEL BUSY
305
306    20/09/2021 20:10:25 RECEIVER-1  ||  PACKET RECEIVED
307
308    20/09/2021 20:10:25 SENDER-1    ||  WAITING
309    20/09/2021 20:10:25 SENDER-2    ||  PACKET 7 SENT TO CHANNEL
310    20/09/2021 20:10:25 SENDER-1    ||  WAITING
311    20/09/2021 20:10:26 SENDER-1    ||  FOUND CHANNEL BUSY
312    20/09/2021 20:10:26 SENDER-1    ||  FOUND CHANNEL BUSY
313
314    20/09/2021 20:10:26 RECEIVER-2  ||  PACKET RECEIVED
315
316    20/09/2021 20:10:26 SENDER-2    ||  PACKET 8 SENT TO CHANNEL
317    20/09/2021 20:10:27 SENDER-1    ||  FOUND CHANNEL BUSY
318    20/09/2021 20:10:27 SENDER-1    ||  FOUND CHANNEL BUSY
319
320    20/09/2021 20:10:27 RECEIVER-2  ||  PACKET RECEIVED
321
322
323
324    ********** 20/09/2021 20:10:28 SENDER-2 STATS **********
325    *    Total packets: 8
326    *    Total Delay: 15.94 secs
327    *    Total collisions: 0
328    *    Throughput: 1.0
329    *******************************************************
330
331
332    20/09/2021 20:10:28 SENDER-1    ||  PACKET 7 SENT TO CHANNEL
333
334    20/09/2021 20:10:29 RECEIVER-1  ||  PACKET RECEIVED
335
336    20/09/2021 20:10:29 SENDER-1    ||  PACKET 8 SENT TO CHANNEL
337
338    20/09/2021 20:10:30 RECEIVER-1  ||  PACKET RECEIVED
339
340
341
342    ********** 20/09/2021 20:10:30 SENDER-1 STATS **********
343    *    Total packets: 8
344    *    Total Delay: 18.34 secs
345    *    Total collisions: 1
346    *    Throughput: 0.889
347    *******************************************************
348
```

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RESULTS and ANALYSIS

To calculate and get an idea about the avg bandwidth, I turn off all the delay elements in the channel and set the Channel to transmit data with a frame size of 72 bytes. It came out to be approximately 500 kbps.

.● **BandWIdth Calculated = 500 Kbps**

● **Avg packets send from each sender = 13**

Number of Senders = n = 2

CSMA Technique	Avg. Delay Per Sender	Avg. Collision Per Sender	Avg. Throughput
One Persistent	23.795	2.50	0.8471
None Persistent	50.73	0.00	1.0000
1/n Persistent	26.86	0.00	1.0000

Number of Senders = n = 4

CSMA Technique	Avg. Delay Per Sender	Avg. Collision Per Sender	Avg. Throughput
One Persistent	44.807	2.00	0.8825
None Persistent	69.97	1.75	0.8825
1/n Persistent	42.27	2.50	0.8432

Number of Senders = n = 6

CSMA Technique	Avg. Delay Per Sender	Avg. Collision Per Sender	Avg. Throughput
One Persistent	61.30	3.67	0.7963
None Persistent	84.06	1.83	0.8800
1/n Persistent	66.93	4.67	0.749

Number of Senders = n = 8

CSMA Technique	Avg. Delay Per Sender	Avg. Collision Per Sender	Avg. Throughput
One Persistent	79.74	13.25	0.5557
None Persistent	115.74	2.37	0.8511
1/n Persistent	81.31	13.00	0.5245

Comparison of Avg Number of Collision:

Avg Number of Collision vs Number of Sender Nodes
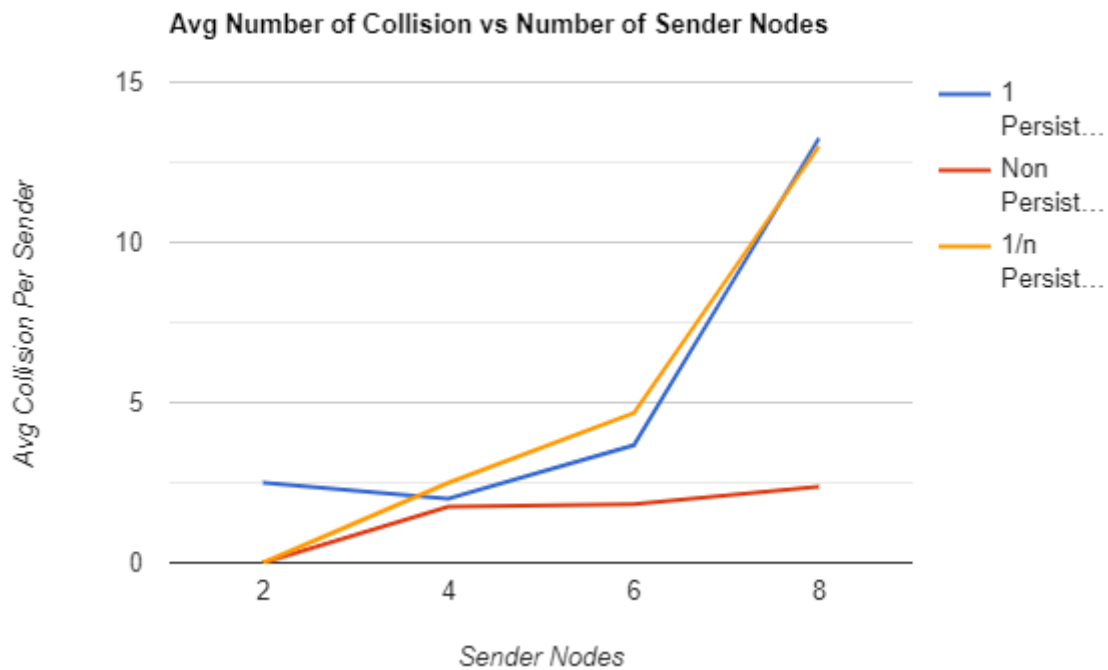
1/n persistent method shows the significant number of collisions and with a greater number of senders it just abruptly increases and almost shows **exponential growth**. The **One-persistent** method actually performs best at the medium number of senders and increases with the increasing number of senders but the **1/n persistent** method outperformed it gradually in the long run. The **Non-persistent** graph actually shows greater consistency throughout and managed to end up having the least number of collisions.

Comparison of Throughputs:

Avg Throughput vs Number of Sender Nodes
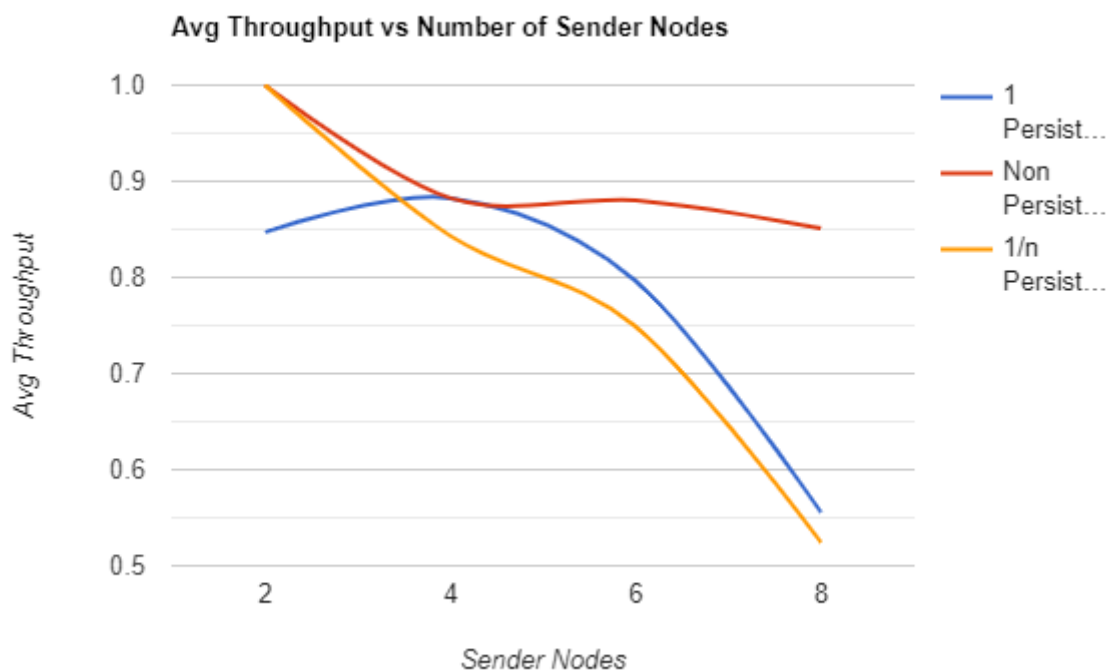
The throughput of a network system is defined as the number of successful transmissions per frame time. The **one persistent** method shows the worst possible throughput and quickly dies to almost zero as the number of senders increases. Interestingly enough **non-persistent** method works pretty well at higher numbers of senders. **1/n persistent** method shows similar performance to **non-persistent** in less number of senders but performs much better than the rest two with the increasing number of senders.

<u>Comparison of Avg Delay:</u>
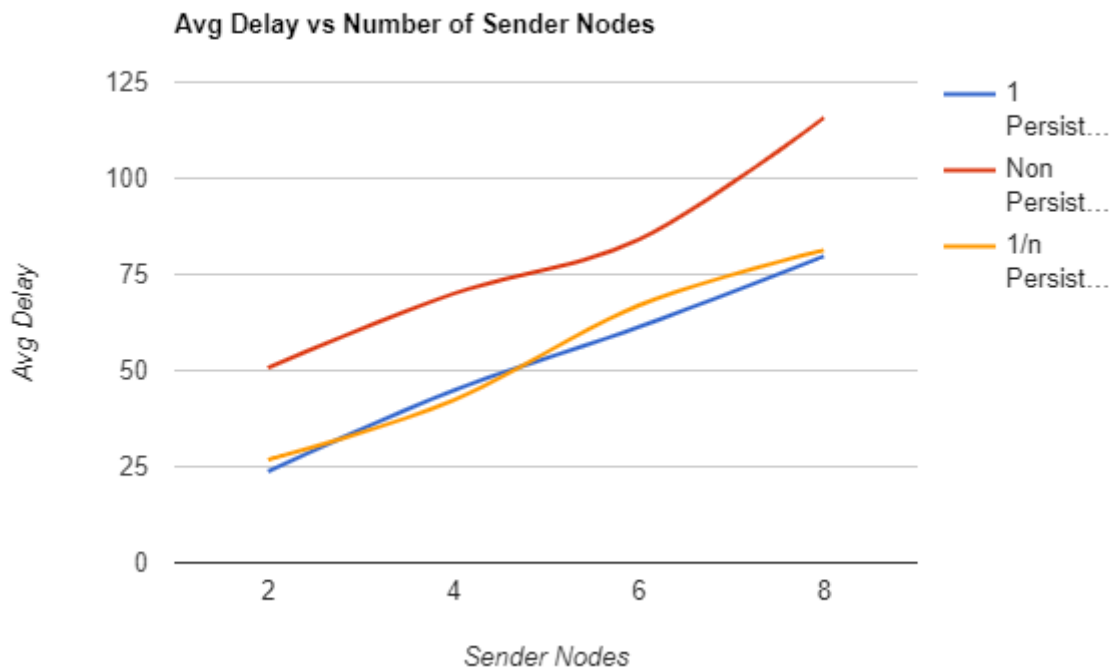
The **Non-persistent** method shows the greatest delay of the bunch. For lower numbers of nodes, **One persisten**t method is the best. In the lower region **One-persistent** method actually able to beat the **1/n persisten**t method, however with increasing sender number it slightly underperforms but in the longer run, the **1/n persistent** method shows the best result and actually is the best of the bunch.

CONCLUSION

In the Collison comparison and Throughput comparison, The **Non-persistent** method actually outperforms both of the rest two methods but in the case of Delay comparison, it abruptly shows huge delay compared to the other two. When we compare the **One-persistent** and **1/n persistent** methods, we can see that the first one always outperforms the latter one in all of the above scenarios.

Scopes of Improvement

● In a relatively small network, the number of nodes falls somewhere between 10-30. So I should've considered more data points at a higher number of nodes.

● A more real-life approach would have been taken into consideration, the receiver nodes are also a part of this sensing algorithms. It would've provided more data points.

● I should've considered more data points regarding **non-persistent** CSMA varying the range of random sleep.

COMMENTS

This assignment has helped me in understanding the different CSMA protocols immensely, by researching and implementing them. It has also helped in understanding the demerits of a protocol, and how such demerits are overcome by other protocols.