

## **TITLE :**

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SUBJECT: COMPUTER NETWORKING LAB

## **PROBLEM STATEMENT :**

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

### **DESCRIPTION:**

#### **The 1-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 station found 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 it is because there is a chance when two or more stations found channel in idle state and the transmit frames at the same time and due to this the chances of collision become very high which can be improved by several other methods.

#### **The Non-persistent CSMA**

In this method, the station that has frames to send, only that station senses for the channel. In case of an idle channel, it will send 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 for 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. The chances of probability decreases but the time wastage increases as there may be time when the station is idle but non of the station is sensing its idleness and not attempting to send the frames.

#### **The p-persistent CSMA**

This is the method that is used when 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 found to be busy, the channel will wait for the next slot. If the channel 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.

The probability  $p$  is chosen such that only one station has the probability of sending at a time and hence it significantly reduces the chances of collision.

## DESIGN:

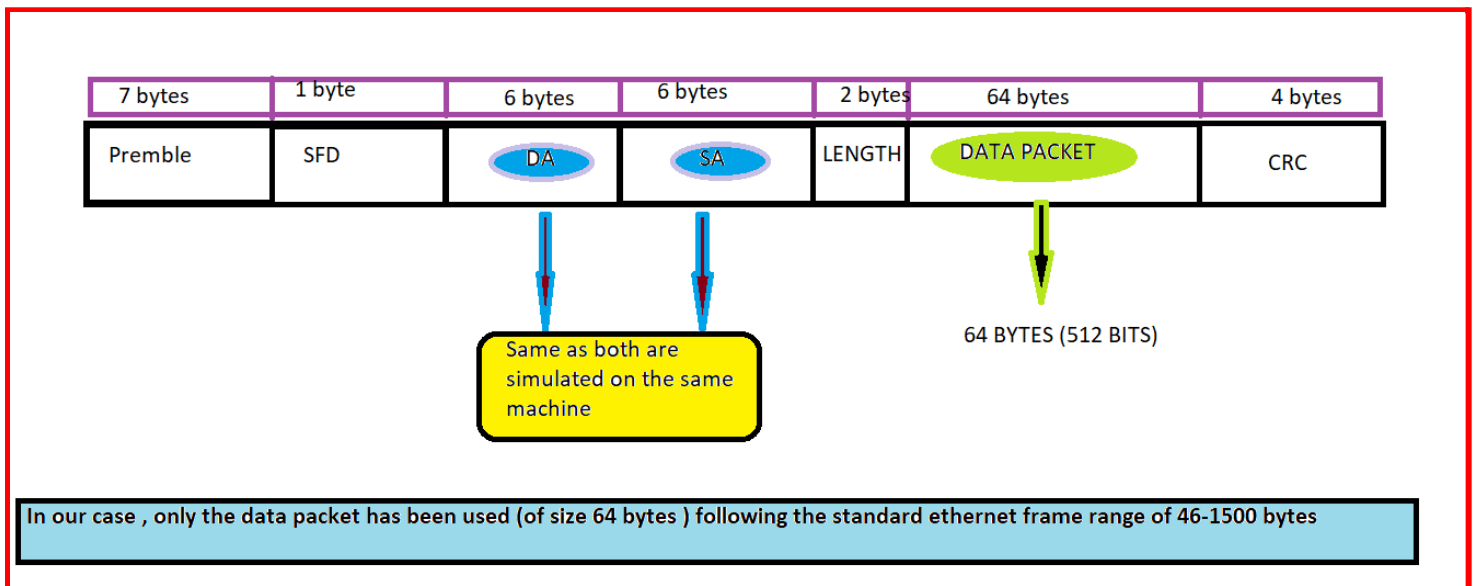
The system has three major components :

- 1.Sender** ( Multithreaded Environment simulating the presence of multiple stations)
- 2.Channel** ( No independent existence )
- 3.Receiver** ( Server in our case)

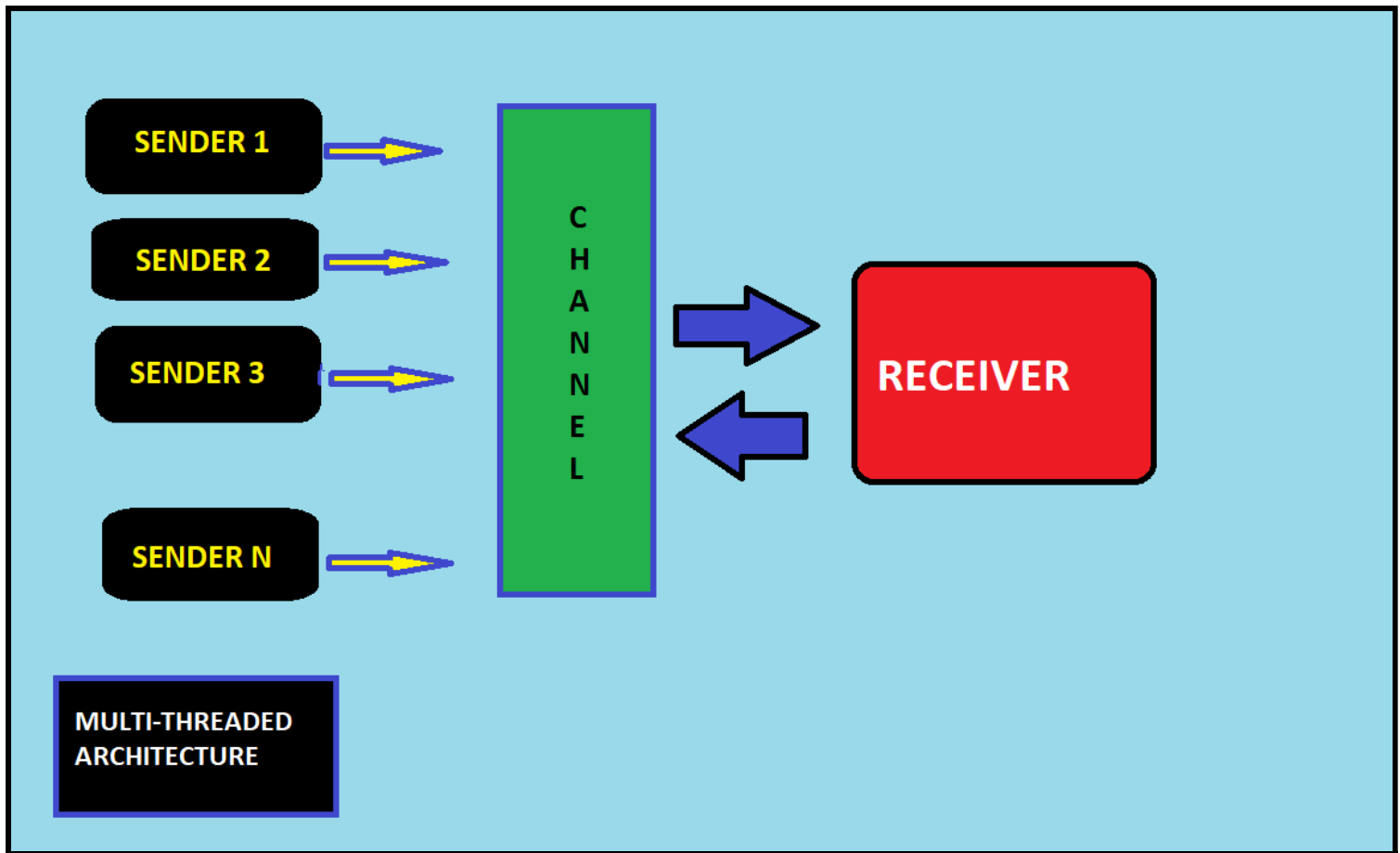
All the three components has been designed using sockets along with multithreading and are interconnected for data transmission.The socket is first sending the data to the Channel.To simulate the real world scenario, we must have some delay between the sending time of the packets and the receipt of the acknowledgement from the receiver side.Since ,in our case the server as well as the client are on the same machines , so a delay() method is used on the channel which is inserting some random delay on the sending of data packets which takes it closer to the real world scenario.

Error control is not an issue of the MAC layer , hence the data packets(frames ) are only used to simulate the environment.

### Frame Format Used



## DIAGRAMMATIC REPRESENTATION OF THE CONTROL FLOW

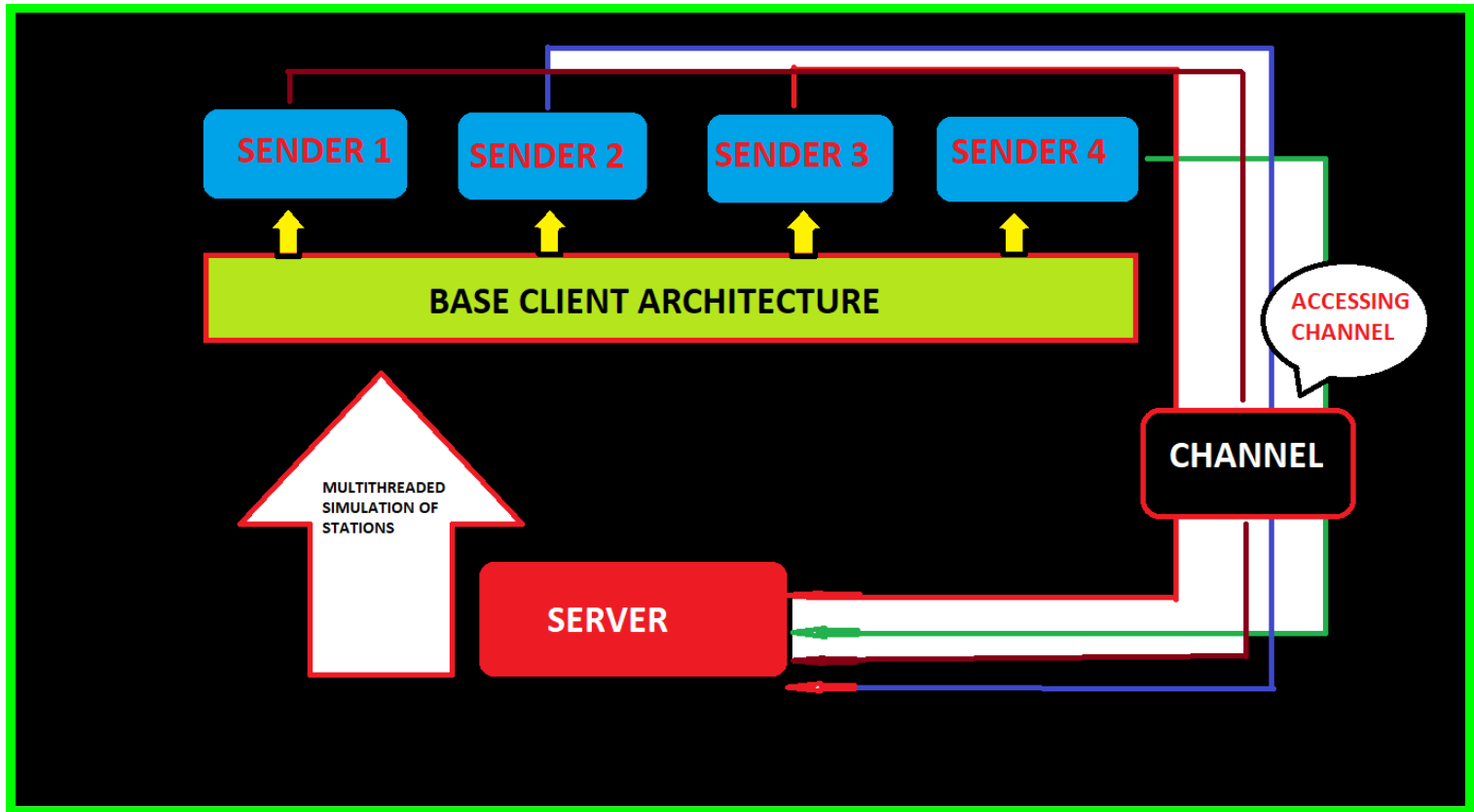


There are several stations or senders which depending upon the algorithm used sense the channels and when finds it idle uses the suitable algorithm to send the packets to the channel which then transmits the packets or frames to the receiver. The receiver sends the acknowledgement for the packets which can be either negative or positive (chosen at runtime in our case) and then the next packet is ready for being sent.

The multithreaded environment simulates the presence of multiple senders a single receiver has been used which receiver the signal from multiple stations and sends the acknowledgement accordingly.

### Flow of Data:

The data packets are taken as input text file which is converted into binary and then segregated into packets of size 64bytes (512 bits) each , following the minimum length format of Standard Ethernet.



Results:

FOR THE RESULTS , WE USE THE FOLLOWING PARAMETERS

1. THROUGHPUT
2. BANDWIDTH
3. EFFICIENCY

THE RESULTS ARE TAKEN BY AS A RELATIVE COMPARISON BY VARYING THE NUMBER OF STATIONS .

Number of Stations are taken input at runtime

-----STATISTICS-----

## TECHNIQUE: ONE-PERSISTENT

NUMBER OF STATIONS : 3

RUN 1:

RTT VALUES:

```
( 'Station3', 1) : 5.011765
( 'Station1', 1) : 5.037752
( 'Station2', 1) : 4.005843
( 'Station2', 2) : 2.010321
( 'Station2', 3) : 4.010702
( 'Station1', 2) : 5.016428
```

```
('Station3', 2) : 4.010591
('Station2', 4) : 3.006716
('Station3', 3) : 1.016708
('Station1', 3) : 5.006396
('Station1', 4) : 1.014309
('Station2', 5) : 3.002128
('Station3', 4) : 4.001883
('Station1', 5) : 3.003587
('Station3', 5) : 1.015709
('Station3', 6) : 3.007335
('Station2', 6) : 5.008862
('Station3', 7) : 5.00127
('Station1', 6) : 1.001463
('Station1', 7) : 4.012839
('Station2', 7) : 3.00273
```

-----Performance Metrics -----

Attempts: Station1 : 14 Collisions: Station1 7

Attempts: Station2 : 18 Collisions: Station2 11

Attempts: Station3 : 13 Collisions: Station3 6

Bandwidth -512bps

Efficiency - Number of successful transmission/Number of Attempts  
=0.466

Throughput-  $0.466 * 512 = 238.93$  bps

**RUN 2:**

RTT VALUES:

```
('Station2', 1) : 3.002351
('Station1', 1) : 3.002351
('Station1', 2) : 2.003611
('Station3', 1) : 5.003208
('Station1', 3) : 2.009903
('Station3', 2) : 4.013581
('Station1', 4) : 4.016332
('Station2', 2) : 3.003002
```

('Station3', 3) : 5.011243  
( 'Station2', 3) : 4.019036  
( 'Station1', 5) : 4.002723  
( 'Station3', 4) : 1.006355  
( 'Station2', 4) : 5.004559  
( 'Station2', 5) : 2.002006  
( 'Station2', 6) : 3.007505  
( 'Station2', 7) : 4.014846  
( 'Station1', 6) : 5.001901  
( 'Station1', 7) : 3.00397  
( 'Station3', 5) : 5.010509  
( 'Station3', 6) : 2.004395  
( 'Station3', 7) : 4.009454

-----Performance Metrics -----

Attempts: Station1 : 20    Collisions: Station1 13  
Attempts: Station2 : 16    Collisions: Station2 9  
Attempts: Station3 : 21    Collisions: Station3 14  
  
Bandwidth    -512bps  
  
Efficiency - Number of successful transmission/Number of Attempts  
              =0.368  
  
Throughput- 0.368 \* 512 = 188.63 bps

NUMBER OF STATIONS :2

RUN 1:

RTT VALUES:

('Station1', 1) : 3.005323  
( 'Station2', 1) : 3.007992  
( 'Station2', 2) : 1.002962  
( 'Station1', 2) : 5.003459  
( 'Station2', 3) : 3.006962  
( 'Station2', 4) : 1.008151  
( 'Station1', 3) : 1.003043  
( 'Station2', 5) : 1.007613  
( 'Station1', 4) : 2.00407

```
('Station2', 6) : 3.008142
('Station2', 7) : 1.009236
('Station1', 5) : 2.002476
('Station1', 6) : 5.002354
('Station1', 7) : 3.008709
```

-----Performance Metrics -----

Attempts: Station1 : 22 Collisions: Station1 15

Attempts: Station2 : 15 Collisions: Station2 8

Bandwidth - 512bps

Efficiency - Number of successful transmission/Number of Attempts  
= 0.378

Throughput -  $0.378 * 512 = 193.73$  bps

**RUN 2:**

RTT VALUES:

```
('Station2', 1) : 2.016719
('Station2', 2) : 2.016211
('Station2', 3) : 5.005215
('Station2', 4) : 2.001985
('Station2', 5) : 4.005123
('Station2', 6) : 2.00527
('Station1', 1) : 4.00302
('Station2', 7) : 2.001876
('Station1', 2) : 5.004149
('Station1', 3) : 5.003963
('Station1', 4) : 4.002137
('Station1', 5) : 2.007007
('Station1', 6) : 1.015625
('Station1', 7) : 1.010096
```

-----Performance Metrics -----

Attempts: Station1 : 38 Collisions: Station1 31

Attempts: Station2 : 12 Collisions: Station2 5

Bandwidth - 512bps

Efficiency - Number of successful transmission/Number of Attempts

= 0.28

Throughput-  $0.28 * 512 = 143.36$  bps

NUMBER OF STATIONS: 5

RUN 1:

RTT VALUES:

```
('Station3', 1) : 3.005088
('Station4', 1) : 5.012278
('Station5', 1) : 4.009064
('Station3', 2) : 4.016422
('Station1', 1) : 5.01548
('Station5', 2) : 1.007142
('Station1', 2) : 1.000856
('Station4', 2) : 5.011262
('Station2', 1) : 5.00998
('Station4', 3) : 4.003679
('Station3', 3) : 4.004162
('Station2', 2) : 5.016193
('Station1', 3) : 5.012882
('Station4', 4) : 3.002586
('Station5', 3) : 5.014433
('Station3', 4) : 3.016616
('Station4', 5) : 4.013358
('Station2', 3) : 5.009076
('Station5', 4) : 5.009089
('Station3', 5) : 1.011984
('Station2', 4) : 1.001743
('Station5', 5) : 3.00437
('Station3', 6) : 5.01643
('Station2', 5) : 5.002362
('Station1', 4) : 2.006901
('Station4', 6) : 3.009173
('Station2', 6) : 3.016577
('Station1', 5) : 5.005536
```



('Station2', 7) : 3.005636  
( 'Station3', 7) : 2.001306  
( 'Station5', 6) : 3.003299  
( 'Station4', 7) : 4.00586  
( 'Station5', 7) : 3.011366  
( 'Station1', 6) : 4.013519  
( 'Station1', 7) : 4.001107

-----Performance Metrics -----

Attempts: Station1 : 25    Collisions: Station1 18  
Attempts: Station2 : 15    Collisions: Station2 8  
Attempts: Station3 : 19    Collisions: Station3 12  
Attempts: Station4 : 18    Collisions: Station4 11  
Attempts: Station5 : 18    Collisions: Station5 11  
  
Bandwidth    - 512bps  
  
Efficiency - Number of successful transmission/Number of Attempts  
              = 0.428  
  
Throughput- 0.428 \* 512 = 219.43 bps

**RUN 2:**

RTT VALUES:

('Station5', 1) : 2.014439  
( 'Station4', 1) : 3.016553  
( 'Station5', 2) : 2.008774  
( 'Station2', 1) : 5.00862  
( 'Station1', 1) : 5.00862  
( 'Station4', 2) : 1.017502  
( 'Station5', 3) : 4.003905  
( 'Station1', 2) : 5.003084  
( 'Station1', 3) : 1.001523  
( 'Station3', 1) : 5.007209  
( 'Station5', 4) : 1.00911  
( 'Station1', 4) : 3.007157  
( 'Station5', 5) : 5.016047  
( 'Station1', 5) : 3.01298

('Station4', 3) : 4.01161  
( 'Station1', 6) : 4.011396  
( 'Station5', 6) : 5.003319  
( 'Station1', 7) : 5.009423  
( 'Station4', 4) : 2.007416  
( 'Station3', 2) : 3.016439  
( 'Station4', 5) : 1.009014  
( 'Station5', 7) : 5.010337  
( 'Station2', 2) : 4.0122  
( 'Station2', 3) : 2.010214  
( 'Station4', 6) : 4.004152  
( 'Station4', 7) : 2.003475  
( 'Station2', 4) : 3.014637  
( 'Station2', 5) : 3.005596  
( 'Station2', 6) : 3.016662  
( 'Station2', 7) : 2.004892  
( 'Station3', 3) : 4.01639  
( 'Station3', 4) : 3.008688  
( 'Station3', 5) : 3.011316  
( 'Station3', 6) : 5.004588  
( 'Station3', 7) : 2.011801

-----Performance Metrics -----

Attempts: Station1 : 10    Collisions: Station1 3  
Attempts: Station2 : 22    Collisions: Station2 15  
Attempts: Station3 : 30    Collisions: Station3 23  
Attempts: Station4 : 17    Collisions: Station4 10  
Attempts: Station5 : 13    Collisions: Station5 6

Bandwidth    -512bps

Efficiency - Number of successful transmission/Number of Attempts  
             = 0.380

Throughput = 0.380 \* 512 = 194.782 bps

NUMBER OF STATIONS: 7

RUN 1:

RTT VALUES:

('Station1', 1) : 1.011825  
('Station3', 1) : 1.011825  
('Station2', 1) : 1.009471  
('Station3', 2) : 5.004586  
('Station5', 1) : 4.005697  
('Station2', 2) : 4.013994  
('Station4', 1) : 5.002647  
('Station3', 3) : 4.002423  
('Station5', 2) : 4.016037  
('Station3', 4) : 4.015277  
('Station3', 5) : 3.0104  
('Station7', 1) : 4.015784  
('Station6', 1) : 3.01405  
('Station5', 3) : 3.014371  
('Station2', 3) : 5.004782  
('Station5', 4) : 1.013413  
('Station3', 6) : 5.005628  
('Station1', 2) : 2.006093  
('Station7', 2) : 5.003073  
('Station2', 4) : 4.007223  
('Station1', 3) : 5.003139  
('Station3', 7) : 2.011945  
('Station1', 4) : 1.002209  
('Station4', 2) : 5.011761  
('Station6', 2) : 1.008055  
('Station5', 5) : 1.003834  
('Station2', 5) : 5.007191  
('Station5', 6) : 2.005261  
('Station6', 3) : 5.012135  
('Station6', 4) : 3.004376  
('Station4', 3) : 5.011543  
('Station1', 5) : 5.00969  
('Station7', 3) : 1.00821

('Station4', 4) : 5.013094  
( 'Station5', 7) : 5.013035  
( 'Station2', 6) : 2.010942  
( 'Station7', 4) : 1.004334  
( 'Station2', 7) : 1.011057  
( 'Station1', 6) : 3.016347  
( 'Station4', 5) : 5.015507  
( 'Station1', 7) : 2.011915  
( 'Station6', 5) : 1.005224  
( 'Station7', 5) : 4.00282  
( 'Station6', 6) : 1.013366  
( 'Station4', 6) : 1.011084  
( 'Station6', 7) : 2.001367  
( 'Station7', 6) : 5.008453  
( 'Station7', 7) : 4.003677  
( 'Station4', 7) : 3.009004

-----Performance Metrics -----

Attempts: Station1 : 19 Collisions: Station1 12  
Attempts: Station2 : 17 Collisions: Station2 10  
Attempts: Station3 : 9 Collisions: Station3 2  
Attempts: Station4 : 31 Collisions: Station4 24  
Attempts: Station5 : 19 Collisions: Station5 12  
Attempts: Station6 : 28 Collisions: Station6 21  
Attempts: Station7 : 29 Collisions: Station7 22

Bandwidth - 512bps

Efficiency -  $\text{Number of successful transmission} / \text{Number of Attempts}$   
= 0.360

Throughput-  $0.360 * 512 = 184.44 \text{ bps}$

RUN 2:

RTT VALUES:

('Station2', 1) : 1.010986  
( 'Station3', 1) : 2.007126  
( 'Station1', 1) : 4.014046

('Station2', 2) : 3.00306  
( 'Station3', 2) : 3.009698  
( 'Station5', 1) : 5.016824  
( 'Station6', 1) : 5.016824  
( 'Station5', 2) : 1.00484  
( 'Station5', 3) : 1.009074  
( 'Station6', 2) : 4.005845  
( 'Station6', 3) : 3.007023  
( 'Station3', 3) : 1.008359  
( 'Station3', 4) : 3.015596  
( 'Station3', 5) : 1.003215  
( 'Station2', 3) : 5.011349  
( 'Station6', 4) : 5.009077  
( 'Station6', 5) : 1.009306  
( 'Station4', 1) : 4.007498  
( 'Station5', 4) : 5.011785  
( 'Station6', 6) : 3.01379  
( 'Station2', 4) : 3.01379  
( 'Station4', 2) : 3.013807  
( 'Station1', 2) : 4.001603  
( 'Station7', 1) : 5.010911  
( 'Station2', 5) : 1.017259  
( 'Station4', 3) : 1.008691  
( 'Station2', 6) : 3.006644  
( 'Station4', 4) : 1.001128  
( 'Station1', 3) : 5.011885  
( 'Station3', 6) : 3.014168  
( 'Station6', 7) : 4.014407  
( 'Station2', 7) : 1.014187  
( 'Station1', 4) : 3.001092  
( 'Station5', 5) : 5.006347  
( 'Station3', 7) : 1.008582  
( 'Station4', 5) : 1.016244  
( 'Station1', 5) : 3.015298

```
('Station4', 6) : 2.005574
('Station5', 6) : 2.015426
('Station1', 6) : 1.00123
('Station1', 7) : 2.016201
('Station5', 7) : 5.008837
('Station4', 7) : 2.010503
('Station7', 2) : 2.007644
('Station7', 3) : 1.008749
('Station7', 4) : 1.00892
('Station7', 5) : 3.01185
('Station7', 6) : 5.013638
('Station7', 7) : 4.002484
```

#### -----Performance Metrics -----

Attempts: Station1 : 18 Collisions: Station1 11

Attempts: Station2 : 13 Collisions: Station2 6

Attempts: Station3 : 14 Collisions: Station3 7

Attempts: Station4 : 24 Collisions: Station4 17

Attempts: Station5 : 20 Collisions: Station5 13

Attempts: Station6 : 10 Collisions: Station6 3

Attempts: Station7 : 27 Collisions: Station7 20

Bandwidth - 512bps

Efficiency - Number of successful transmission/Number of Attempts  
= 0.388

Throughput-  $0.388 * 512 = 198.65$  bps

## TECHNIQUE:NON-PERSISTENT

NUMBER OF STATIONS:2

RUN 1:

RTT VALUES:

```
('Station1', 1) : 7.009645
```

```
('Station2', 1) : 7.009645
```

```
('Station1', 2) : 8.016019
```

```
('Station1', 3) : 6.01253
```

```
('Station1', 4) : 8.017305
```

```
('Station2', 2) : 5.026526
('Station1', 5) : 4.015171
('Station2', 3) : 8.013518
('Station1', 6) : 6.021458
('Station2', 4) : 8.007449
('Station2', 5) : 6.028303
('Station2', 6) : 5.013459
('Station2', 7) : 8.011459
('Station1', 7) : 8.00881
```

-----Performance Metrics -----

Attempts: Station1 : 12 Collisions: Station1 5

Attempts: Station2 : 11 Collisions: Station2 4

Bandwidth - 512bps

Efficiency - Number of successful transmission/Number of Attempts  
=0.608

Throughput-  $0.608 * 512 = 311.65 \text{ bps}$

**RUN 2:**

**RTT VALUES:**

```
('Station1', 1) : 5.035805
('Station1', 2) : 5.017491
('Station2', 1) : 7.015926
('Station1', 3) : 5.022992
('Station1', 4) : 5.017364
('Station1', 5) : 7.007831
('Station2', 2) : 7.011778
('Station1', 6) : 8.021964
('Station1', 7) : 8.003334
('Station2', 3) : 4.015618
('Station2', 4) : 5.014847
('Station2', 5) : 8.00684
('Station2', 6) : 7.023711
('Station2', 7) : 5.015823
```

-----Performance Metrics -----

Attempts: Station1 : 13 Collisions: Station1 6

Attempts: Station2 : 18 Collisions: Station2 11

Bandwidth -512bps

Efficiency - Number of successful transmission/Number of Attempts  
=0.451

Throughput-  $0.451 * 512 = 231.22$  bps

NUMBER OF STATIONS: 2

RUN 1:

RTT VALUES:

('Station2', 1) : 6.025596

('Station2', 2) : 4.019499

('Station2', 3) : 4.016549

('Station2', 4) : 4.020783

('Station2', 5) : 8.021355

('Station1', 1) : 5.018307

('Station2', 6) : 6.028084

('Station1', 2) : 4.02328

('Station1', 3) : 6.00655

('Station1', 4) : 8.009653

('Station2', 7) : 8.008083

('Station1', 5) : 7.017391

('Station1', 6) : 4.017475

('Station1', 7) : 7.014522

-----Performance Metrics -----

Attempts: Station1 : 14 Collisions: Station1 7

Attempts: Station2 : 14 Collisions: Station2 7

Bandwidth -512bps

Efficiency - Number of successful transmission/Number of Attempts  
=0.50

Throughput-  $0.50 * 512 = 256$  bps

RUN 2:

RTT VALUES:



('Station2', 1) : 4.007392  
( 'Station1', 1) : 5.010986  
( 'Station1', 2) : 4.011497  
( 'Station2', 2) : 7.021424  
( 'Station2', 3) : 7.010883  
( 'Station2', 4) : 8.01416  
( 'Station2', 5) : 4.020305  
( 'Station1', 3) : 6.021442  
( 'Station1', 4) : 4.022322  
( 'Station2', 6) : 7.028691  
( 'Station1', 5) : 7.021035  
( 'Station1', 6) : 7.027262  
( 'Station2', 7) : 7.015629  
( 'Station1', 7) : 5.017497

-----Performance Metrics -----

Attempts: Station1 : 13 Collisions: Station1 6

Attempts: Station2 : 11 Collisions: Station2 4

Bandwidth - 512bps

Efficiency - Number of successful transmission/Number of Attempts  
=0.583

Throughput-  $0.583 * 512 = 298.66$  bps

NUMBER OF STATIONS:3

RUN 1:

RTT VALUES:

('Station3', 1) : 3.015336  
( 'Station3', 2) : 3.006881  
( 'Station1', 1) : 3.015102  
( 'Station1', 2) : 3.007635  
( 'Station3', 3) : 3.008377  
( 'Station2', 1) : 3.009294  
( 'Station3', 4) : 3.010297  
( 'Station3', 5) : 3.008252

```
('Station1', 3) : 3.002393
('Station3', 6) : 3.003188
('Station1', 4) : 3.012564
('Station3', 7) : 3.013475
('Station2', 2) : 3.001567
('Station1', 5) : 3.001056
('Station2', 3) : 3.015412
('Station2', 4) : 3.006031
('Station2', 5) : 3.001647
('Station1', 6) : 3.013586
('Station2', 6) : 3.010277
('Station1', 7) : 3.009447
('Station2', 7) : 3.009645
```

-----Performance Metrics -----

Attempts: Station1 : 18 Collisions: Station1 11

Attempts: Station2 : 18 Collisions: Station2 11

Attempts: Station3 : 9 Collisions: Station3 2

Bandwidth - 512bps

Efficiency - Number of successful transmission/Number of Attempts  
=0.466

Throughput-  $0.466 * 512 = 238.93$  bps

## TECHNIQUE : P-PERSISTENT

NUMBER OF STATIONS:2

RUN 1:

RTT VALUES:

```
('Station1', 1) : 2.011297
('Station1', 2) : 2.003796
('Station2', 1) : 5.007088
('Station2', 2) : 2.004803
('Station2', 3) : 4.007905
('Station1', 3) : 4.008904
('Station2', 4) : 1.009448
```

```
('Station2', 5) : 4.014626
('Station1', 4) : 3.009775
('Station2', 6) : 1.0037
('Station1', 5) : 1.014922
('Station2', 7) : 1.015193
('Station1', 6) : 3.011588
('Station1', 7) : 1.003111
```

-----Performance Metrics -----

Attempts: Station1 : 10 Collisions: Station1 3

Attempts: Station2 : 8 Collisions: Station2 1

Bandwidth - 512bps

Efficiency - Number of successful transmission/Number of Attempts  
=0.778

Throughput-  $0.778 * 512 = 398.22$  bps

RUN 2:

NUMBER OF STATIONS:3

RTT VALUES:

```
('Station3', 1) : 3.010386
('Station2', 1) : 4.013064
('Station1', 1) : 5.015451
('Station2', 2) : 2.008792
('Station1', 2) : 2.011388
('Station3', 2) : 5.003086
('Station1', 3) : 5.015411
('Station3', 3) : 5.002526
('Station2', 3) : 4.0038
('Station1', 4) : 2.008942
('Station1', 5) : 2.005893
('Station3', 4) : 4.014997
('Station3', 5) : 1.005397
('Station2', 4) : 3.012325
('Station3', 6) : 3.01132
('Station1', 6) : 3.003089
```

```
('Station3', 7) : 3.010649
('Station2', 5) : 3.010649
('Station1', 7) : 4.015177
('Station2', 6) : 5.00542
('Station2', 7) : 2.015673
```

-----Performance Metrics -----

Attempts: Station1 : 8 Collisions: Station1 1

Attempts: Station2 : 12 Collisions: Station2 5

Attempts: Station3 : 8 Collisions: Station3 1

Bandwidth - 512bps

Efficiency - Number of successful transmission/Number of Attempts  
=0.75

Throughput-  $0.75 * 512 = 384$  bps

RUN 3:

NUMBER OF STATIONS:5

RTT VALUES:

```
('Station2', 1) : 0.0
('Station3', 1) : 0.000999
('Station5', 1) : 0.0
('Station1', 1) : 0.000999
('Station2', 2) : 0.001305
('Station5', 2) : 0.001503
('Station1', 2) : 0.001503
('Station3', 2) : 0.000505
('Station1', 3) : 0.001002
('Station3', 3) : 0.001002
('Station2', 3) : 0.001002
('Station4', 1) : 0.0
('Station5', 3) : 0.001
('Station3', 4) : 0.001
('Station1', 4) : 0.002003
('Station3', 5) : 0.002003
('Station2', 4) : 0.002002
```

('Station4', 2) : 0.002002  
( 'Station3', 6) : 0.001  
( 'Station5', 4) : 0.001999  
( 'Station2', 5) : 0.0  
( 'Station4', 3) : 0.000999  
( 'Station2', 6) : 0.001001  
( 'Station4', 4) : 0.001001  
( 'Station3', 7) : 0.000998  
( 'Station2', 7) : 0.000998  
( 'Station5', 5) : 0.0  
( 'Station4', 5) : 0.0  
( 'Station1', 5) : 0.001999  
( 'Station5', 6) : 0.001001  
( 'Station1', 6) : 0.0  
( 'Station5', 7) : 0.000998  
( 'Station1', 7) : 0.0  
( 'Station4', 6) : 0.0  
( 'Station4', 7) : 0.001002

-----Performance Metrics -----

Attempts: Station1 : 10 Collisions: Station1 3

Attempts: Station2 : 10 Collisions: Station2 3

Attempts: Station3 : 9 Collisions: Station3 2

Attempts: Station4 : 18 Collisions: Station4 11

Attempts: Station5 : 12 Collisions: Station5 5

Bandwidth -512bps

Efficiency - Number of successful transmission/Number of Attempts

=0.593

Throughput-  $0.593 * 512 = 303.73$  bps

AVERAGE THROUGHPUT OF ALL TECHNIQUES:

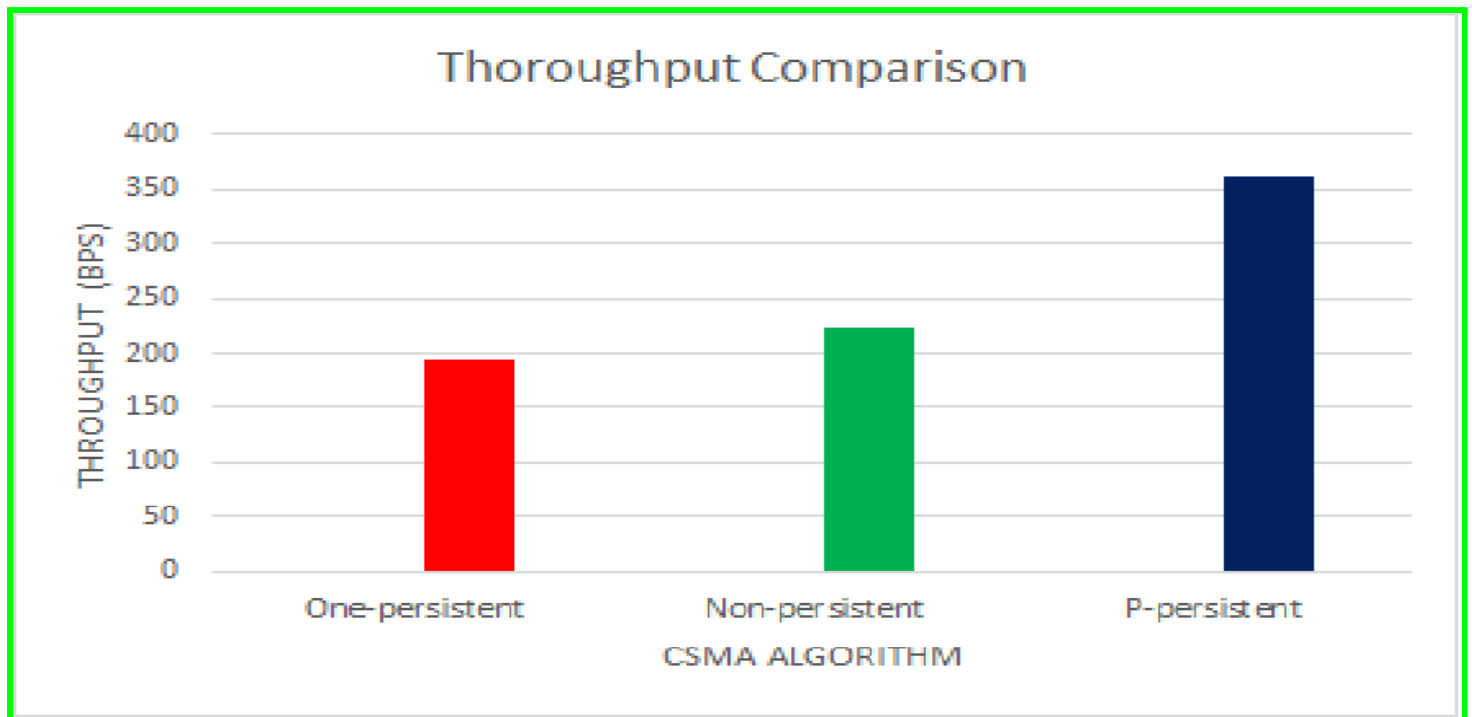
ONE-PERSISTENT - 195.2715 bps

NON-PERSISTENT - 222.743 bps

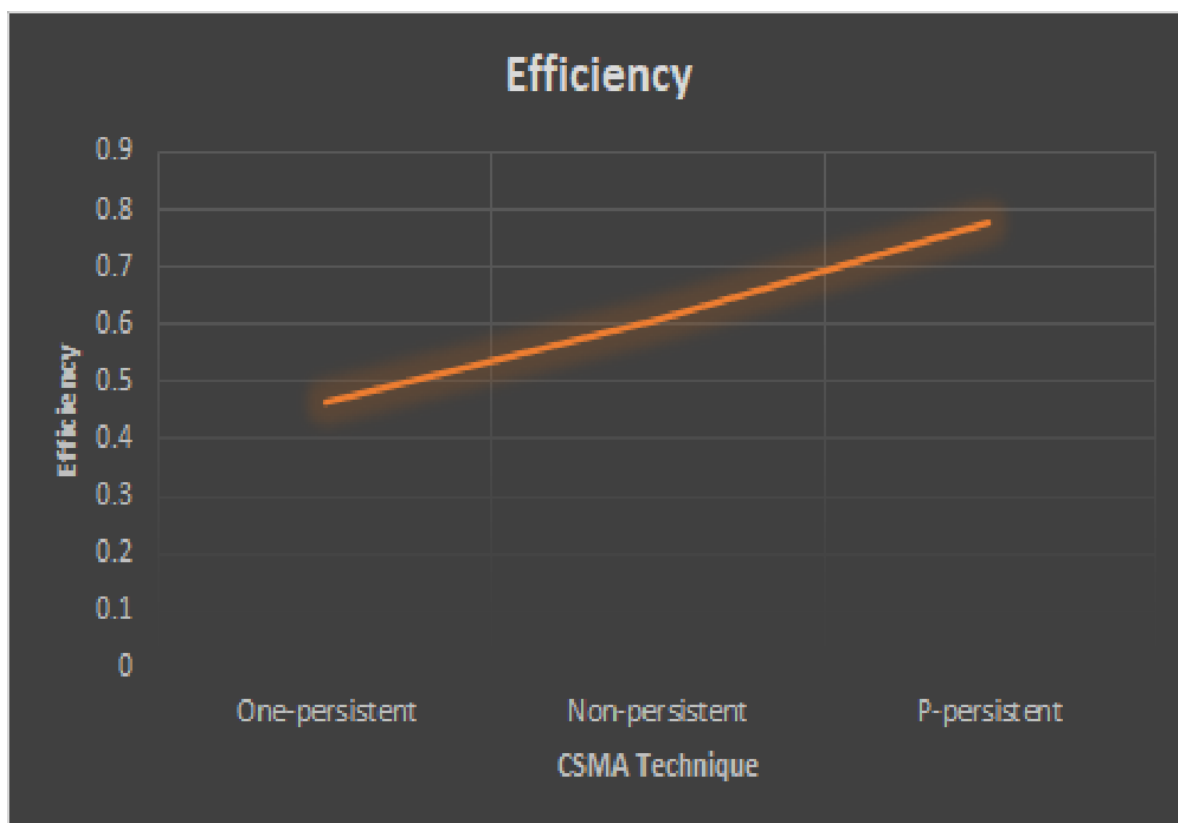
P-PERSISTENT - 361.98 bps

We can see that the throughput or the effective bandwidth seen by all the techniques sees an increment from one-persistent to p-persistent. P has been given by user at the runtime .

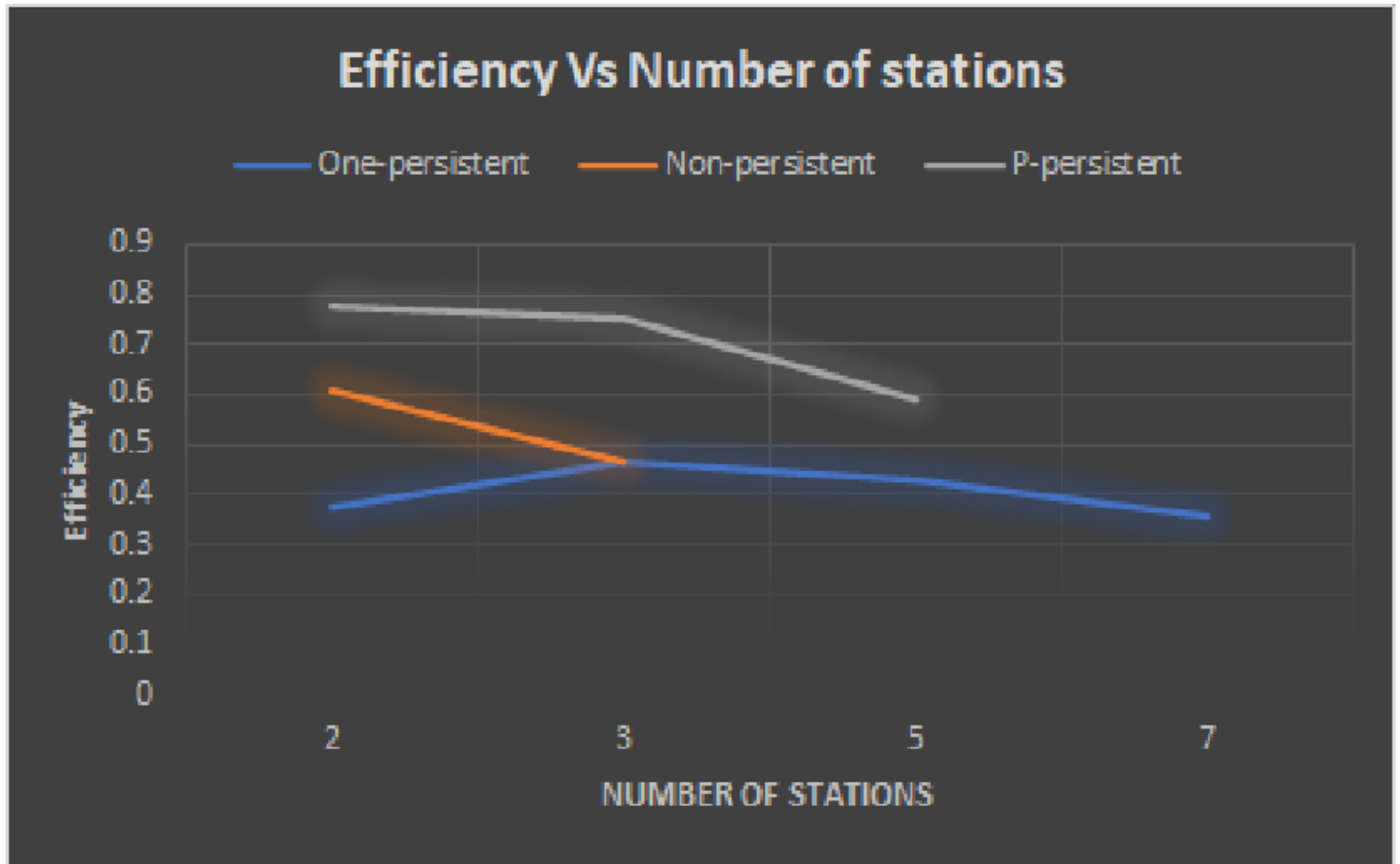
## THROUGHPUT VS CSMA TECHNIQUE



## EFFICIENCY VS CSMA TECHNIQUE



## EFFICIENCY VS NUMBER OF STATIONS



### ANALYSIS:

WE OBSERVE THAT P-PERSISTENT CSMA TECHNIQUE IS PRODUCING BETTER RESULTS AS COMPARED TO THE ONE-PERSISTENT OR NON-PERSISTENT TECHNIQUES . THE P-PERSISTENT TECHNIQUES HAS MORE EFFICIENCY THAN THE OTHER TWO AS IT IS USING THE PROBABILITY THEORY FOR THE CHANNELS IN ORDER TO SENSE AND SEND THE DATA .

### SCOPE OF IMPROVEMENT

THERE IS DEFINITELY A SCOPE OF IMPROVEMENT IN OUR RESULTS IF WE USE MORE RESULTS AND REDUCE THE RANDOMNESS ERROR AND ALSO OPTIMISE THE NUMBER OF STATIONS.