IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-5, Issue-6 E-ISSN: 2347-2693

PEAR: Protected Based Energy- Aware Routing For WSNs

A.Santha Devi[1*], **V. Vinoba**[2]

[1*] PG & Research Department of Mathematics, K.N.G.A.College, Thanjavur, Tamil Nadu, India
[2]PG & Research Department of Mathematics, K.N.G.A.College, Thanjavur, Tamil Nadu, India

**Corresponding Author: santha7771@gmail.com*

Available online at: www.ijcseonline.org

Received: 19/May/2017, Revised: 27/May/2017, Accepted: 22/Jun/2017, Published: 30/Jun/2017

***Abstract*—** Energy aware routing protocols can be ordered into energy saver and energy administrator. Energy saver protocols diminish energy utilization completely. The greater part of them attempt to locate the most limited way amongst source and goal to diminish energy utilization. Yet, energy administrator protocols adjust energy utilization in network to maintain a strategic distance from network dividing. Discovering best route just in light of energy adjusting thought may prompt long way with high postponement and declines network lifetime. Then again, discovering best route just with the briefest separation thought may prompt network apportioning. This paper enhances SEER routing protocol. Conventional SEER is just energy saver and has poor thought regarding energy adjusting. Our proposed protocol, named PEAR, considers energy adjusting and ideal separation both. It finds a reasonable tradeoff between energy adjusting and ideal separation by learning automata idea. We reproduce and assess routing protocols by NS2 simulator.

***Keywords*—** *Sensor Network, Energy Aware, Routing Protocol, SEER Protocol..*

I. INTRODUCTION

A Wireless Sensor Network (WSN) contains hundreds or thousands of sensor hubs. Essentially, every sensor hub contains detecting, preparing, transmission, portability, position discovering framework, and power units. Be that as it may, so-me of these segments are discretionary like the versatility.

Sensor hubs are normally scattered in a sensor field, which is a region where the sensor hubs are sent. Sensor hubs facilitate among themselves to create fantastic data about the physical condition. These sensors can convey either among each other or specifically to an outside base-station (BS). A base-station might be a settled hub or a portable hub equipped for associating the sensor network to a current correspondences foundation or to the Internet where a client can have admittance to the detailed information.

Many routing calculations have been created for sensor and impromptu networks. These routing protocols can be ordered by the network structure as level, progressive, or area based. In level networks, all hubs assume a similar part while various leveled protocols go for bunching the hubs so group heads can do some total and diminishment of information keeping in mind the end goal to spare energy. Area based protocols use the position data to transfer the information to the coveted locales instead of the entire network.

Then again, energy utilization in sensor networks is an imperative element. Since batteries conveyed by every versatile hub have restricted power supply, handling force is constrained, which thusly confines administrations and applications that can be bolstered by every hub. This is a major issue in sensor networks on the grounds that, as every hub is going about as both an end framework and a router in the meantime, extra energy is required to forward parcels from different hubs.

The majority of energy aware routing protocols are intended to spare aggregate energy utilization. They for the most part locate the briefest way amongst Source and Sink to diminish energy utilization. As we would like to think, an energy saver protocol that adjusts energy utilization is superior to a poor energy server protocol. Discovering best route just with the briefest separation thought may prompt network dividing. Then again, discovering best route just in light of energy adjusting thought may prompt long way with high postponement and reductions network lifetime.

Soothsayer is a basic energy effective routing protocol. It tries to diminish number of transmissions. In any case, it has poor thought regarding energy administration and energy adjusting. Then again, LABER routing protocol tries to adjust energy utilization. Yet, it has some unmistakable issues, for example, low exactness in refreshing of energy and high control overhead. In LABER, the Acknowledgment parcel is sent to past information sender and alternate neighbors can't refresh energy level of sender of Acknowledgment; low exactness. In addition, the Acknowledgment parcel is an additional control overhead. We attempt to refresh energy without Acknowledgment bundles to build exactness and reduction control overhead.

This paper locations to plan an energy-aware routing protocol for level structure wireless sensor networks. The proposed protocol, PEAR, tries to spare and adjust energy utilization in network. It finds ideal route in energy level and jump number both. Routing choices in PEAR depend on the separation to the Base Station and also on residual battery energy levels of hubs on the way towards the base station.

II. MOTIVATION

The majority of energy-aware routing protocols are just energy saver. They don't have an adequate thought regarding energy adjusting. This paper locations to propose an energy saver protocol that considers energy adjusting as well. We discovered SEER routing protocol reasonable to progress. Diviner routing protocol is a basic energy aware routing protocol that considers energy sparing and energy adjusting both. In any case, it has poor thought regarding energy adjusting. Our proposed routing protocol, named PEAR, enhances SEER in energy adjusting and network lifetime.

III. SEER ROUTING PROTOCOL

The distinctive strides required in the routing of bundles in a SEER network are examined next. Note that every hub is required to keep a neighbor table, which contains a passage for every hub inside transmission remove.

STEP 1: Network setup and neighbor disclosure

Once the network has been conveyed in the zone where it is to work, the sink transmits a communicate bundle. The communicate parcel contains the header fields appeared in Table 1.

Table 1. Fields contained in the network layer header of broadcast messages.

Filed	**Size (bits)**
Source address	16
Destination address	16
Sequence number	8
Hop count	8
Energy level	16
Total	64

The source and goal locations are 16 bit addresses empowering 65536 (216) one of a kind locations. Each node in the network is expected to have a one of a kind address inside the network. The 8-bit grouping number is utilized to recognize new communicate messages. The sink increases the grouping number each time it sends another communicate message.

Hubs store the arrangement number locally and forward communicate messages just if the succession number of the message is not quite the same as the put away one. The succession number uses 8 bits keeping in mind the end goal to guarantee that inactivity in the network does not make hubs erroneously forward old communicate messages. An 8-bit bounce number guarantees that no-des can be up to 255 jumps from the sink.

At the point when a hub gets this underlying communicate message, it checks whether it has a passage in its neighbor table for the hub that transmitted the message. If not, the collector hub includes a passage that comprises of the neighbor address, bounce check and energy level. The hub then augmentations the jump include put away the message and stores this bounce consider its own particular jump check. It then retransmits communicate, however changes the source deliver field to its address and the energy level field to its residual energy level. Each hub in the network retransmits the communicate message once, to the greater part of its neighbors.

On the off chance that a hub gets a communicate message with a lower jump number than the bounce tally it as of now has, it refreshes its bounce check. At the point when this underlying communicate has been surge ed through the network, every hub knows its bounce tally and has the address, jump tally and energy level of each of its neighbors.

STEP 2: Transmitting new information

At the point when a hub watches new information, as characterized prior, it starts the way toward routing. Two sorts of information bundles can be sent: typical information and basic information. In the event that a message is viewed as basic, for instance when the detected temperature changes from 25℃ to 100℃ inside a brief timeframe, a banner is set in the message showing that it is basic. A hub that starts a basic message transmits it to two neighbors rather than just a single. The fields contained in the network layer header of information messages are appeared in Table 2.

Filed Size (bits)
Source address 16
Destination address 16
Creator address 16
Critical flag 1
Hop count 8
Energy level 16
Total 73

The maker deliver field is utilized to advise the sink of which hub in the network started the information message, since the source address is changed at each bounce of the routing way. It is accepted that the sink knows where each hub is in the network. On the off chance that the sink does not know which hub began the information and where the hub is found, the information is pointless.

A hub constructs its routing choice with respect to two measurements, to be specific bounce tally and remaining energy. A hub looks its neighbor table for every one of its neighbors with littler jump tallies than itself. In the event that there is just a single such neighbor, that neighbor is chosen as the goal for the message. In the event that there is more than one neighbor with a littler bounce number, the hub chooses the neighbor who has the most noteworthy remain-ing energy passage in the neighbor table. On the off chance that a hub does not have a neighbor with a littler jump check, it looks for a neighbor with a bounce tally that is the same as its own. On the off chance that there is just a single such neighbor, that neighbor is chosen. In the event that more than one neighbor has a similar jump number, the neighbor with the most astounding residual energy is chosen. In the event that a hub does not have any neighbors with bounce tallies littler or equivalent to its own jump tally, the message is disposed of.

Prior to the message is sent, the rest of the energy passage for the chose neighbor is diminished in the neighbor table. On the off chance that the message is a basic message, the way toward choosing a neighbor is rehashed and the message is sent to a moment neighbor. Utilizing jump consider the routing metric guarantees that the message is constantly sent toward the sink.

STEP 3: Forwarding information

At the point when hubs get an information message they refresh the rest of the energy esteem in the neighbor table for the neighbor that sent the message. Hubs that forward information messages take after a similar procedure, aside from minor contrasts, that the starting hub uses to choose the following neighbor in the routing way. The most essential distinction is that sending hubs take the maker address and source address into thought while choosing the following jump neighbor. While looking the neighbor table for hubs with jump checks littler or equivalent to its own, sending hubs additionally ensure that they don't choose either the maker of the message, or the hub from whom the message was gotten as the following goal. This guarantees there are no routing circles in the network.

STEP 4: Energy refreshes

Hubs might be utilized by more than one neighbor for routing and in this way the energy esteem put away in the neighbor tables of both of the hub's neighbors won't be totally precise. At the point when a hub's residual energy falls underneath a specific limit, it transmits an energy message to the greater part of its neighbors to illuminate them of its energy level. The fields contained in the header of an energy message are appeared in Table 3. Energy messages don't contain any information.

Filed Size (bits)
Source address 16
Destination address 16
Hop count 8
Energy level 16
Total 56

STEP 5: Network Stability

The sink hub intermittently sends a communicate message through the network with the goal that hubs can include new neighbors that joined the network to neighbor tables and expel neighbors that have fizzled from the neighbor tables.

Hubs additionally refresh remaining energy values put away in the neighbor tables. Note that communicate messages don't contain any information.

IV. APPLYING NATURAL LANGUAGE PROCESSING TECHNIQUES TO NONCODING RNA IDENTIFICATION

4.1. Introduction to Learning Automata

Learning automata is a theoretical model that haphazardly chooses one activity out of its limited arrangement of activities and performs it on an arbitrary domain. Condition then assesses the chose activity and reactions to the automata with a support flag. In light of chose activity, and got flag, the automata refreshes its inner state and chooses its next activity. Figure 1 delineates the connection between an automata and its condition.

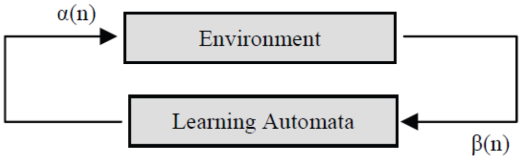

Figure 1. Relationship between learning automata and its environment

Condition can be characterized by the triple E = {α, β, c} where $\alpha = \{\alpha_1, \alpha_2, ..., \alpha_r\}$ speaks to a limited info set, $\beta = \{\beta_1, \beta_2, ..., \beta_r\}$ speaks to the yield set, and c = {$c_1, c_2, ..., c_r$} is an arrangement of punishment probabilities, where every component c_i of c compares to one information activity α_i Situations, in which β, can take just paired qualities 0 or 1 are alluded to as P-models. A further speculation of nature permits limited yield sets with more than two components that take values in the interim. Such a domain is alluded to as Q-model. At last, when the yield of the earth is a nonstop arbitrary variable that accept values in the interim, it is alluded to as an S-display. Learning automata are grouped into settled structure stochastic and variable structure stochastic. In the accompanying, we consider just factor structure automata.

A variable-structure robot is characterized by the quadruple $\{\alpha, \beta, p, T\}$ in which $\alpha = \{\alpha_1, \alpha_2, \dots, \alpha_r\}$ speaks to the activity set of the automata, $\beta = \{\beta_1, \beta_2, \dots, \beta_r\}$ speaks to the information set, $p = \{p_1, p_2, \dots, p_r\}$ speaks to the activity likelihood set, lastly $p(n+1) = T$ speaks to the learning calculation. This robot works as takes after. In light of the activity likelihood set p, machine haphazardly chooses an activity α_i, and performs it on the earth. In the wake of accepting the earth's fortification flag, robot refreshes its activity likelihood set in light of Rel. (1) for ideal reactions, and Rel. (2) for horrible ones.

$$
\begin{aligned}
&p_i(n+1) = p_i(n) + a[1 - p_i(n)] \\
&p_j(n+1) = (1-a)p_j(n) \qquad \forall j, \ \ j \neq i
\end{aligned}
$$

$$
\begin{aligned}
&p_i(n+1) = (1-b)p_i(n) \\
&p_j(n+1) = \frac{b}{r-1} + (1-b)p_j(n) \qquad \forall j \quad j \neq i
\end{aligned}
$$

In these two conditions, a and b are reward and punishment parameters separately. For a = b, learning calculation is called L_{R-P}, for a << b, it is called $L_{R\varepsilon P}$, and for $b = 0$, it is called L_{R-I}.

V. PEAR ROUTING PROTOCOL

PEAR is an amplified rendition of customary SEER routing protocol with some noticeable contrast uniquely in sending information strategy. The distinctive strides required in the routing of parcels in a PEAR network are examined next.

STEP 1: Network setup and neighbor revelation

The sink introduces the network by flooding the network with a communicate message. Every hub that gets the start bundle includes a passage that comprises of neighbor id, energy level and jump tally. At that point it figures and inserts the choice likelihood of neighbor hubs into the Neighbor List in light of Rel. (3).

The hub then additions the bounce include put away the message and after that retransmits communicate, however changes the source deliver field to its address and the energy level field to its residual energy level. Each hub in the network retransmits the communicate message just once, to the majority of its neighbors.

At the point when this underlying communicate has been overwhelmed through the network, every hub knows their bounce tally, energy level and likelihood of each of its neighbors.

$$
\Pr ob_s = 1/2 \times \left(\frac{1/HopCount_s}{\sum_{i=1}^{m} 1/HopCount_i} + \frac{EnergyLevel_s}{\sum_{i=1}^{m} EnergyLevel_i} \right) \qquad \forall s \leq m
$$

STEP 2: Forwarding information

At the point when a hub watches new information it starts the way toward routing. In customary SEER, the neighbor with a bounce number that is littler than the sending hub's jump consider is chosen the following jump. In the event that various neighbors have littler bounce tallies, the neighbor with the most elevated residual energy is chosen as the following jump. On the off chance that a hub does not have a neighbor with a littler jump tally, it chooses the neighbor with the most noteworthy residual energy from neighbors with an equivalent bounce check to it. In the event that the hub does not have a neighbor with an equivalent bounce check to it, the message is disposed of.

In any case, choosing next bounce in our proposed protocol, PEAR, depends on learning automata. A hub looks into its neighbor table for the neighbors with most elevated likelihood. The energy level of information sender hub is connected to original information bundle, piggybacking. At that point the information bundle is sent to neighbor with most elevated likelihood.

STEP 3: Updating energy and probabilities

All neighbors of information sender hub get the sent information bundle, by catching method. They just refresh the rest of the energy esteem in the neighbor table for the neighbor that sent the information bundle, by piggybacking system, Figure 2(a). Likewise, the past information sender hub gets its information bundle again and refreshes all probabilities in neighbor List, Figure 2(b).

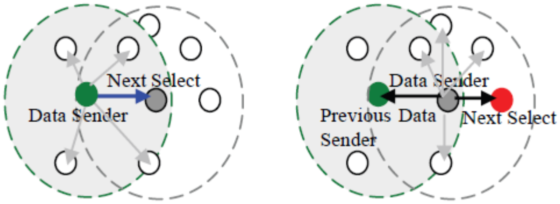

Figure 2. Updating (a) energy level (b) energy level and probabilities.

In Figure 2(a), green hub chooses dim hub as its most astounding likelihood neighbor and advances the information parcel to it. The dark hub gets information parcel and updates energy level of green hub in its Neighbor List. Another neighbor just updates energy level of green hub in their Neighbor List and after that disposes of the information bundle. In Figure 2(b), the dark hub is information sender that chooses the red hub as most elevated likelihood neighbor. Subsequently, dim no-de sends information to red. The red hub gets the information dadcket from dim and refresh energy level of dark hub. Green hub gets the information parcel again by catching and updates energy level of dim hub and after that updates likelihood of its neighbors.

There are 4 behavioral situations when past information sender hub gets the information parcel by catching.

- If [*($Energy_s$/Avgenergy)* + *(HopCount/AvgHopCount)* < 2] then the route penalizes with β. β is computed based on Rel. (6). (Very bad)
- If [(*$Energy_s$/Avgenergy*) + *(HopCount/AvgHopCount)* = 2] then the route penalizes with β/2. (Bad)
- If [2 < (*$Energy_s$/Avgenergy*) + *(HopCount/AvgHop-Count)* < 2.2] then the route rewards with α/2. α is computed based on Rel. (5). (Acceptable)
- If [(*$Energy_s$/Avgenergy*) + (*HopCount/AvgHopCount)* ≥ 2] then the route rewards with α. α is computed based on Rel. (5). (Good)

That $Energy_s$ is the received energy of data sender no- de, next selected node, and *HopCount* is the distance of data sender node from Station.

Avgenergy is the average energy level of neighbor nodes. *AvgHopCount* is average distance of all neighbor nodes from the Station.

$$Avgenergy = (\sum_{i=1}^{m} EnergyLevel_i) / m$$

In the Rel. (4), *$EnergyLevel_i$* is the energy level of *$neighbor_i$* and *m* is Neighbor List size.

Avghopcount is the average *hopcounts* of neighbor nodes from the Station node.

$$AvgHopCoun = (\sum_{i=1}^{m} HopCoun_i) / m$$

In the Rel. (5), *$HopCount_i$* is the distance of *$neighbor_i$* from Station and *m* is Neighbor List size.

$$\alpha = \lambda + \delta_1 \frac{Energy_i + MaxHop - HopCoun_i}{InitEnergy + MaxHop}$$

$$\beta = \lambda + \delta_2 \frac{Avgenergy - Energy_i + HopCoun_i}{Avgenergy + MaxHop}$$

In Rel. (6) and Rel. (7), α and β are reward and penalty parameters respectively, *$HopCoun_i$* is distance between sender node and Station node, *InitEnergy* is the initial energy of nodes, *Maxhop* is maximum distance between nodes in network and λ is minimum value for reward and penalty parameters.

δ1 and δ2 are selected which cause to dose not exceed of a threshold for α and β parameters.

The operation of the PEAR protocol can be outlined as takes after:

- The sink introduces the network by flooding the net-work with a communicate message.
- Nodes add every one of their neighbors' data to their neighbor tables.
- The hub with most elevated likelihood is chosen and information parcel is sent to it.

- The energy level of information sender hub is refreshed by its neighbors.
- The likelihood of information sender hub is refreshed into the Neighbor List of past information sender hub in each jump.

PEAR routing protocol does not require an energy message, Step.4 in conventional SEER, on the grounds that the energy level of every sender hub is refreshed into its Neighbor Table naturally, catching and piggybacking. Additionally the sink hub sends a communicate message through the network with the goal that hubs can include new neighbors that joined the network to neighbor tables and expel neighbors that have fizzled from the neighbor tables. Be that as it may, sending rate of communicate message through the network is identified with versatility. The network with none versatility hubs measurements no compelling reason to send communicate message and additionally the network with high portability.

VI. SIMULATION MODEL

This segment recreates and looks at our proposed routing protocol, PEAR, with customary SEER routing protocol.

Table 4. Simulation setting

SIMULATION-TIME	1200 SECOND
TERRAIN-DIMENSIONS	1000 m * 1000 m
NUMBER-OF-NODES	200, 300, 500, 1000, 2000
NODE-PLACEMENT	Uniform/Random
MOBILITY	NONE
NUMBER OF EVENTS (Sources)	100
TEMPARATURE	290.0 (in K)
RADIO-BANDWIDTH	2000000 (in bps)
RADIO-TX-POWER	5.0 (in dBm)
ENERGY- TRANSMIT-LEVEL	0.0002 (in mW)
MAC-PROTOCOL	802.11
NETWORK-PROTOCOL	IP
PROPAGA-TION-PATHLOSS	FREE-SPACE
RADIO-TYPE	RADIO-ACCNOISE

To analyze the routing protocols, a parallel discrete occasion driven simulator, NS2, is utilized. NS2 is a reenactment apparatus for vast wireless and wired networks. Table 4 depicts the point by point setup for our simulator.

VII. SIMULATION RESULTS

In this segment we assess and look at the different defeat ing plans. The execution measures of enthusiasm for this study are: an) Average energy utilization of transmission (in mW); b) Energy adjusting. The factors are: number of hubs and hub situation.

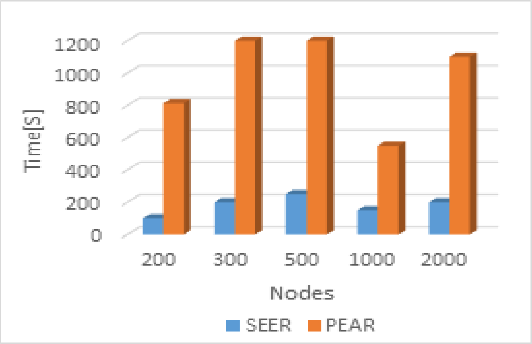

Figure 3. Time at which the first neighbor of Station fails due to depleting its energy source. The nodes are randomly distributed over the sensor area.

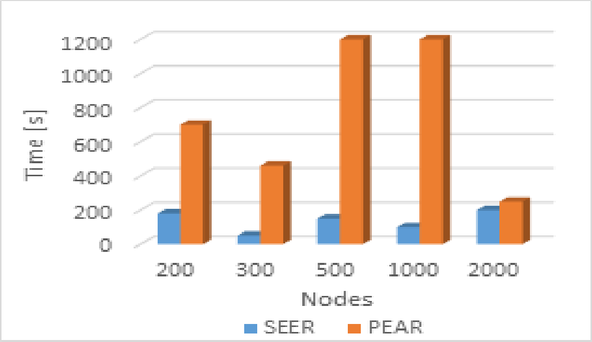

Figure 4. Time at which the first neighbor of Station fails due to depleting its energy source. The nodes are uniformly distributed over the sensor area.

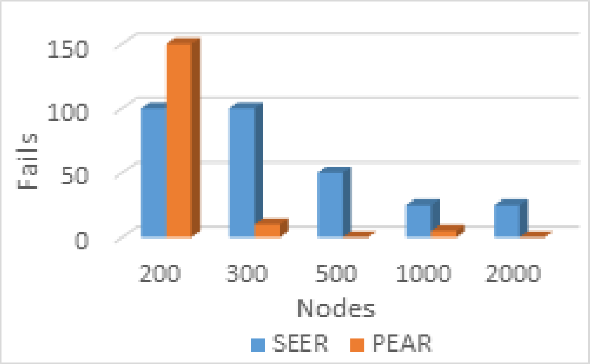

Figure 5. Number of fails at the end of simulation. The nodes are randomly distributed over the sensor area.

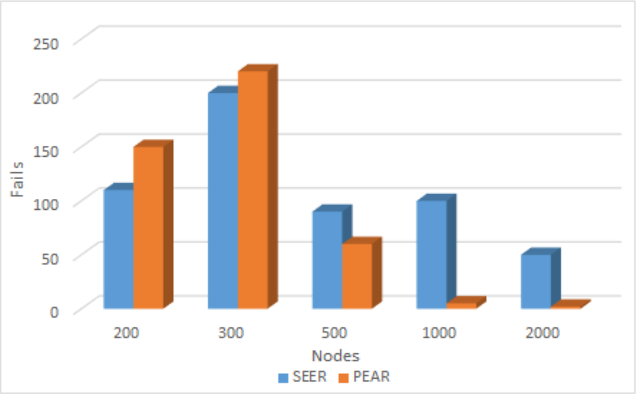

Figure 6. Number of fails at the end of simulation. The nodes are uniformly distributed over the sensor area.

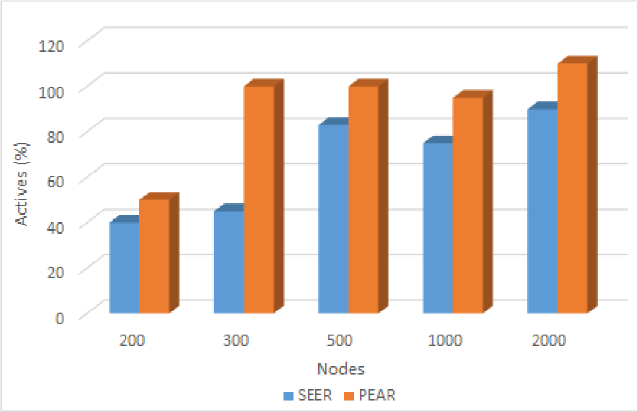

Figure 7. Percentage of active neighbors of Station at the end of simulation. The nodes are randomly distributed over the sensor area.

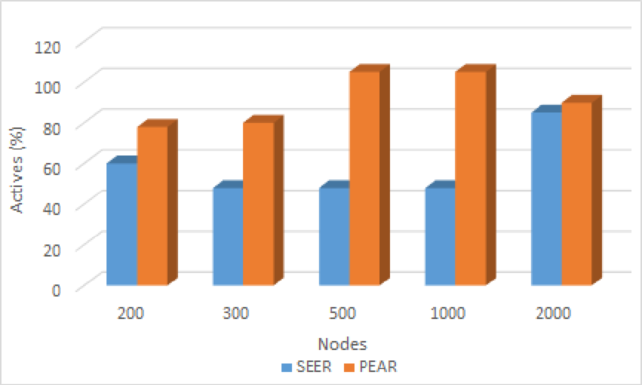

Figure 8. Percentage of active neighbors of Station at the end of simulation. The nodes are uniformly distributed over the sensor area.

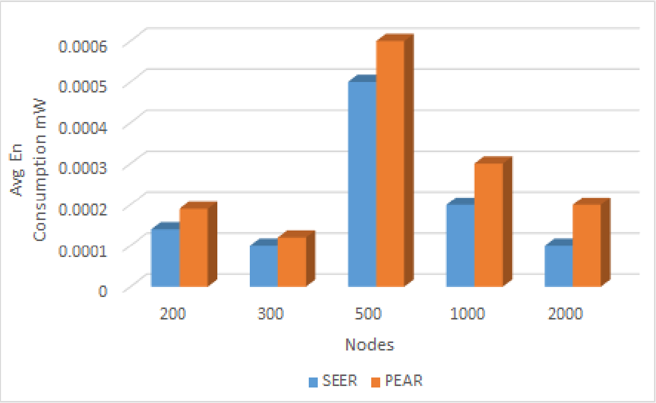

Figure 9. Average energy consumption (mW) in transmission mode. The nodes are randomly distributed over the sensor area.

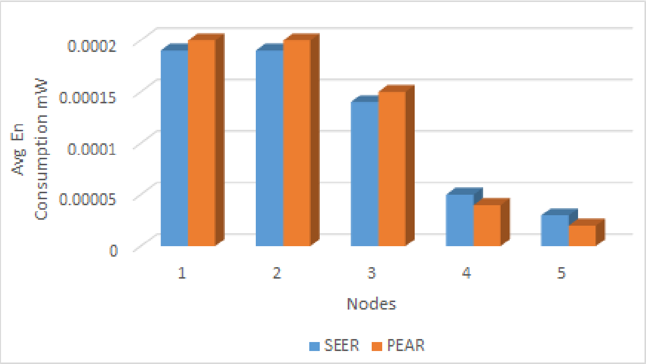

Figure 10. Average energy consumption (mW) in transmission mode. The nodes are uniformly distributed over the sensor area.

The recreation of the protocols begun with a communicate message toward begin of the reproduction. We select 100 Sources to send information parcels to the Station amid the recreation. The Sources are chosen arbitrarily in various circumstances. Each Source creates a 512-piece information parcel and advances it through the network. Reenactments are performed to assess the network lifetime accomplished by every protocol. Toward the start of reenactment, the transmission energy level of every hub was 0.0002 mW. Four tests are accomplished to assess the protocols:

Test 1: The time until the principal neighbor of sink falls flat.

Test 2: Number of comes up short.

Test 3: Percentage of dynamic neighbors of Station toward the finish of reproduction.

Test 4: The normal residual energy of the considerable number of hubs in the network, at transmission mode.

For the most part, the outcomes from Test 1, Test 2, Test 3 and Figures 3-8 demonstrate that PEAR is superior to the SEER protocol in energy overseeing. This is because of the way that PEAR sends information bundle along an adjusted way. Additionally toward the finish of reenactment PEAR has low comes up short. In this way, execution of our protocol is great particularly in high-thickness networks. Then again, the consequences of Test 4, Figures 9 and 10 demonstrate that there are not noticeable distinction in energy utilization amongst SEER and PEAR.

Along these lines, we could enhance SEER routing protocol in energy adjusting without noticeable addition in energy utilization. It implies our PEAR routing protocol can expand network lifetime contrast and customary SEER.

VIII. CONCLUSIONS

In this paper we considered energy aware routing protocols. At that point we proposed another energy saver/balancer routing protocol. The bease of our review was SEER routing protocol. We mimicked and contrasted our routing protocol and conventional SEER. Comes about demonstrated that our protocol for the most part was superior to SEER in energy. Our PEAR protocol had low comes up short. It was more balancer than SEER routing protocol particularly in high-thickness networks. When all is said in done we found that PEAR gives better execution, contrasted with SEER.

REFERENCES

[1] Backhyun Kim, and Iksoo Kim, *"Energy Aware Routing Protocol in Wireless Sensor Networks"*, in IJCSNSVOL.6 No.1, January 2006.

[2] Peter K.K. Loh and Yi Pan, *"An Energy-Aware Clustering Approach for Wireless Sensor Networks"*, I.J. Communications, Network and System Sciences, 2009, 2, 91-168.

[3] V. Prasad, VS. Sunsan, "*Multi path dynamic routing for data integrity and delay Minimization differentiated services in wireless sensor network*", International Journal of Scientific Research in Computer Science and Engineering, Vol.4, Issue.4, pp.20-23, 2016.

[4] Adel Gaafar A.Elrahim, Hussein A.Elsayed, Salwa El Ramly, Magdy M. Ibrahim, *"An Energy Aware WSN Geographic Routing Protocol"*, Universal Journal of Computer Science and Engineering Technology, 1 (2), 105-111, Nov. 2010.

[5] U. Korupolu, S. Kartik, GK. Chakravarthi, "*An Efficient Approach for Secure Data Aggregation Method in Wireless Sensor Networks with the impact of Collusion Attacks*", International Journal of Scientific Research in Computer Science and Engineering, Vol.4, Issue.3, pp.26-29, 2016.

[6] KazemSohraby, Danielminoli and TaiebZnati, *"Wireless Sensor Networks: Technology, Protocols, and Applications",* published by John Wiley & Sons, Inc., Hoboken ew Jersey, 2007.

[7] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "*Wireless Sensor Networks: A Survey*" Computer Networks, Vol. 38, No.4, pp.393-422, 2002.

[8] Wu, Zhengyu; Song, Hantao; Jiang, Shaofeng; Xu, Xiaomei, *"Energy-Aware Grid Multipath Routing Protocol in Mobile Ad Hoc network (MANET)"*, IEEE Asia International Conference on modeling & simulation (AMS), pp. 36-41, 2007.

[9] Shanti.C and Sahoo.A. *"DGRAM: A Delay Guaranteed Routing and MAC Protocol for Wireless Sensor Networks",* IEEE Transactions on Mobile Computing, Vol.9, No.10, pp.1407-1423, 2010.

[10] Zhengyu Wu, Xiangjun Dong and Lin Cui, *"A Grid-based Energy Aware Node-Disjoint Multipath Routing Algorithm for Mobile Ad Hoc networks (MANETs)"*, IEEE International Conference on Computing, Networking and Communications (ICNC), pp. 244-248, 2007.

[11] R. Nathiya, S.G. Santhi, "*Energy Efficient Routing with Mobile Collector in Wireless Sensor Networks (WSNs)*", International Journal of Computer Sciences and Engineering, Vol.2, Issue.2, pp.36-43, 2014.

[12] R.V. Pawar, S.S. Mahajan, "*Performance Analysis of Wireless Sensor Network Using Cognitive Radio Concept*", International Journal of Computer Sciences and Engineering, Vol.2, Issue.4, pp.136-137, 2014.

[13] Gurbinder Singh Brar, Shalli Rani, Vinay Chopra, Rahul Malhotra, Houbing Song and Syed Hassan Ahmed, *"Energy Efficient Direction-Based PDORP Routing Protocol for WSN"*, Published in: IEEE Access, Volume: 4, Page(s): 3182 – 3194.

[14] Sathish Kumar S and Dr. A. Grace Selvarani, "*Improving Energy Efficiency by Using Tree-Based Routing Protocol for Wireless Sensor Network*", International Journal of Computer Sciences and Engineering, Vol.3, Issue.3, pp.201-206, 2015.

[15] Shusen Yang, Xinyu Yang, Julie A. McCann, Tong Zhang, Guozheng Liu and Zheng Liu, *"Distributed Networking in Autonomic Solar Powered Wireless Sensor Networks"*, Published in: IEEE Journal on Selected Areas in Communications, Volume: 31, Issue: 12, December 2013.

[16] Degan Zhang, Guang Li, Ke Zheng, Xuechao Ming and Zhao-Hua Pan, *"An Energy-Balanced Routing Method Based on Forward-Aware Factor for Wireless Sensor Networks"*, Published in: IEEE Transactions on Industrial Informatics, Volume: 10, Issue: 1, Feb. 2014.

[17] Subramanian Ganesh and Ramachandran Amutha, *"Efficient and secure routing protocol for wireless sensor networks through SNR based dynamic clustering mechanisms"*, Published in: Journal of Communications and Networks, Volume: 15, Issue: 4, Aug. 2013.

[18] Aditya Singh Mandloi and Vinita Choudhary, "*An Efficient Clustering Technique for Deterministically Deployed Wireless Sensor Networks*", International Journal of Scientific Research in Network Security and Communication, Vol.1, Issue.1, pp.6-10, 2013.

[19] Lili Zhang and Yan Zhang, *"Energy-Efficient Cross-Layer Protocol of Channel-Aware Geographic-Informed Forwarding in Wireless Sensor Networks"*, Published in: IEEE Transactions on Vehicular Technology, Volume: 58, Issue: 6, July 2009.