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Energy Efficiency Adapted Sector based Stable Election Protocol in Wireless Sensor Networks

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Abstract: Wireless Sensor System has malformed into an captivating looking at area, on the basis that to an assortment of deployment in numerous fields like medicinal application, forces application, surroundings circumstance monitoring, and capture surveillance . An improved throughput with inefficiently approved protocol. Different convention are exhibit for decrease of energy per bit transmit. The enormous preponderance of protocols resolute by two phases heterogeneous network to be incorporate two sorts of normal nodes and advanced nodes. Advanced nodes cover additional amount of energy than normal nodes. For largest part, the nodes combine to make clusters. This cluster head is used to make transmission of packets data from node to base station. As stable election protocol was introduced. On account of SEP both advance just as should be normal nodes having detached probability to change in the head of cluster. It is more probable that advance nodes put in an emergence as the head of the cluster in contrast with normal nodes. An route for as well improve the output of this type of understanding, Zonal-SEP was introduce, in Z-SEP field is partition in zones. Sector based –SEP is normal nodes which are close to the periphery may use advance nodes as cluster heads for data transfer to BS. Select areas in the field and develop a combine of intermediate hubs, Modified Sector based -SEP was introduce in MS-SEP field is separation in Sector based. Here conclusion is that by appropriately choosing areas in the field and utilise a couple of quantities of super hubs, a better output with same number of advanced hubs and intermediate hubs.
Keywords: WSN, SEP, Z-SEP, S-SEP, MS-SEP, AS-SEP.

I. INTRODUCTION

Wireless Sensor Networks is comprised of a substantial amount of economical, less power consumable and multi-operational detecting gadgets known as sensor nodes. Every sensor node is outfitted with detecting, data processing and transmitting capacities [1-4]. The previously discussed small detecting gadgets are known as nodes. They comprise of transceiver (for sending and getting signals or information starting with one hub then onto the next), CPU (with the end goal of information handling), battery (for vitality) and memory (for putting away information). As per the applications, size of each sensor hub changes accordingly. In certain military or even in some reconnaissance applications it may be infinitesimally small. Parameters, for example, battery, memory size and handling speed are the deciding factors for its cost. In past, various protocols are put forward, where developed nodes have additional amount energy than normal nodes [4-9]. These advance nodes are put in to build throughput. In this research article, we tried in regards to the dispersion of the sensor nodes in such manner to extent the throughput; it might be improving unaccompanied of making increase in advanced nodes energy. Firstly, we present two recently put forward protocols namely Z-SEP and S-SEP, which lay down the fundamentals of proposed protocol.

II. RELATED WORK

A. Z-SEP

In an incredible number of routing protocols, deployments of nodes are in a disorderly method in the system field. Likewise, in system the nodes' energy isn't being utilized in an effective way [9]. The field is adjusted in the Zone based stable Election protocol: There is network field is grouped into three zones. The course of action of the three zones is acknowledged by their energy level and Y-directions of framework speak to field. These three zones are titled as zone-0, Head zone-1 and Head zone-2.Here, we assumed that, additional amount of energy node is a small measure of entire nodes in comparison to normal nodes and defines as advance nodes. Assuming that, m as proportion of advanced nodes from the entire nodes which are having 'α' times additional amount of energy in contrast of remaining entire nodes. Where, $[(1-m)\times n]$ represents the normal nodes;(n)represents entire number of nodes. For example, we are assuming the dimension of the field $(100\times100)\ m^2$, where, nodes (advanced as well as normal) are dispersed in an irregular manner.

1) *Zone-0:* Normal nodes are establishing in an irregular way and, remains in the middle of($20 < Y \leq 80$).
2) *Head zone-1:* A portion of advanced nodes is establishing an irregular in this zone, in the middle of($0<Y\leq 20$).
3) *Head zone-2:* Remaining fraction of advanced nodes is establishing in an irregular manner, in($80 < Y \leq 100$).
4) *Z-SEP Operation:* In the case of Zone-0, the transmission of data from the entire nodes to the base station is done directly. Normal nodes collect all the data that is important and transmit it to data to base station directly. Head zone 1 and 2 having higher energy nodes make the transmission of information through cluster head to the base station. Selection of a head of the Cluster among entire nodes of Head zone 1 and 2 is performed using probability. Head of the Cluster gathers information from all of the nodes and makes its transmission to the sink (BS).The important task is the selection of head of the cluster.

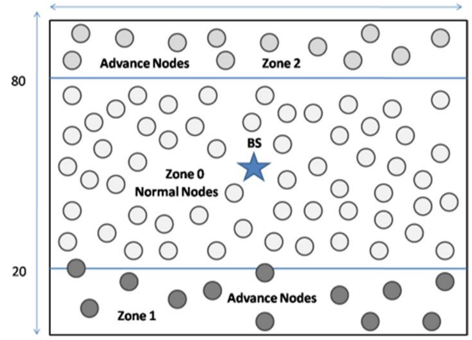

Fig.-1: Node arrangement in rectangular field of area $(100\times100)m^2$

Fig-1 demonstrates the placement of the advanced node in an irregular manner in Head zone 1 and 2.We can have Cluster in advanced node alone. For example, we have an ideal fraction of clusters$K_{(opt.)}$,(n):represents the amount of advance nodes. As per the Stable Election Protocol, we can characterize the optimal likelihood of cluster head as,

$$P_{(opt).} = \frac{K_{(opt.)}}{n} \quad (1)$$

It is decided by each node to be a cluster head in current round. In between 0 and 1, a random number is generated for the node. In the event of this generated number is less or equal than threshold $T(n)$for node, here it is as head of the cluster and defined as,

$$T(n) = \begin{cases} \frac{P_{(opt)}}{1-P_{(opt)}\left(r \times \mathrm{mod}\frac{1}{P_{(opt)}}\right)} & ;\ \text{if } n \in H' \\ 0 & ;\ \text{elsewhere} \end{cases} \quad (2)$$

Where, the *H'* defines the number of nodes not taken as head of the cluster in previous$\frac{1}{P_{(opt)}}$rounds.

The below given equation defines the chance for advance nodes to become as a head of the cluster.

$$P_{(adv.)} = [(\frac{P_{(opt)}}{(1+\alpha m)})(1+\alpha) \quad (3)$$

According to threshold for advance nodes is

$$T(adv.) = \begin{cases} \frac{P_{(adv)}}{1-P_{(adv)}\left(r \times \mathrm{mod}\frac{1}{P_{(adv)}}\right)} & ;\ \text{if adv} \in H' \\ 0 & ;\ \text{otherwise} \end{cases} \quad (4)$$

In this arrangement of developed nodes that are not being picked as head of the cluster in on-going $\frac{1}{P_{(adv)}}$rounds. After we have the arrangement of head of the cluster, the head of the cluster impart information to the nodes. This information is gotten by the hubs and they settle on the choice to which head of the cluster and it will proceed to the current round. This is called cluster formation stage. As per the quality of signal received, nodes offer reaction to cluster head and be as a part of it. Cluster head right now appoint a TDMA position in which nodes can exchange information to head of the cluster for the hubs at that time. After the finishing of the advancement of clusters of information of every node, transmission of the information to the group leader within the time made definite to the node by the group head.

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B. S-SEP

To solve unequal distance problem previously it was put forward that to divide the total area in four sectors as presented in figure-2 [10].

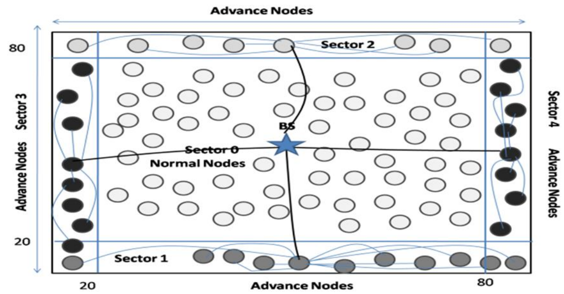

Fig.-2: Four sector based network architecture.

Every sector can be classified as

1) *Sector-1:* $0<x<X$ and $0<y<y_1$
2) *Sector-2:* $0<x<X$ and $y_2<y<Y$
3) *Sector-3:* $0<x<x_1$ and $0<y<Y$
4) *Sector-4:* $x_2<x<X$ and $0<y<Y$

The primary benefits of S-SEP are:

a) Improved proper deployment of developed nodes.
b) A less number of advanced nodes are used to cover remote locations from BS.
c) Less distance from BS to farthest node.
d) Enhanced throughput and stability period with minimum initial energy.

C. MS-SEP

In this work we suggest further modifications in S-SEP and define as MS-SEP. the suggested modifications are as under:

1) Divide the field into five zones.
2) Inclusion of intermediate nodes in association with normal and advance nodes.

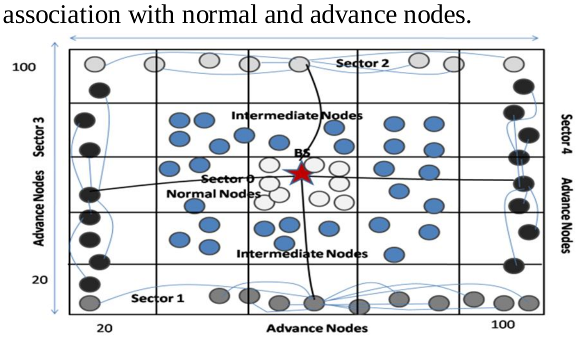

Fig.-3: Network architecture with put forward Protocol

The distribution of nodes is as follows:

Advanced Nodes
Sector-1: 0<x<100 and 0<y<20
Sector-2: 0<x<100 and 80<y<100
Sector-3: 0<x<20 and 20<y<80
Sector-4: 80<x<100 and 20<y<80
Intermediate Nodes
Sector-5: 20<x<80 and 20<y<40
Sector-6: 20<x<80 and 60<y<80
Sector-7: 20<x<40 and 40<y<60
Sector-8: 60<x<80 and 40<y<60
Normal Nodes

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In the utmost initial experiment, the entire numbers of considered nodes are 100, out of them, 20 are advanced nodes, 16 are intermediate nodes and remaining 64 nodes are normal nodes. The energy of normal nodes is considered to be E_0 the energy of intermediate node is $[E_0(1+\beta)]$ and the energy of advanced node is $[E_0(1+\alpha)]$. Here it is noted that, $\beta<\alpha$. The random deployments of nodes under various protocols are presented in Figure 8 to Figure 10. However, the position of base station is kept at fixed position of (50. 50).

III. AS-SEP

In this work we suggest further modifications in MS-SEP and define as AS-SEP. the suggested modifications are as under:

A. Divide the field into thirteen sectors.
B. Inclusion of Super nodes in association with normal, intermediate and advance nodes.

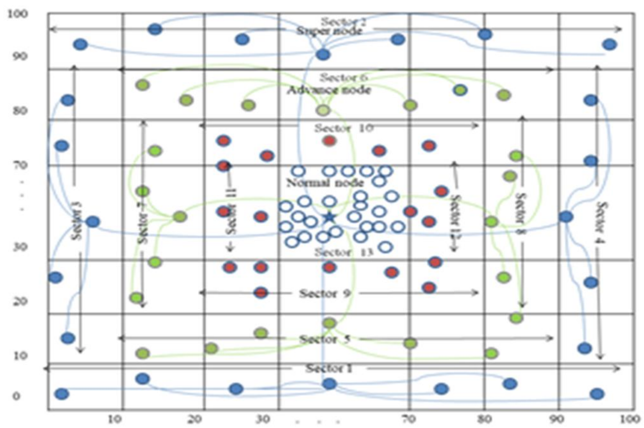

Fig.-4: Network architecture with put forward Protocol

The distribution of nodes is as follows:

1) Super Nodes
Sector 1: $0<x<100$ and $0<y<10$
Sector 2: $0<x<100$ and $90<y<100$
Sector 3: $0<x<10$ and $10<y<90$
Sector 4: $90<x<100$ and $10<y<90$
2) Advanced Nodes
Sector 5: $10<x<90$ and $10<y<20$
Sector 6: $10<x<90$ and $80<y<90$
Sector 7: $10<x<20$ and $20<y<80$
Sector 8: $80<x<90$ and $20<y<80$
3) Intermediate Nodes
Sector 9: $20<x<80$ and $20<y<30$
Sector 10: $20<x<80$ and $70<y<80$
Sector 11: $20<x<30$ and $30<y<70$
Sector 12: $70<x<80$ and $30<y<70$
4) Normal Nodes
Sector 13: $30<x<70$ and $30<y<70$

In the first experiment, the total number of considered nodes are 100, out of which 28 node are super nodes, 20 nodes are advanced nodes, 16 nodes are intermediate nodes and rest 36 nodes are normal nodes. The energy of normal nodes is considered to be E_0 the energy of intermediate node is $E_0(1+\mu)$, the energy of advanced node is $E_0(1+\beta)$ and the energy of super node is $E_0(1+\alpha)$. Here it is noted that, $\mu<\beta<\alpha$. The random deployment of nodes under various protocols is presented in the position of base station is kept at fixed position of (50. 50).

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IV. NETWORK MODEL

In the system model, a couple of sensible suppositions are made which are as per the following:

A. In absolute n sensor hubs are dispersed consistently in a square field of measurement X×Y.
B. The system is static in nature; accordingly every one of the hubs and the BS are stationary after organization.
C. There are two sorts of hubs in Z-SEP, S-SEP and MS-SEP is three sorts of hubs while in AS-SEP there is four kinds of hubs in this way the system is heterogeneous.
D. Every one of the sensors hubs are sent arbitrarily are they are area ignorant.
E. The BS is in the focal point of the sensor field.
F. Every hub has a particular character (id).

V. RADIO MODEL

To obtain an achievable Signal-to-Noise Ratio (SNR), here we use, radio energy scattering model , during the transmission of an(Lp) −bit of the message signal separates d, the radio model uses the energy can be express as:

$$E_{TX}(l,d) = \begin{cases} L_p E_{(elec)} + L_p \in_{fs} d^2 \text{ ; if } d < d_0 \\ L_p E_{(elec)} + L_p \in_{mp} d^4 \text{ ; if } d \geq d_0 \end{cases} \quad (5)$$

Where, $d_0 = \sqrt{\frac{\in_{fs}}{\in_{mp}}}$.

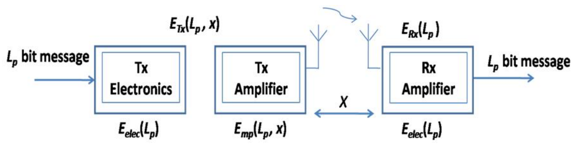


Fig. -5: Representation of Radio model. [3]

Now, at the transmitter or the receiver circuit, the energy dissipation per bit of the successful operation can be represented by ($E_{elec.}$).The transmitter amplifier model uses parameter (ε_{fs}) as well as(ε_{mp}) these are dependent on the separation of the sender to the receiver, that is represented by(x) [7]. The radio will expand to receive an (L_p)-bit of the message [$E_{RX}(L_P) = L_P E_{ELEC.}$].The center position of the field I used for BS; since, the distance of BS to any node is less than (x_0).According to the initial energy of the nodes, nodes are classified into normal nodes, advanced nodes and super nodes in a three-level heterogeneous network. Therefore, the reference values of are also different for the three types of nodes, which can be written as

$$p_i = \begin{cases} \frac{p_{nrm} E_i}{E_{ave}} & s_i \text{ is normal node} \\ \frac{p_{int} E_i}{E_{ave}} & s_i \text{ is intermediate node} \\ \frac{p_{adv} E_i}{E_{ave}} & s_i \text{ is advanced node} \\ \frac{p_{adv} E_i}{E_{ave}} & s_i \text{ is super node} \end{cases}$$

Thus, we can obtain the different thresholds T(n)[15].
Parameters that are utilized in the estimation and for the simulation are listed in Table- 1.

Table-1: List of parameters and their values

Parameters	Value
Initial Energy (E_0).	0.25J, 0.50 J
Energy for data aggregation E_{DA}	5 nJ/bit/signal
Transmission and Receiving energy	5 nJ/bit
Amplification energy for short distance ε_{fs}	10 pJ/bit/m^2
Amplification energy for long distance ε_{mp}	0.013 pJ/bit/m^4
Packet size	4000 bits
Total nodes	100
Fraction of advance nodes	0.2

Stability period, Network lifetime and Throughput are used to evaluate the performance of the protocols, and these are as,

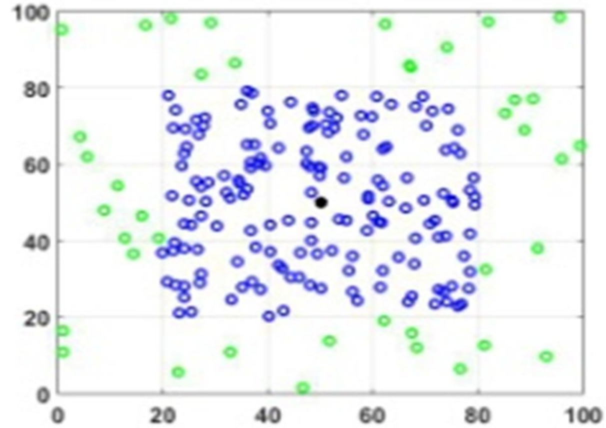


Fig.-6: Deployment in S-SEP.

In Fig.-6, (100×100) m^2 field is used for simulation of S-SEP. The blue 'o' symbol is used as a representation of Normal nodes and that are deployed in square 20<X<80 and 20<Y<80. For some time,green 'o' symbols are used as a representation of advanced node and that are deployed in the region remains left, and, the mark with '×' is represents the position of the BS'.

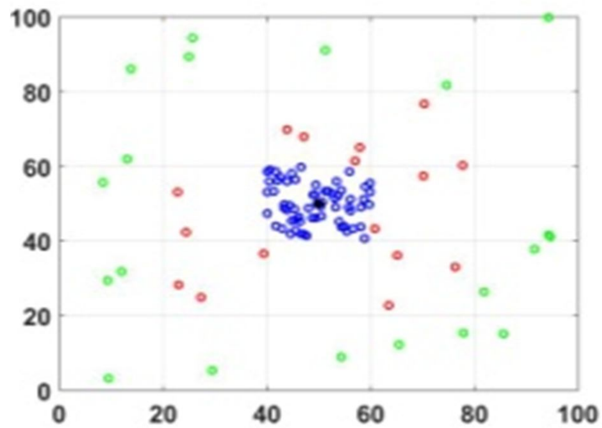


Fig.-7: Deployment in MS-SEP.

In Fig.-7,(100×100) m^2 field is used for simulation of MS-SEP. The blue 'o' symbol is used as a representation of Normal nodes and that are deployed in according to above defined boundaries. And, the mark with '×' is represents the BS.

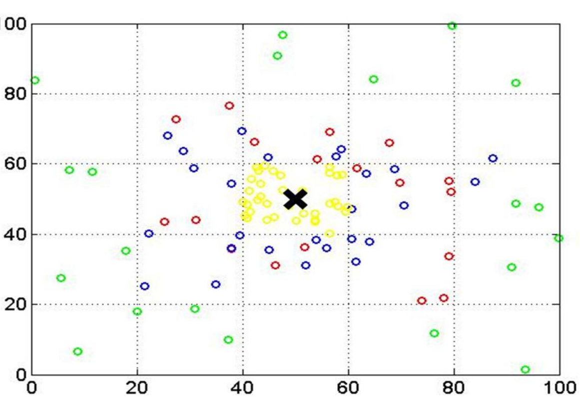


Fig.-8: Deployment in MS-SEP.

In Fig.-8, simulation preview of 100×100 m2 field is appeared for AS-SEP. Ordinary hubs are appeared with yellow 'o' and are sent in as indicated by above characterized limits. Once more, BS is appeared with '×'.

Fig.-9(a), for S-SEP and MS-SEP protocol, having intermediate nodes of energy 0.75*J*. as well as advance node of energy 1.0*J*. is going to draw active nodes vs. rounds plot.

Similarly, Fig.-9(b), dead nodes vs. round is drawn. In S-SEP protocol utmost initial node is being dead after 1761 rounds for some time rearmost node is being dead after 3717 rounds.

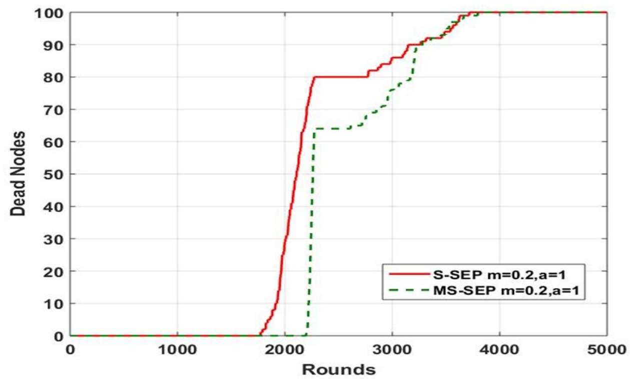


Fig.-9(a): Dead nodes vs. rounds.

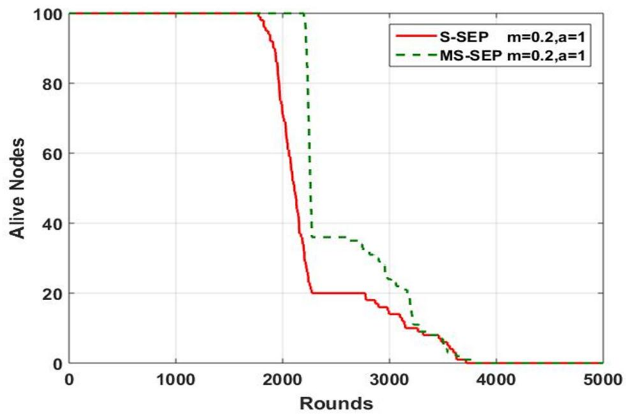


Fig.-9(b): Active nodes vs. rounds.

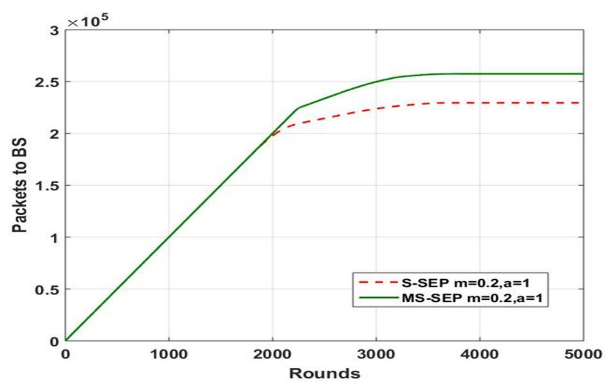


Fig.-9(c): Packet to BS vs. rounds.

In MS-SEP protocol utmost initial node is being dead after 2185 rounds and rearmost node after 3824 rounds. the separation of nodes from the base station is not equal for some time in S-SEP protocol the separation of hubs is indistinguishable.

Fig.-9(c),for S-SEP and MS-SEP protocol having intermediate node of energy 0.75J is going to draw packet to BS vs. rounds plot. Number of packets is going to transmit to BS for S-SEP protocol is 2.294×10^5 and for MS-SEP number of packets is going to transmit to BS is 2.575×10^5.

Therefore, number of packet received at BS increased around 5%. In precise, relatively results for S-SEP are described in Table 2. The enhancement in stability period is 12.25%, for some time enhancement in network lifetime is only 2.44%.

Table 2: Comparison of protocols parameters

Parameters	S-SEP	MS-SEP
Stability Period (in Rounds)	1770	2194
Network Lifetime (in Rounds)	3724	3815
Throughput (in Packets)	2.294×10^5	2.575×10^5

VI. COMPARISON OF MS-SEP AND AS-SEP

In WSN applications, throughput is an important parameter; in this section we have made comparison of both MS-SEP and AS-SEP under same throughput conditions. We have carried out multiple of experiments and figured out that for MS-SEP, 64 normal nodes, 16 intermediate nodes and 20 advanced nodes performance is same as for AS-SEP while considering 36 normal nodes, 16 intermediate nodes , 20 advanced nodes and 28 super nodes. Thus, a total of 100 nodes are deployed.

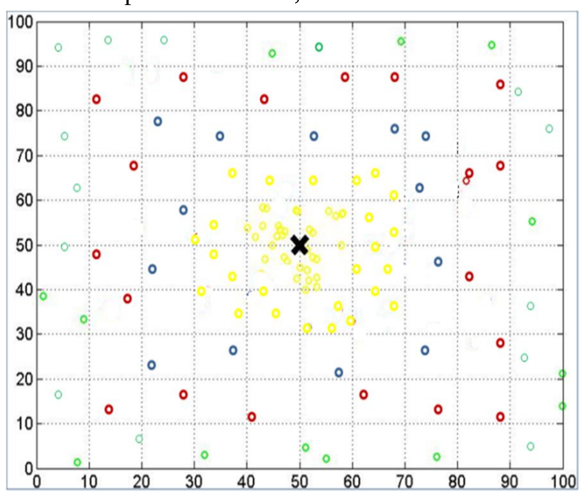
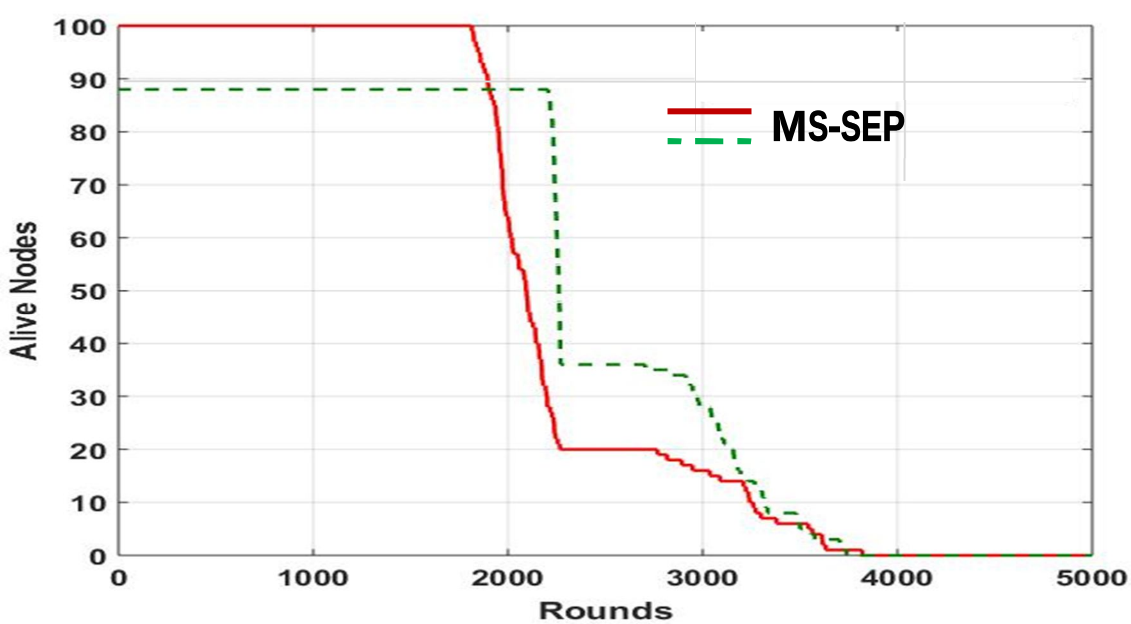


Fig. 10: Deployment of nodes in AS-SEP protocol (100 nodes)



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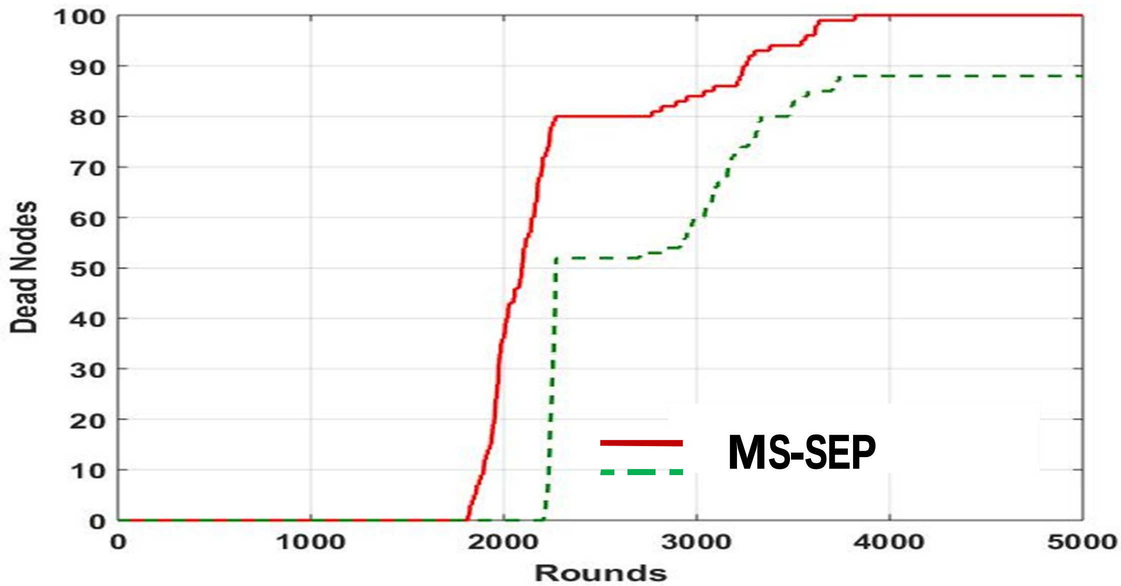

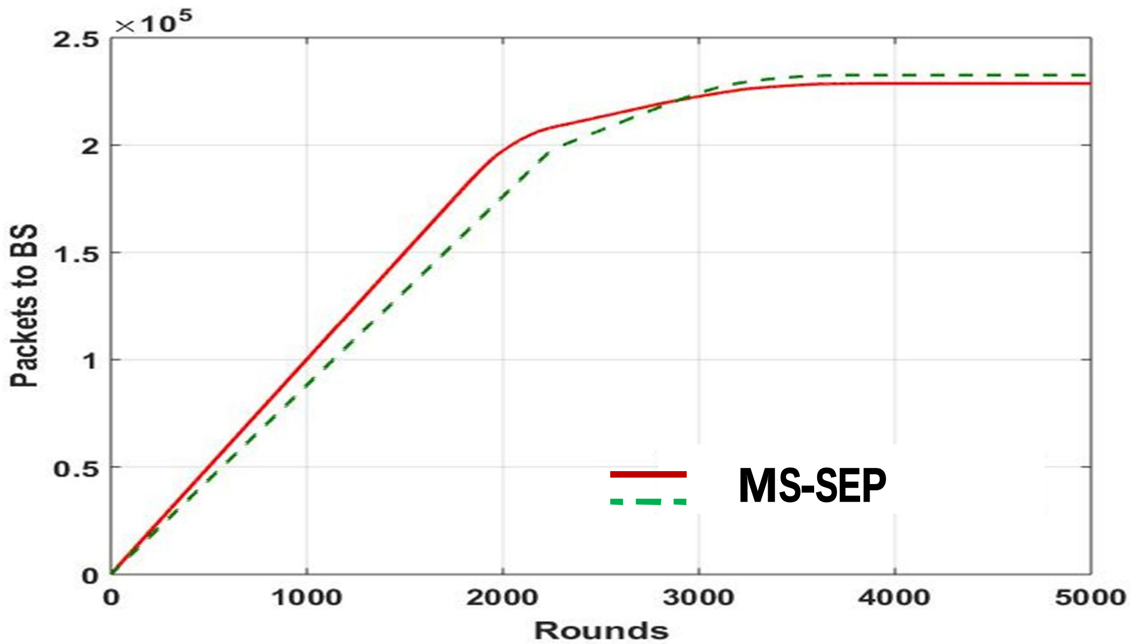

Fig.-11(a): Alive nodes vs. rounds, (b) Dead nodes vs. rounds, (c)Packet to BS vs. rounds.

In Fig.-11(a), alive hubs versus rounds for MS-SEP and AS-SEP convention is appeared, while in Fig.-11(b), dead hubs versus rounds is appeared. In the event of MS-SEP convention, first hub bites the dust after 1806 adjusts, and last hub after 3851 rounds. While in AS-SEP first hub passes on after 2203 adjusts and last hub kicks the bucket 3752 rounds. The packet transfer to BS versus round is appeared in Fig.-11(c), For MS-SEP protocol quantity of packets transmitted to BS is 2.286×10^5 and for AS-SEP the quantity of packets to BS is 2.326×10^5

Table 2: Comparison of protocols parameters

Parameters	MS-SEP	AS-SEP
Stability Period (in Rounds)	2194	2285
Network Lifetime (in Rounds)	3815	3924
Throughput (in Packets)	2.575×10^5	2.675×10^5

The performance of AS-SEP is 12.24% higher than S-SEP protocol and 17.24% higher than MS-SEP protocol.

VII. COMPARISON OF ENERGY

A. *Energy Calculations*

Total energy in S-SEP protocol is

E_{TS} = (n-q)E_0 + qE_0(1+α)

Where, *q* represents the number of advanced nodes.

Similarly, total energy in MS-SEP protocol is,

E_{TMS} = (n-q-r)E_0+ qE_0(1+α) + rE_0(1+β).

Where, r represents the number of intermediate nodes.

Considering *n*=100, *q*=20, *r*=16, *α*=1, *β*=0.5.

Total energy in S-SEP protocol is,

E_{TS} = (n-q)E_0 + qE_0(1+α) =120E_0.

Total energy in MS-SEP protocol is,

E_{TMS} = (n-q-r)E_0+ qE_0(1+α) + rE_0(1+β) =128E_0

Therefore, energy is increased by 8E_0 units.

B. *Energy Calculations*

Total energy in S-SEP protocol is,

E_{TS} = (n-q)×E_0 + q×E_0×(1+α),

Where, *q* represents the number of advanced nodes.

Similarly, total energy in MS-SEP protocol is,

E_{TMS} = (n-q-r)×E_0 + q×E_0×(1+α) + r×E_0×(1+β),

Where, r represents the number of intermediate nodes.

Similarly, total energy in AS-SEP protocol is,

E_{TMS} = (n-q-r)×E_0 + q×E_0×(1+α) + r×E_0×(1+β) + p×E_0×(1+μ),

Where, p represents the number of super nodes.

Considering *n*=100, p=28,*q*=20, *r*=16, *α*=1, *β*=0.5,μ=0.25.

Total energy in S-SEP protocol is,

E_{TS} = (n-q)×E_0 + q×E_0×(1+α) =120E_0.

Total energy in MS-SEP protocol with *n*=100, is

E_{TMS} = (n-q-r)×E_0 + q×E_0×(1+α) + r×E_0×(1+β) =128E_0

Total energy in AS-SEP protocol with *n*=100, is

E_{TMS} = (n-q-r-p)×E_0 + q×E_0×(1+α) + r×E_0×(1+β) + p×E_0×(1+μ) =135E_0

Therefore, energy saving is 7 E_0 units.

VIII. CONCLUSIONS

This research article focuses on the performance assessment of AS-SEP. This research is concentrating on the designing and judging the performance of wireless network protocol.Since, The performance of AS-SEP is 19.90% higher than Z-SEP, 12.24% higher than S-SEP protocol and 17.24% higher than MS-SEP protocol. Thus, with less number of super nodes advanced nodes and intermediate nodes a better performance in concern of number of packets received by BS can be obtained with a S-SEP. Therefore, energy saving is 7 E_0 units. It has been found that the inclusion of super nodes is beneficial and performance of the MS-SEP protocol can be enhanced significantly.

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