# CHAPTER4

# SIMULATION AND RESULT

# Chapter Four
# Simulation and Result

## 4.1 Simulation Scenario and Parameters

In this chapter EN-LEACH protocol is discussed in detail. This protocol is primarily based on MODLEACH protocol.

The Network is distributed into number of clusters; each cluster contains number of nodes of which one of them is acting as the CH.

Each CH receives data from all of its client nodes and performs some necessary iteration for compression, cluster Heads forward the compressed data to Base Station.

In this research, three very important parameters p(probability of choosing a CH), are considered and their effect on performance of the network are studied and analyzed. MODLEACH utilized these parameters by variation in probability and hard threshold, soft threshold is fixed.

Simulations are done to show their behavior on the performance of the network.

- **Simulations**

Simulations are conducted using matlab (R2008) the name MATLAB stands for Matrix Laboratory, because its basic data elements is a matrix (Array), MATLAB can be used for math computations, Modeling and simulations, data analysis and processing, visualization and Graphics and algorithm development.

Assumptions for simulation scenarios:

1-Sensor nodes are randomly distributed in square region.

2-Nodes energy is limited.

3-Nodes location is fixed after deployed.

4-The base station is in center of region with fixed location.

- **Parameters**

Table 4.1: Network parameters [13].

| Network parameter | Value |
|---|---|
| Network Size | 400 x 400 m2 |
| Number of nodes | 100 |
| Sensor nodes initial energy | 0.5 J |
| Packet size | 4000 bits |
| Energy consumption in idle state | 50 nJ/bit |
| Data aggregation energy consumption | 5 nJ/bit/report |
| Amplification energy (cluster to BS), d≤ d0, Emp | 0.0013 pJ/bit/m2 |
| Amplification energy (cluster to BS), d≥ d0, Efs | 10 pJ/bit/m2 |
| Amplification energy (intra cluster communication), d≤ d1 | Emp */10 = Emp1* |
| Amplification energy (intra cluster communication), d≥ d1 | Efs */10 = Efs1* |

Table 4.2: Impact of probability (p) in the Network

| S.No | Probability | Maximum rounds traversed | Packet send to Base Station | Packet send to Cluster Head | First dead at round |
|---|---|---|---|---|---|
| 1 | 0.1 | 1095 | 6985 | 55340 | 161 |
| 2 | 0.3 | 1377 | 14650 | 33850 | 68 |
| 3 | 0.4 | 1482 | 18100 | 28360 | 52 |
| 4 | 0.5 | 1707 | 22160 | 21520 | 38 |
| 5 | 0.9 | 1975 | 34620 | 3820 | 18 |

## 4.2 Impact of probability in the Network

In a wireless sensor network computing capacity and stored energy is limited. Due to these limiting computing capacities, network lifetime and throughput are affected in the simulation.

- **Network Life Time**

The network lifetime of the sensor network is the lifetime of the network from the starting of the network to the end of the network. It means the time from where the network starts its operation till the phase network has completed its operation. The operation is measured in terms of the rounds. Thus the network lifetime is measured in two ways a live node and dead nodes [16, 17].

- **Throughput**

The amount of data received by the base station describes the rate of the accuracy of the nodes, throughput, and the more data received means high accuracy. The throughput of the sensor network is measured

by the total number of packets sent to base station, packets sent to cluster head during the network lifetime and cluster head formation [16, 17].

## 4.3 Simulation Results

above graphs in Figures represent the count of cluster heads with the variation in the value of (probability) p of choosing a (Cluster Head) CH. The plots clearly indicate that for the value of p=0.1,the numbers of CHs are generated too less, and then get larger when probability is increased to p=0.3,0.4,0.5, at p=0.9 numbers of cluster head is large which can contribute a lot to the consumption of energy.

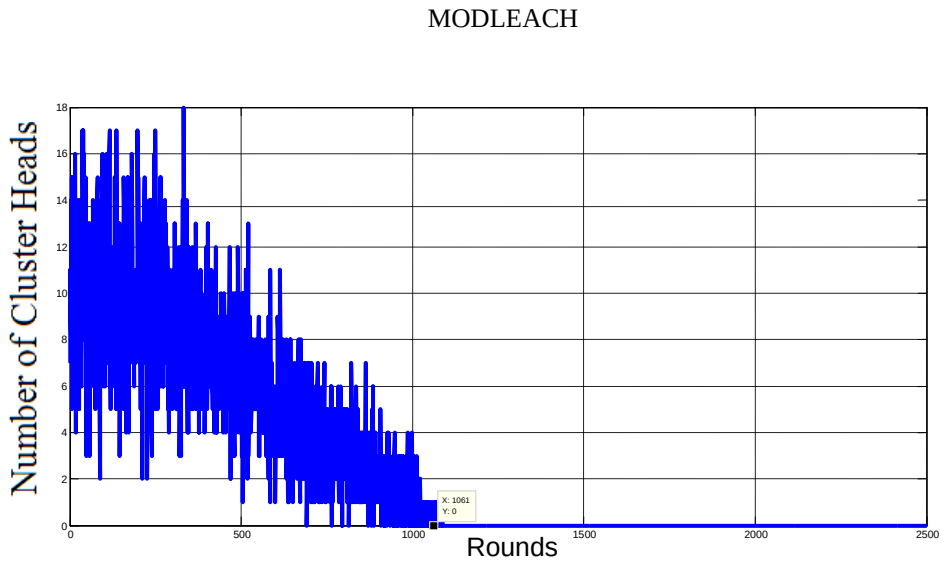


Figure 4.1: Number of cluster head for MOD-LEACH at p=0.1

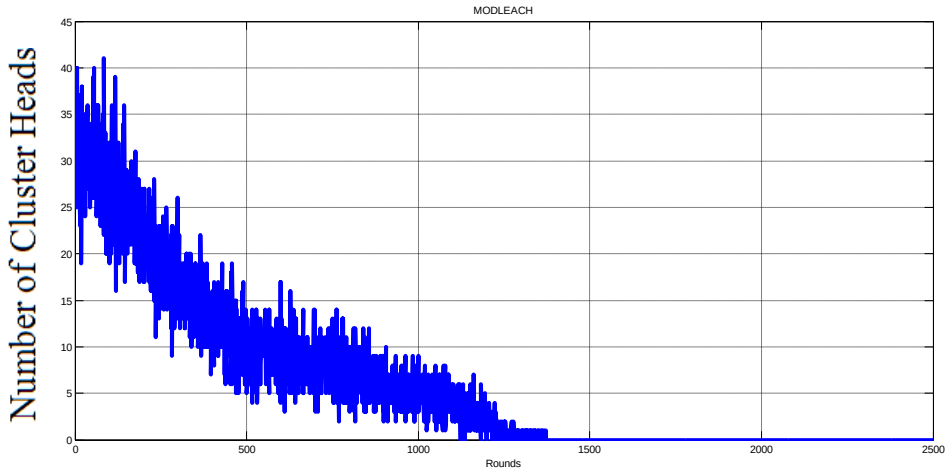


Figure 4.2: Number of cluster head for MOD-LEACH at p=0.3

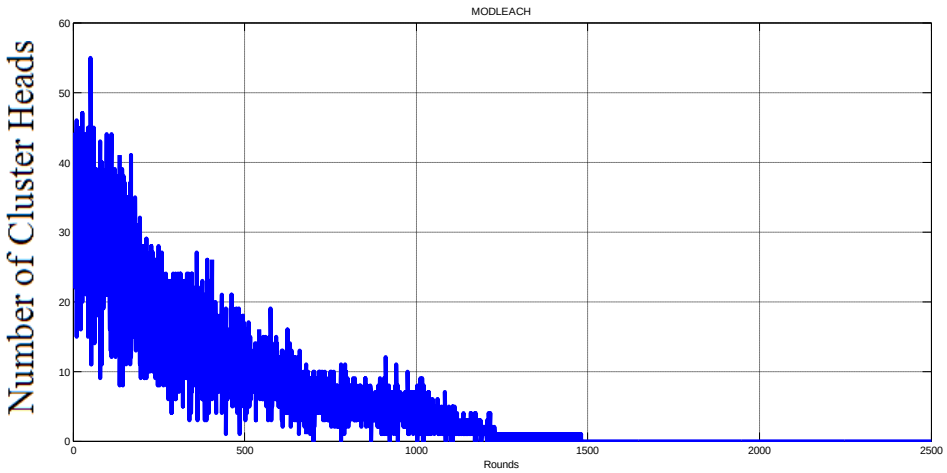


Figure 4.3: Number of cluster head for MOD-LEACH at p=0.4

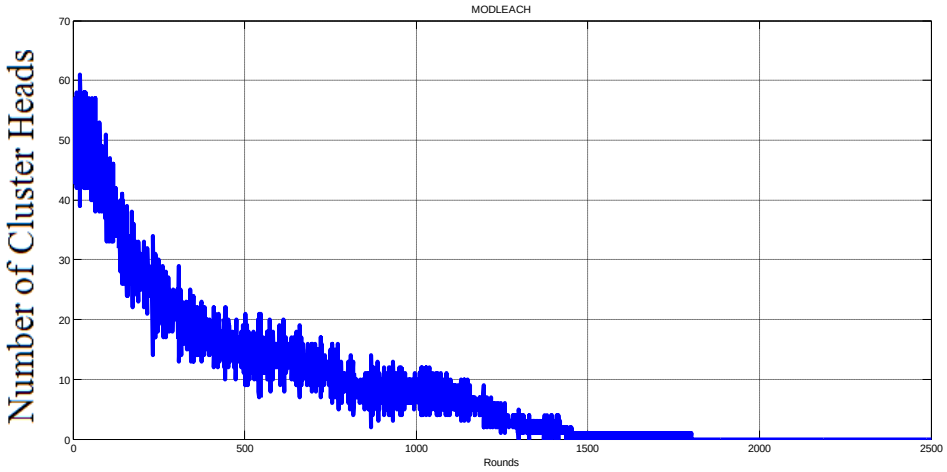


Figure 4.4: Number of cluster head for MOD-LEACH at p=0.5

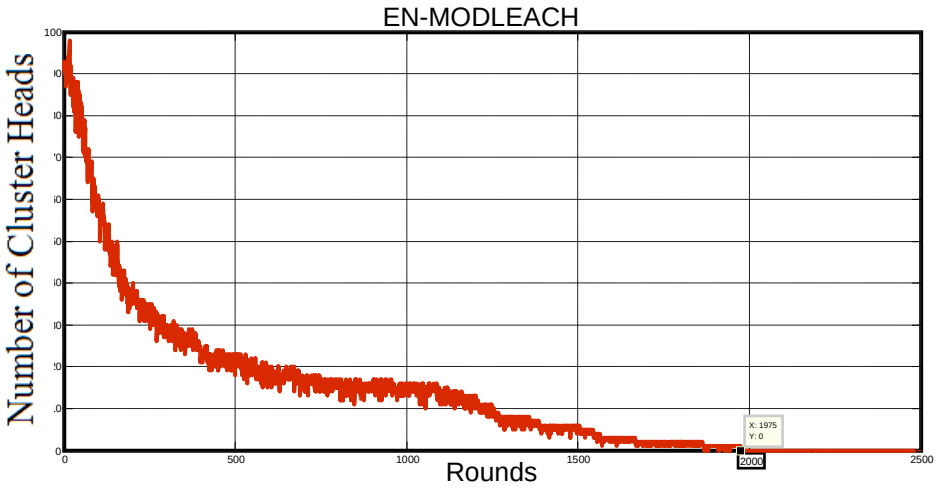


Figure 4.5: Number of cluster head for EN- MOD LEACH

The plots in figures reflect the number of alive nodes versus the number of rounds taken in a network for its completion or till the last node dead.

The plots are plotted varying the values of p. For p=0.1, the stability period is quite better, but the network dies quite early at around 1095 rounds. For p= 0.9, the stability is quite less but the final rounds are going up to 1975 rounds. for p=0.5, intermediate, average and acceptable values are got in terms of stability period and maximum rounds traversed.

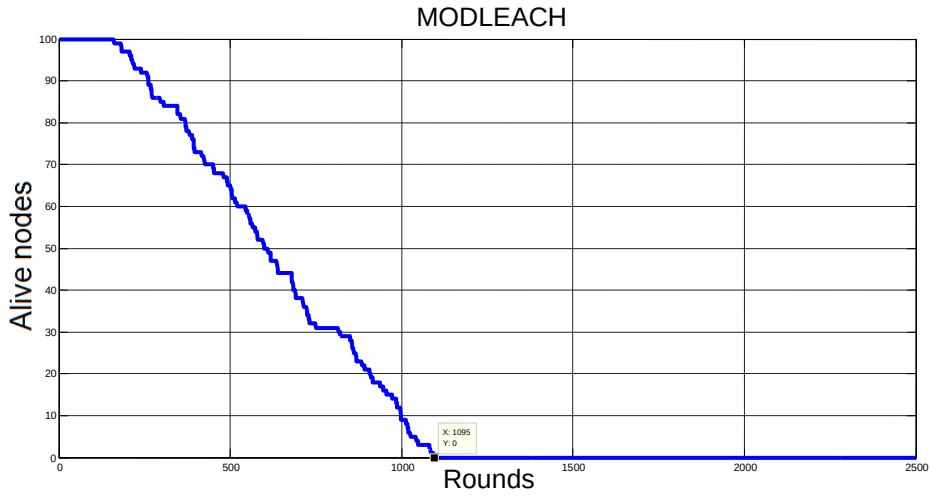


Figure 4.6: Alive nodes for MOD-LEACH at p=0.1

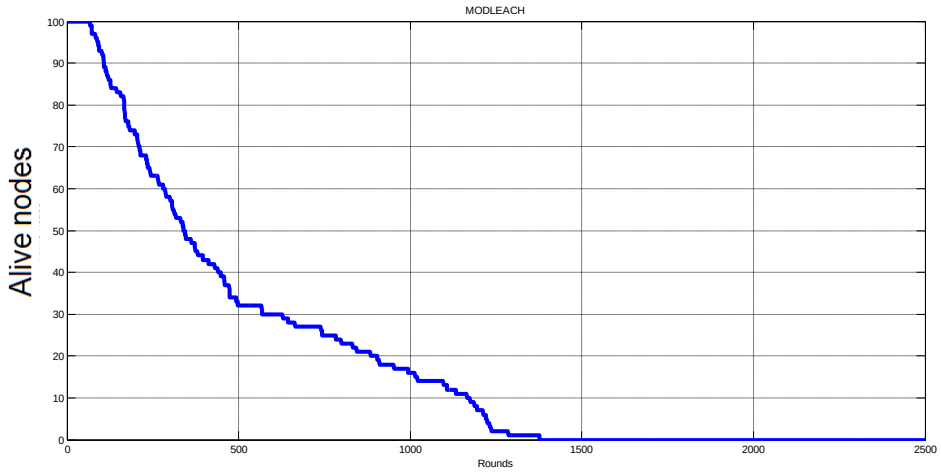


Figure 4.7: Alive nodes for MOD-LEACH at p=0.3

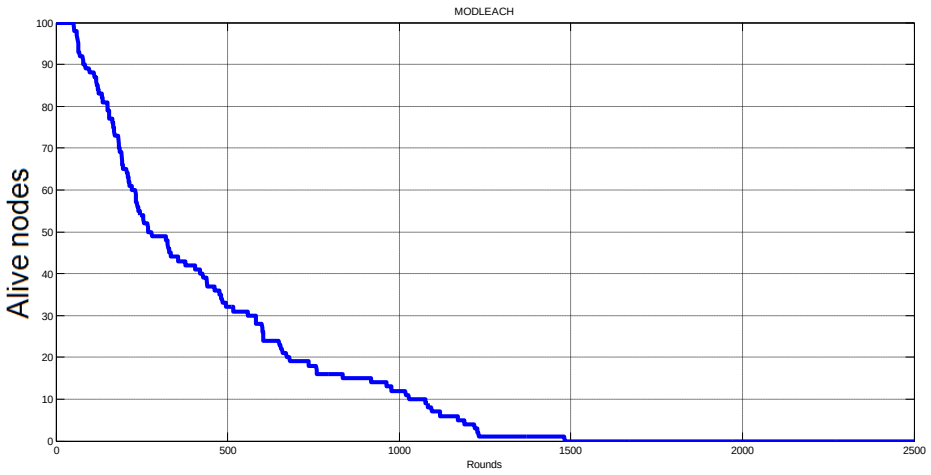


Figure 4.8: Alive nodes for MOD-LEACH at p=0.4

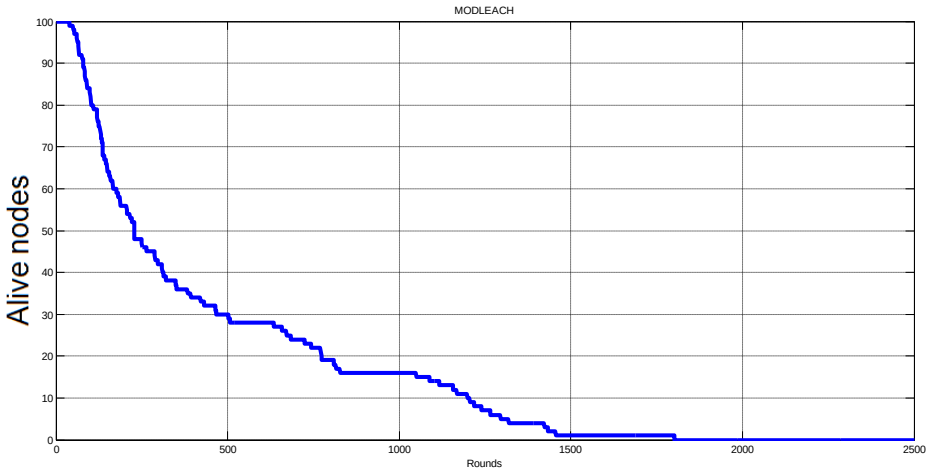


Figure 4.9: Alive nodes for MOD-LEACH at p=0.5

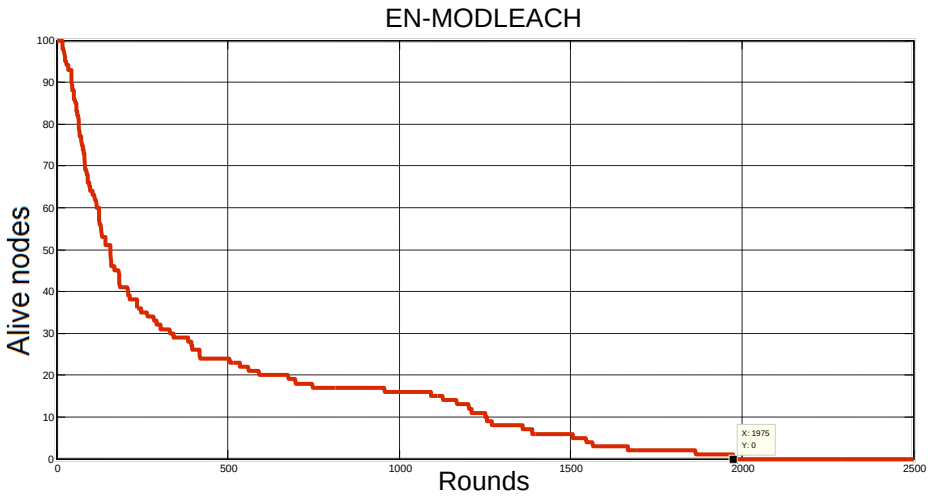


Figure 4.10: Alive nodes for EN-MOD LEACH

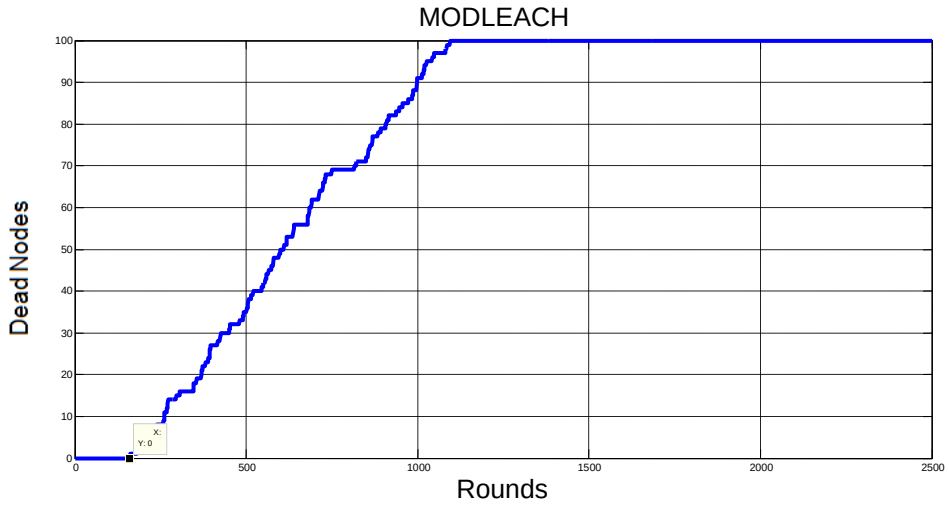


Figure 4.11: Dead nodes for MOD-LEACH at p=0.1

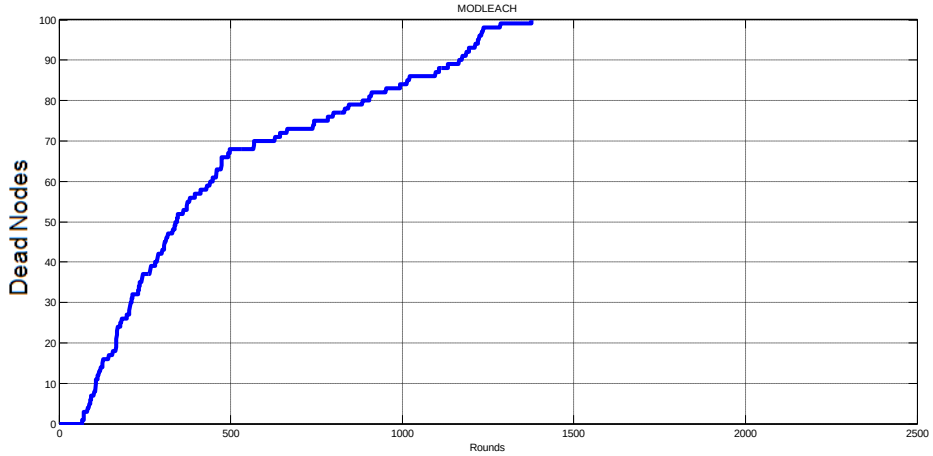


Figure 4.12: Dead nodes for MOD-LEACH at p=0.3

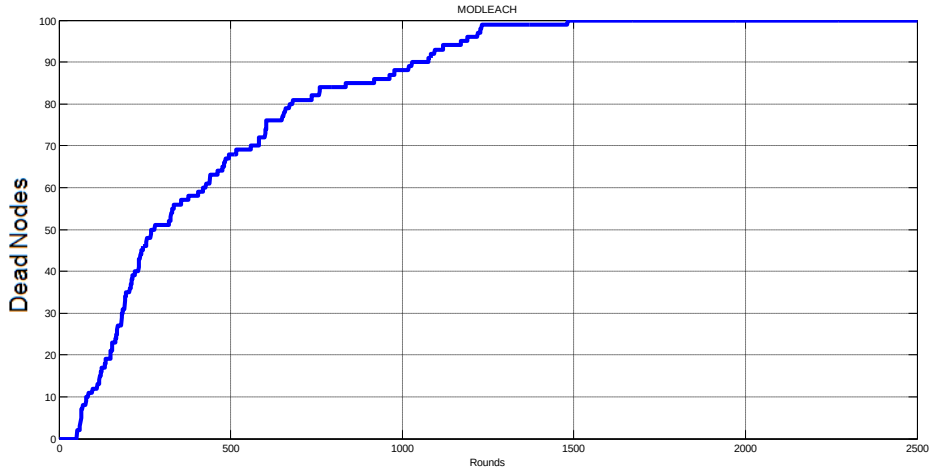


Figure 4.13: Dead nodes for MOD-LEACH at p=0.4

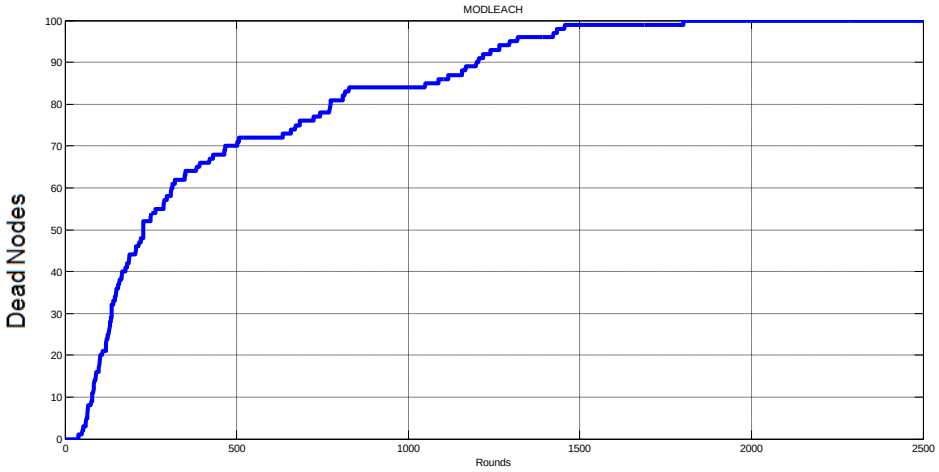


Figure 4.14: Dead nodes for MOD-LEACH at p=0.5

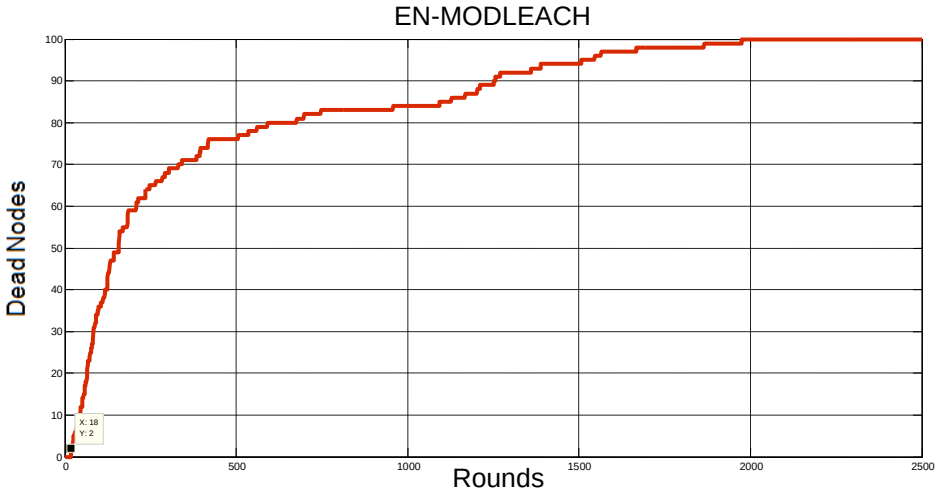


Figure 4.15: Dead nodes for EN-MOD LEACH

In Fig 7,8:Packets send to clusterhead at p=0.1 to p=0.5 is more than p=0.9 ; because data is compressed before send to cluster head[14] .

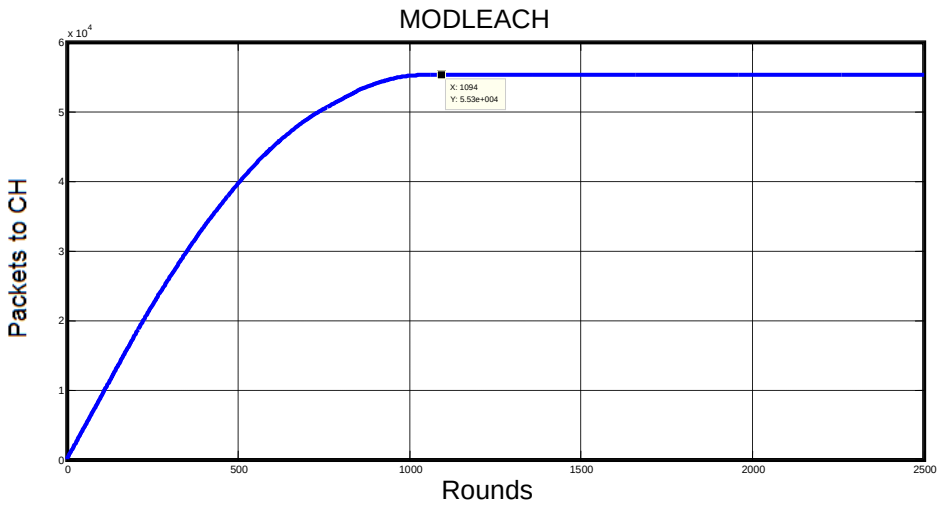


Figure 4.16: Packet to cluster head for MOD-LEACH at p=0.1

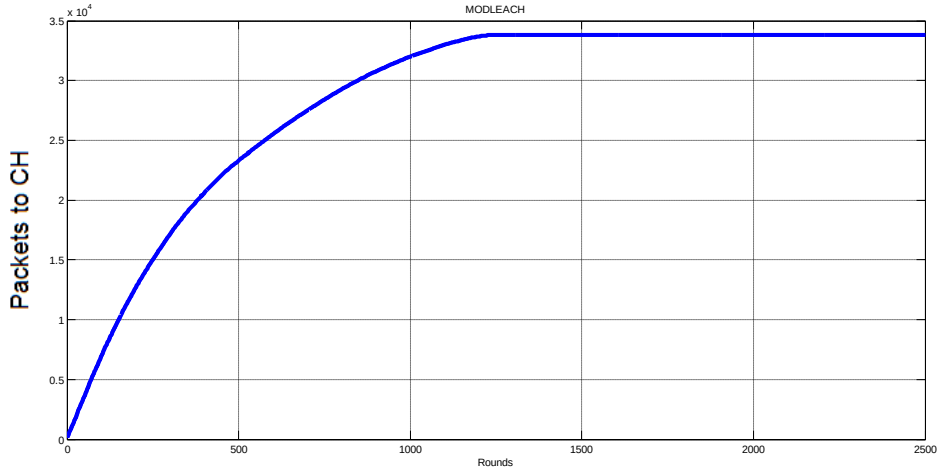


Figure 4.17: packet to cluster head for MOD-LEACH at p=0.3

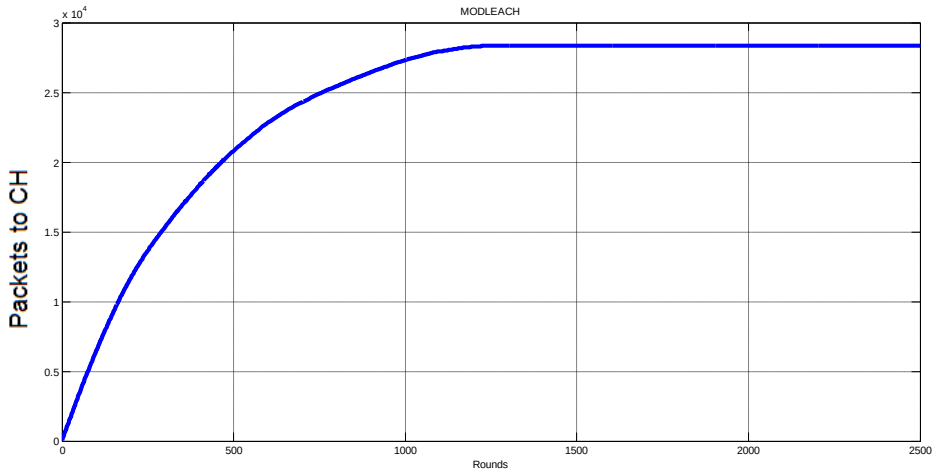


Figure 4.18: packet to cluster head for MOD-LEACH at p=0.4

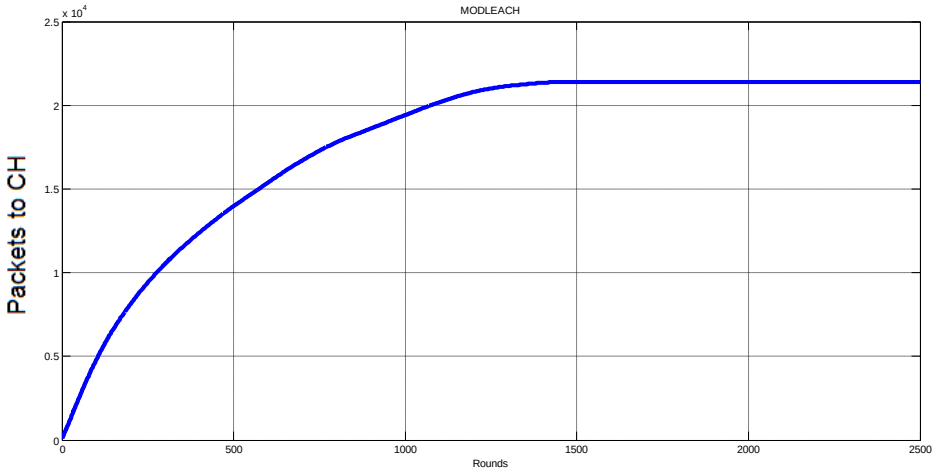


Figure 4.19: packet to cluster head for MOD-LEACH at p=0.5

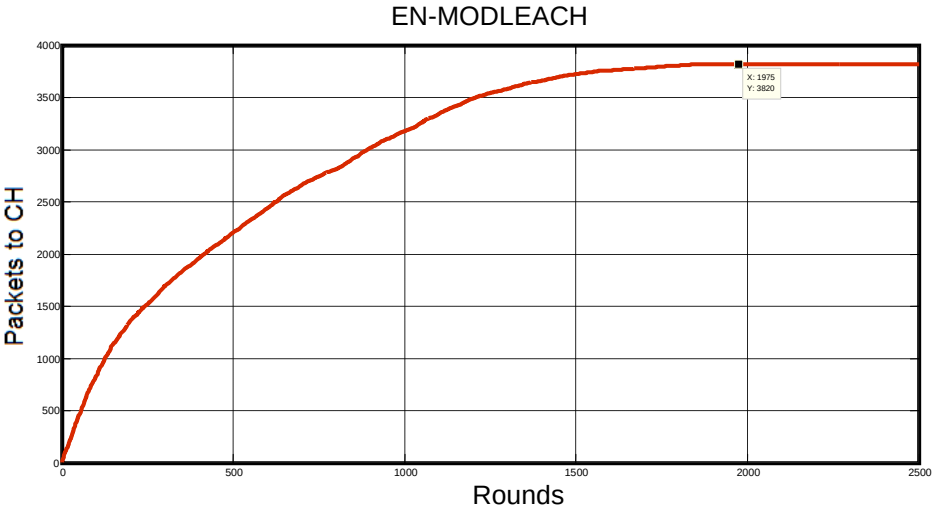


Figure 4.20: Packet to cluster head for EN-MOD LEACH

The plots in fig: 9, 10 are plotted for different values of taking into consideration the packets sent to base station versus the rounds for which the network is working. The plots clearly reveal changing value of p from p=0.1 to p= 0.9, increase the number of packets sent to base station that mean high accuracy[16,17].

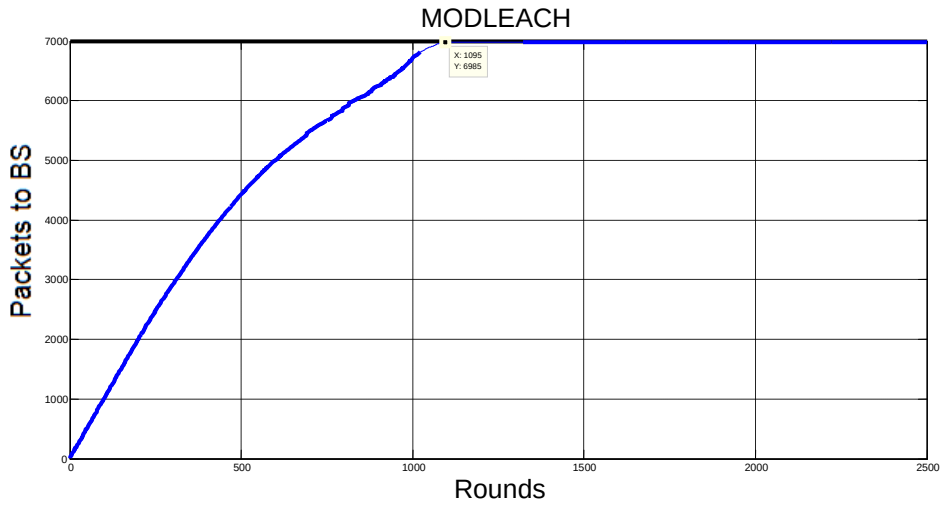


Figure 4.21: Packet to base station for MOD-LEACH at p=0.1

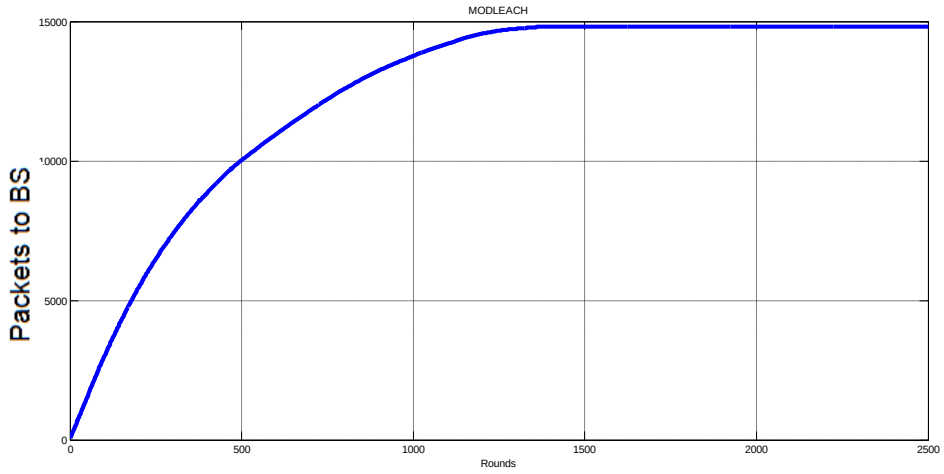


Figure 4.22: packet to base station for MOD-LEACH at p=0.3

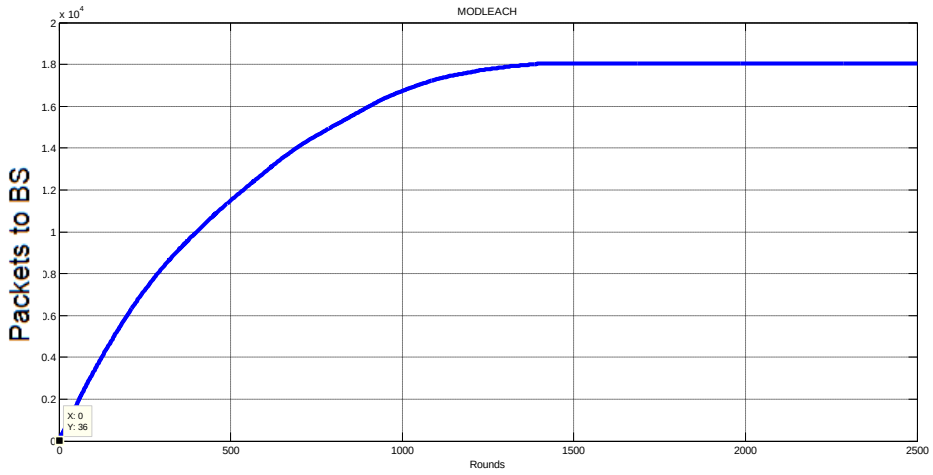


Figure 4.23: packet to base station for MOD-LEACH at p=0.4

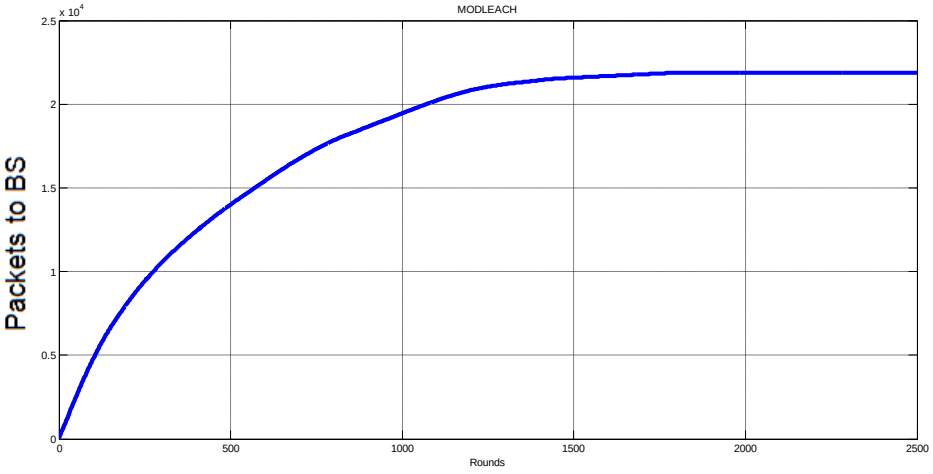


Figure 4.24: packet to base station for MOD-LEACH at p=0.5

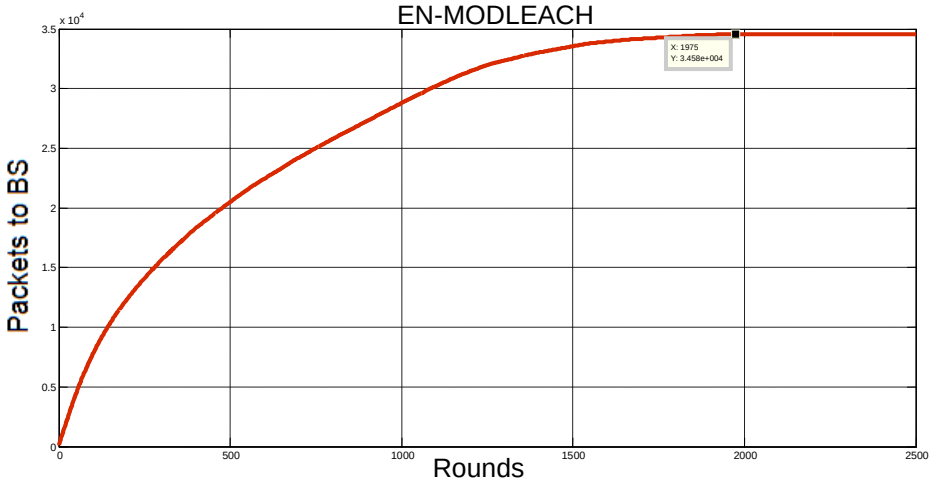


Figure 4.25: Packet to base station for EN-MOD LEACH

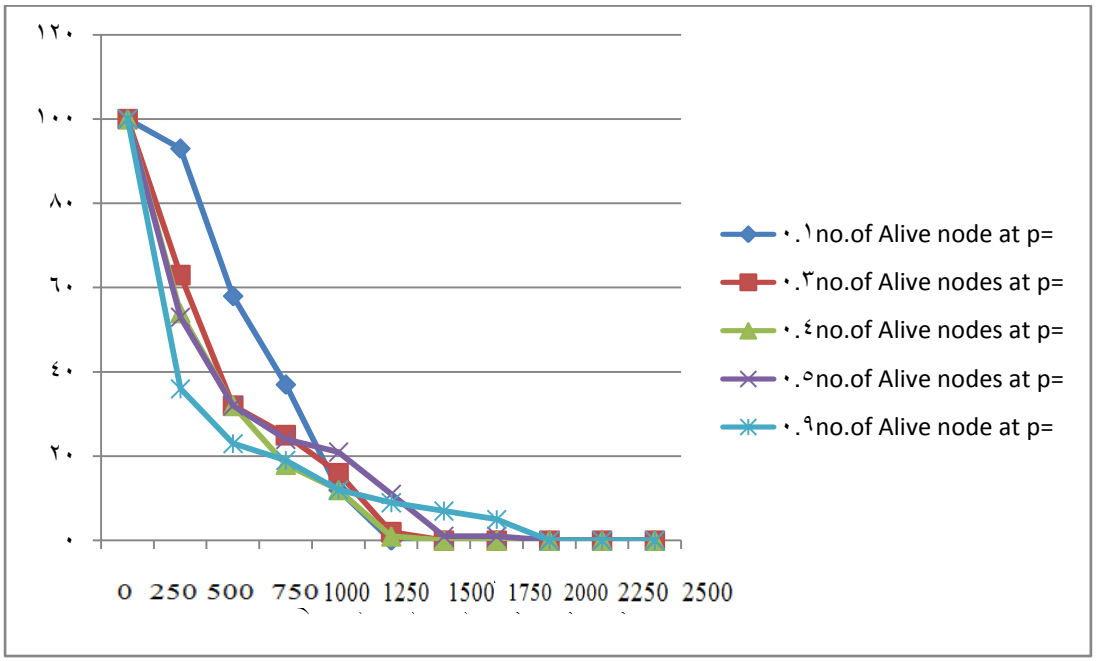


Figure 4.26: Number of Alive nodes

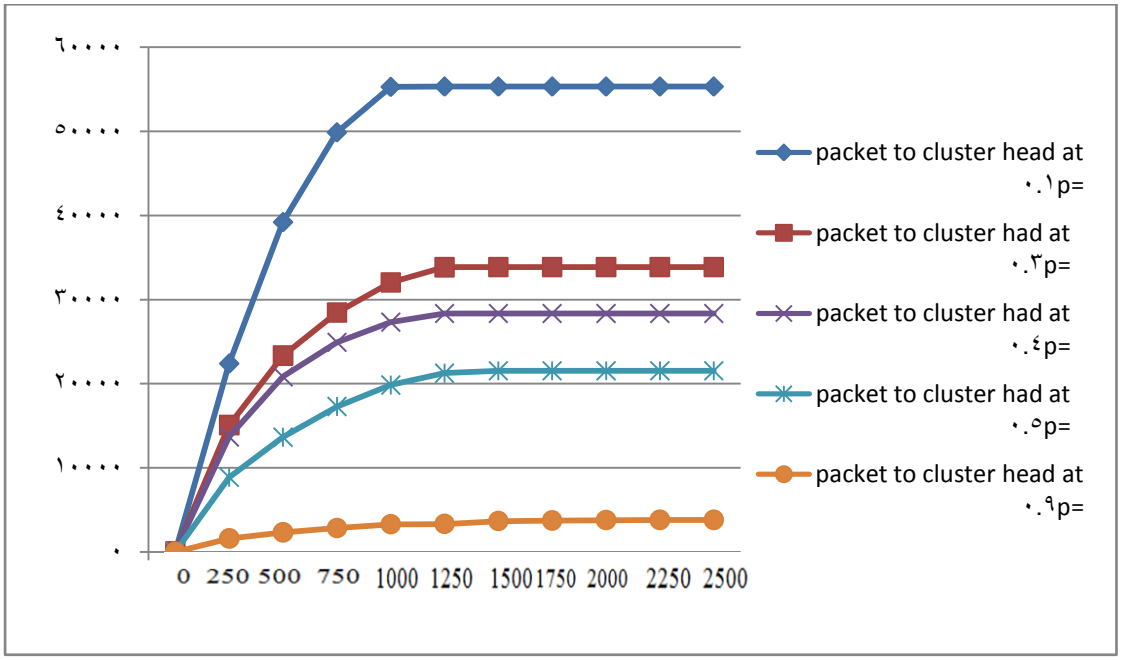


Figure 4.27: Packet send to cluster head

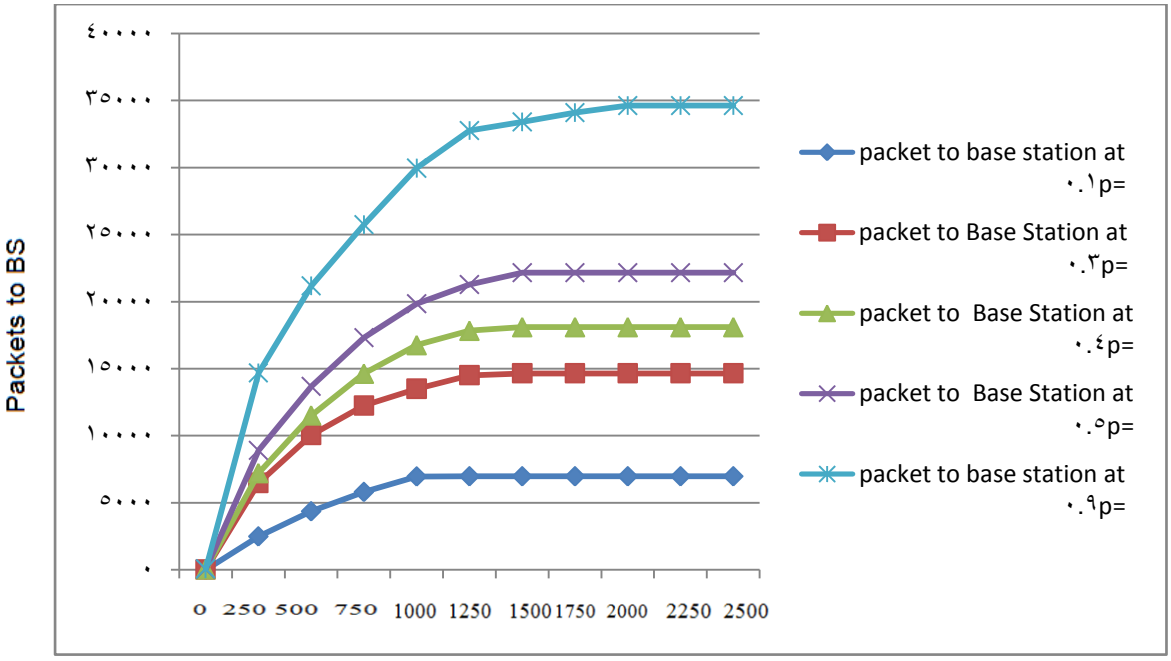


Figure 4.28: Packet send to Base station

In the second set of experiments, are varied the values of hard threshold by keeping the p constant and then making p variable.

Table 4.3: Effect of Hard Threshold on the Network

| S.NO | Probability (p) | Hard Threshold(h) | Maximum rounds in a network | First dead node of the networks |
|---|---|---|---|---|
| 1 | 0.1 | 100 | 1095 | 160 |
| 2 | 0.1 | 200 | 1248 | 159 |
| 3 | 0.1 | 300 | 1200 | 155 |
| 4 | 0.1 | 400 | 1261 | 148 |
| 5 | 0.9 | 100 | 1886 | 20 |
| 6 | 0.9 | 200 | 2129 | 22 |
| 7 | 0.9 | 300 | 1952 | 25 |
| 8 | 0.9 | 400 | 2012 | 22 |

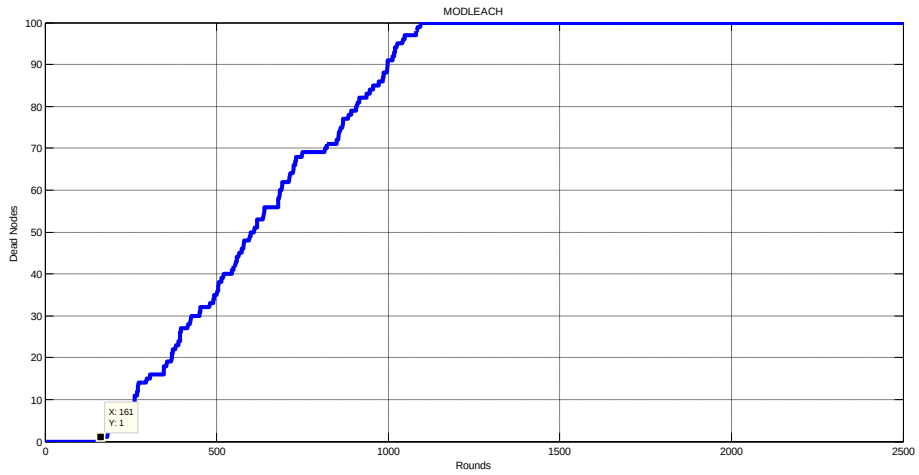


Figure 4.29: Dead nodes for MOD-LEACH at p=0.1, h=100

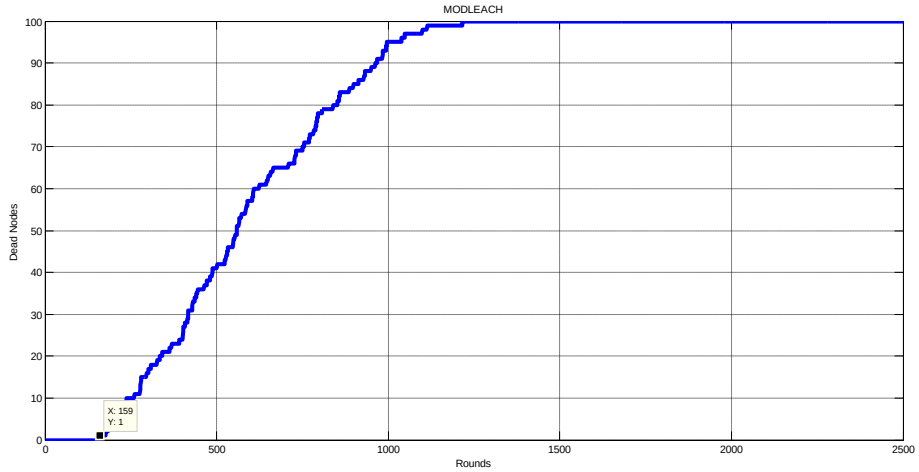


Figure 4.30: Dead nodes for MOD-LEACH at p=0.1, h=200

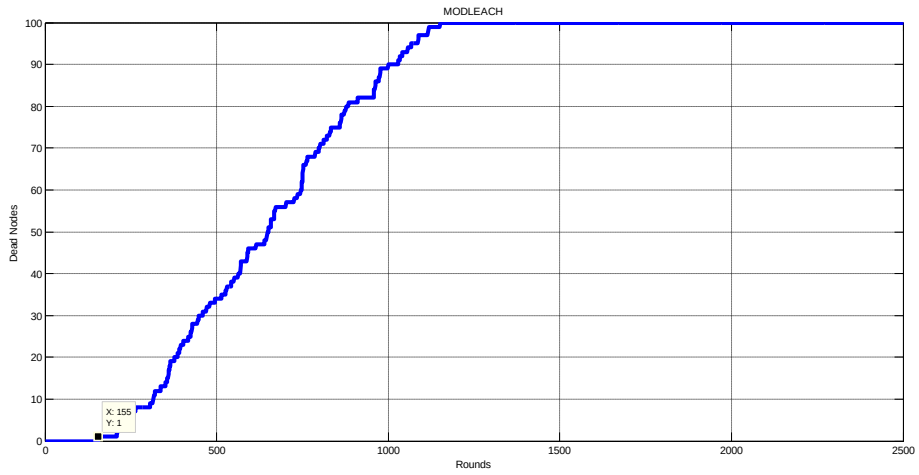


Figure 4.31: Dead nodes for MOD-LEACH at p=0.1, h=300

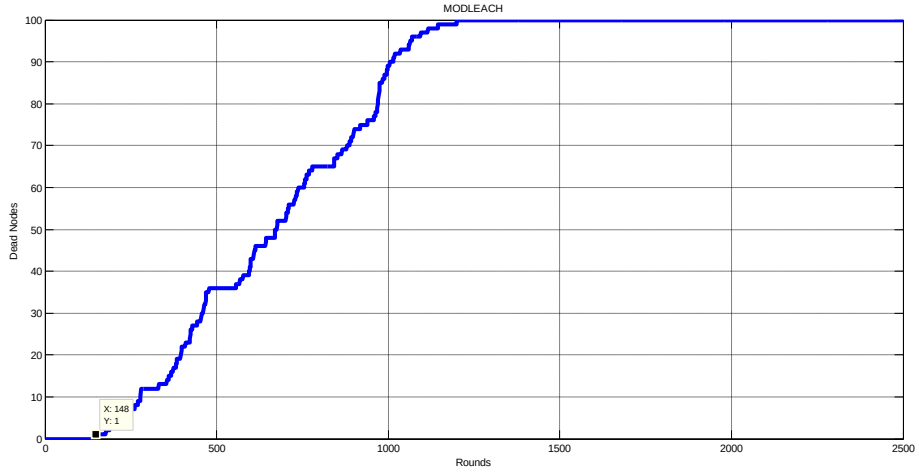


Figure 4.32: Dead nodes for MOD-LEACH at p=0.1, h=400

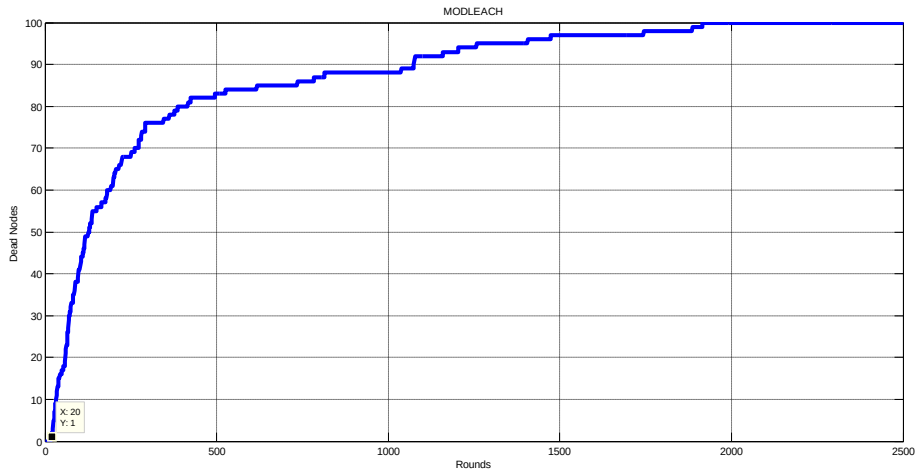


Figure 4.33: Dead nodes for MOD-LEACH at p=0.9, h=100

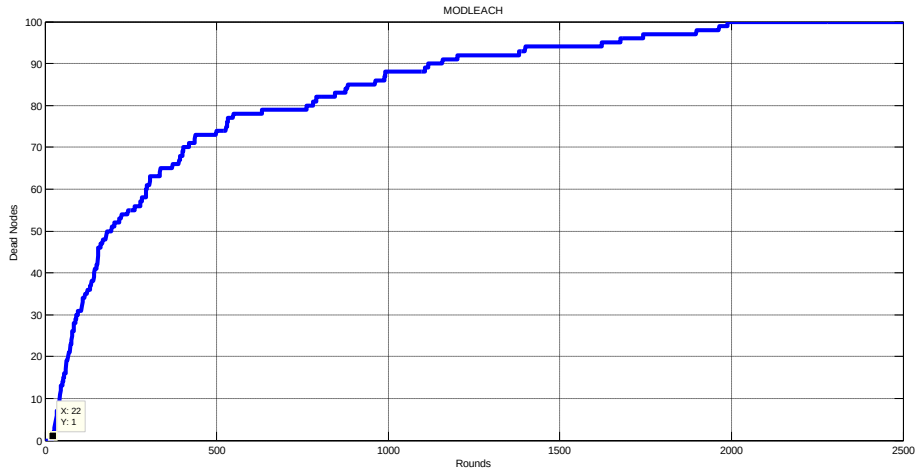


Figure 4.34: Dead nodes for MOD-LEACH at p=0.9, h=200

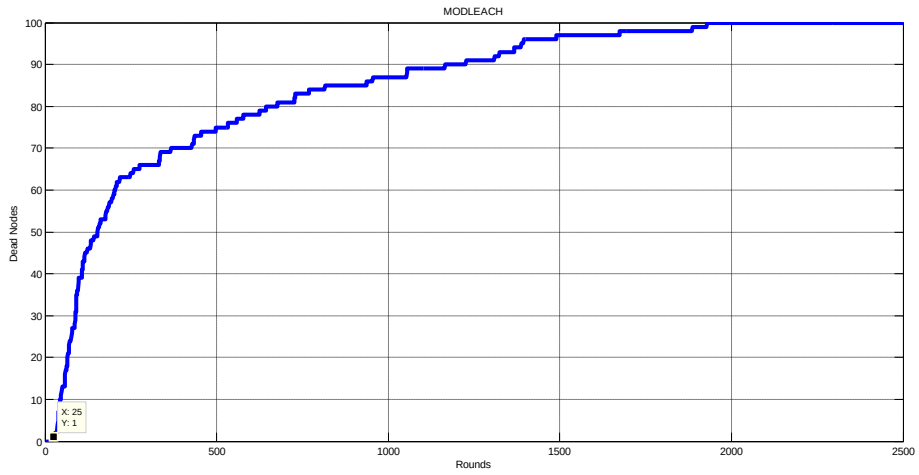


Figure 4.35: Dead nodes for MOD-LEACH at p=0.9, h=300

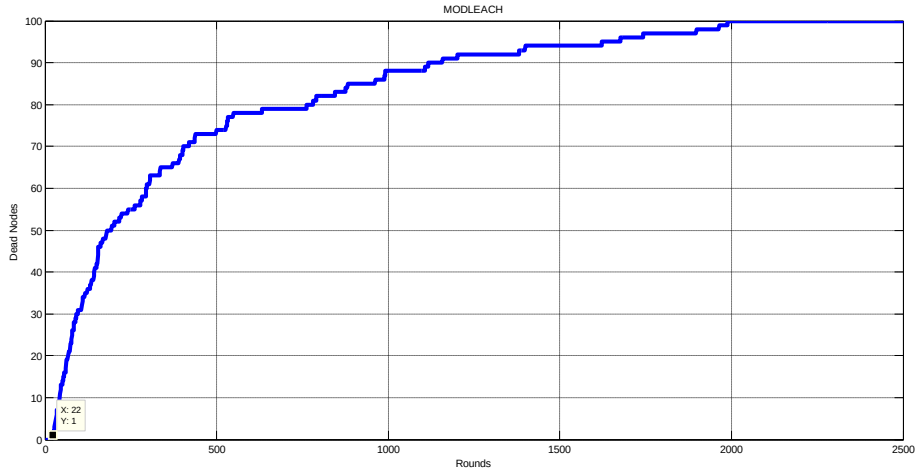


Figure 4.36: Dead nodes for MOD-LEACH at p=0.9, h=400

Hard thresholds have no profound effect on the stability period of the network.

## 4.4 Simulation analysis

- Probability of choosing a cluster head ∝maximum round of a network see table 4-2.

  At p=0.1 max round=1095

  At P=0.9 max round 1975

- probability of choosing cluster head ∝ 1/first dead node of network

  At p=0.1 first dead node 161

  At P=0.9 the first dead node 18

Probability of choosing cluster head ∝ packet sent to base station

At p=0.1 packets sent to base station =698

At p=0.9 packets sent to base station =34620

Increasing probability to p=0.9 certainly makes the performance of the MODLEACH considerably enhanced.

From table hard thresholds have no profound effect on the stability period of the network.

According to simulation results proved that our protocol EN-MODLEACH outperforms MODLEACH protocol in certain respects.