Minimal Energy Consumption in MANET Using Cluster Head Selection and PLGP-M

W.R.Salem Jeyaseelan, Assistant Professor, J.J.College of Engg. & Tech., Trichy, India
Shanmugasundaram Hariharan, Associate Professor, TRP Engg. College (SRM Group), Trichy, India

Abstract: *Lack of infrastructure, Route discovery management and Energy consumption monitoring in MANET poses very big challenges for researchers working in this field. The existing protocols like Link State Routing, Destination Sequence Distance Vector, Low Energy Adaptive Cluster Hierarchy and Parno Luk Gaustad Perrig (PLGP) are not well suited for decentralized schemes because of the energy constraints in nodes which need to be taken into consideration while designing routing protocols. This paper presents the design and implementation using NS-2 simulator for optimal route discovery management by using Cluster Head Selection (CHS) and constructing less energy consuming route by PLGP-MANET (PLGP-M) algorithms. Our proposed system gives effective route discovery management which saves the energy. It is also inferred that CHS algorithm in ad-hoc networks maximizes the lifetime of the nodes in order to minimize maintenance, while PLGP-M reduces energy by finding optimal routing path and maximizes the overall performance.*

Keywords: *Ad-hoc Networks, Energy-consumption, MANET, NS-2, PLGP, Routing.*

---

1. Introduction

Mobile Ad-hoc Networks (MANET) can be defined as a system of autonomous mobile nodes that communicate over wireless links without any preinstalled infrastructure. MANET consists of a collection of wireless mobile nodes which dynamically exchange data among themselves without a fixed base station or a wired backbone network. They have dynamic topology due to the mobility of the nodes in the network [1]. The nodes that were present in the MANET generally move through with the specific patterns (e.g. see Table 1). Most of the existing work requires the data to be sent back to centralized storage nodes continuously and only consider stable network topology but within the coverage area. The central goal of this work is to ensure node-to-node message delivery, to consume the network resources. Some issues and faults [16] while deploying the MANET is shown below:

- ***Unpredictability of environment:*** Ad hoc networks may be deployed in unknown terrains, hazardous conditions, and even hostile environments where tampering or the actual destruction of a node may be imminent. Depending on the environment, node failures may occur frequently [2].
- ***Unreliability of wireless medium:*** Communication through the wireless medium is unreliable and subject to errors. Also, due to varying environmental conditions such as high levels of electro-magnetic interference (EMI) or inclement weather, the quality of the wireless link may be unpredictable [10].
- ***Resource-constrained nodes:*** Nodes in a MANET are typically battery powered as well as limited in storage and processing capabilities [6].

Moreover, they may be situated in areas where it is not possible to re-charge and thus have limited lifetimes [4]. Because of these limitations, they must have algorithm

which are energy-efficient as well as operating with limited processing and memory resources [5]. The available bandwidth of the wireless medium may also be limited because nodes may not be able to sacrifice the energy consumed by operating at full link speed [14].

- ***Dynamic topology:*** The topology in an ad hoc network may change constantly due to the mobility of nodes [3]. As nodes move in and out of range of each other, some links break while new links between nodes are created [15].
- ***Transmission Errors:*** Transmitted packets are garbled and received in error state when there is unreliability and unpredictability.
- ***Node Failures:*** Due to the hazardous condition [8], node may fail at any time so when the energy gets depleted, entire nodes become failed to provide the services.
- ***Link Failure:*** This is due to the lines to break which are providing the link for communication. *Route Breakages:* Due to topology changes, the predicted routes get altered [19].

- ***Congested Nodes or Links:*** Due to the fault implementation in the routing protocol, Congestion takes place. Congestion leads to the delays and the packet loss.

The main objective of our work is to investigate the power consumption and finding out the optimal way to save the energy in MANET. The largest energy drain of the network is mainly due to route discovery during the transmission phase [11]. The MANET consumes most of the energy for route discovery and route management because of their infrastructure less network. In distance vector routing [7], each router broadcasts to all of its neighboring routers its view of the distance to all other nodes; the neighboring routers then compute the shortest path to each node. In link-state routing [27], each router broadcasts to its neighboring nodes its view of the status of each of its adjacent links; the neighboring routers then compute the shortest distance to each node based upon the complete topology of the network. Clearly, routing in MANET must take into consideration their important characteristics such as node mobility [30]. The energy consumption is minimized during the data communication with the help of CHS and PLGP-M algorithms. In initial setup phase, CHS algorithm examines whether every node has been maintained the availability with its neighbor. According to this the node which has constitutes with maximum number of neighbor is chosen as Cluster Head and thus the transaction is performed by Head. Then PLGP-M algorithm is used to monitor the hop counts between the source and destination by allowing the limited number of hop counts. It eliminates the battery power draining from unnecessary route management.

This paper organized as follows. While section 1 presented basics on MANET issues and routing protocols, section 2 provides some related research carried out in this area. Section 3 explains the implementation of CHS & PLGP-M algorithms. Section 4 provides the results and discussion. Finally, we conclude our work and provide future enhancement in section 5.

2. Related Works:

Many research works have been done on the MANET route discovery, route maintenance and power consumption aspects [23]. They were focused the route establishment along with the data transmission rate in wireless environment and the energy level of the node is maintained according to the size of the information is being transmitted [17].Traffic on mobile node is affected by the CoolSpots because it reduces the battery energy of the nodes. Pering et.al. [18] implemented a switching policy that will determine whether to use Bluetooth or WiFi for network traffic since that paper claims that "wireless communication subsystems account for a major component of the total power consumption. The paper also makes a pretty bold claim saying that more than a 50% reduction in energy consumption by the wireless subsystem is possible, which can effectively double the system battery lifetime. But, the latest applications such as Google Place, ShowNearby, and TripAdvisor are not suitable for this approach.

Maximizing α-Lifetime of Wireless Sensor Networks with Solar Energy Sources [12, 22] proposes some techniques to plan an arbitrary WSN. The authors' suggested hierarchical network architecture, similar to realistic scenarios, where nodes with renewable energy with less communication demands. The key design issue of this network architecture is the development of a new optimization framework to calculate the optimal assignment of renewable energy supplies to maximize network lifetime, obtaining the minimum number of energy supplies and their node assignment [25]. Then they conducted an optimization step to additionally minimize the number of packet hops between the source and the sink. The goal of the optimization framework and the assignment algorithm is to deploy primary nodes, so that lifetime is maximized. The optimization framework consists of two problems [26]. The first one defines a set of constraints to maximize lifetime, whereas the second one is designed to optimize *flow assignments*, minimizing the average number of packet hops, once the maximum lifetime is known [28]. The lifetime maximization is addressed by allocating different capacity batteries to network nodes (which also implies a different role for the nodes in the network). In this, the authors formulate the problem and demonstrate the improvement of the WSN lifetime [13]. To this end, the work proposes an algorithm that efficiently solves the allocation of the most powerful chemical batteries as a function of the nodes' energy requirements. To maximize the lifetime, characterizing the energy consumption through a Measurement Square Error (MSE) algorithm [31] was introduced. The authors' obtained results are relevant when the sum of all power batteries is used as a goal of the optimization. The lifetime is maximized when a sink node is placed at the center of the nodes deployment, achieving significant results as regards the balancing of node operation.

Iranli, et. al., [9] developed a two-level WSN, where the lower level nodes transmit data to micro-servers at the top level, providing connectivity between the sensors and a central base station. This work provides a framework that optimizes the positions and the initial energy assigned to the micro-servers [21]. The authors study lifetime in WSNs with Gaussian-distributed nodes in a two-dimensional space. The main contribution is the identification of the key parameters for lifetime maximization and the proposal of two location algorithms for the nodes. However, the results achieved only apply to Gaussian distributions [29] of the network nodes location and cannot be easily extended to other deployment distributions. The utilization of virtual backbones in which a few nodes are in charge of collecting data from the remaining network nodes and transmitting them to the sinks. In both approaches, chemical batteries power all the nodes, restricting the network lifetime in case of a single backbone. The Exploiting Sink Mobility for Maximizing Sensor Networks Lifetime is to maximize lifetime by solving a linear model, so as to choose which particular nodes the mobile sink must visit. As can be expected, a mobile sink increases network lifetime [24]. However, the authors do not consider the energy required for sink mobility and other crucial issues, such as the technological feasibility of the solution [20]. On the other hand, the work discusses several WSN cross-layer algorithms intended for lifetime maximization by using appropriate flow assignment techniques. These algorithms offer better lifetime than traditional solutions as the IEEE 802.15.4 standard. However, one of the major drawbacks is the centralized behavior of all of them, which, in practice, makes them unfeasible for large-scale networks.

Our proposed algorithms used to maximize the lifetime of the intermediate nodes by using the CHS algorithm and the minimal-hop distance to cover the maximum number of nodes by using PLGP-M algorithm, we presented in section 4.

3. Proposed CHS & PLGP-M Algorithms:

The Survey on Energy Consumption Entities on the Smartphone Platform, the power consumption of mobile devices and their parts along with the energy saving methods were analyzed. Here, that model is implemented in the mobile nodes of the ad-hoc devices. That is, whenever there is a need of power, the mobile nodes use it; otherwise the power is in OFF mode.

3.1 Cluster Head Selection Algorithm

The proposed CHS algorithm has given the optimal solution for problems which has been discussed in the section 3 by forwarding the packets via cluster head. This provides very fast route recovery and route maintenance process in MANET environment. Figure 1 has shown the scenario for the CHS selection process.

3.1.1 Route Selection Criterion

The route with minimum hop is selected as the best route among all the route candidates. The node which has the maximum number of neighboring nodes is selected as the cluster head, and the routing via that cluster header node. The destination node is not within the cluster, then the cluster head borrows the routing table from the other nodes which having the respected destination. It tabulated in table 2. If there are hops, which exceeds the maximum number of hops, the node discards that path and sends the message in another way.

3.1.2 Overall Procedure

The criterion is first selected and BER (Bit Error Rate) is measured for every wireless links periodically. If the BER of a wireless link is below the threshold value, it is not used (i.e.) the data or the control messages are not transmitted via that wireless link. Routes are established pro-actively. Base station broadcasts an RREF message. When the relay station, receives the RREF message, it then decides whether to re-broadcast the message. If the really system, receives the same RREF at the next time, it does not accept it. This process is repeated for every transmission. Then the user sends the RREQ message to every node. The nodes receiving the packet, forward it to base station by referring the table which are constructed earlier in the proactive phase. The base station selects at most only maximum routes by considering minimum number of limited hops given. Then base station returns the RREP message to user via selected best route.

3.1.3 Parameters for Route Establishment

The parameters used for route establishment is given in Table 1. According to pattern considered, the route establishment will be carried out.

3.1.4 Selecting the cluster header node

Clustering divides the network into different virtual groups based n some rules. The main goal of this clustering is to achieve scalability in presence of large network and high mobility. There are various clustering algorithm in MANETs. These clustering algorithms provide the service of resource utilization. But these are only concentrating on the energy utilization during the forwarding phase. But to provide a better energy saving methodology, there is a need to concentrate on the route establishment phase itself. Thus the energy is properly consumed at the whole network at the communication. Initially, send the hello messages to every node in the network. Each node calculates its neighbor and updates its neighboring information in their routing table. From Table 2, select the node which covers maximum number of neighboring nodes. Thus the node which is having the maximal number of neighboring nodes acts as the cluster header. This cluster header is informing it to the other entire neighboring node as it was the header node (table3). Then the cluster head collect the tables from neighboring node. In case of, there is not a destination node in the header's neighboring node; the other nodes are able to send the packets.

3.1.5 Neighbor Table

This is an effective algorithm for clustering and selecting the cluster head in MANETs. There are many clustering schemes like IP based clustering, connectivity based clustering, probability based clustering and weighted based clustering. But this paper presents the Head Selection clustering.

Table 1. Routing parameters considered for our experiment

Number of available routes	7
Maximum Number of Hops	6
Distance Range	100* 200 sq.m
Path Loss	SNR= 20 dB at 100m
Fading	Rayleigh
Modulation Scheme	BPSK
Packet Length	512 bytes

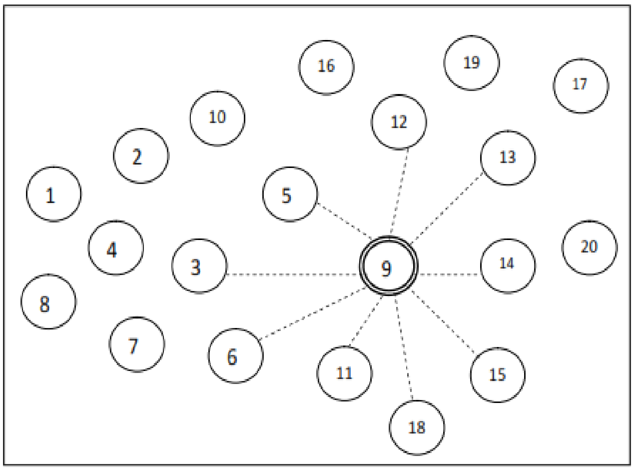

Figure 1. Cluster Head Selection Process

3.1.6 Cluster Formation and data sending in CH selection Algorithm

Step 1. Send H to its neighbor
Step 2. Store the IDs of replied neighbors and make table
Step 3. Send the table for head selection
Step 4. if (table= =head)
Step 5. collect all other tables
Step 6. Check, if the network formed into clusters
Step 7. if no: cluster formation using constructed table
Step 8. if yes : Cluster Header Node Selection by the CH
algorithm
Step 9. Send Join-Request from CH to all other nodes
Step 10. Combine the other nodes table to CH
Step 11. CH creates the schedule and sends it to the nodes
Step 12. Send Data from nodes to CH

According to the CHS algorithm node 9 has been selected as Cluster Head among the all 20 nodes available in the coverage area. Correspondingly the neighbor nodes are updated as shown in table 3.

Table 2. Cluster Head Neighbors after head selection

Cluster Head Neighbors	Neighboring nodes
Node 3	2,4,5,6,7,9,10
Node 5	3,9,10,12
Node 6	3,5,7,9,11,18
Node 11	6,9,18
Node 12	5,9,13,16,19
Node 13	9,12,14,19,20
Node 14	9,13,15,20
Node 15	9,11,14,18
Node18	9,11,15

Table 3. Updated Cluster Head neighbors of node 9

Cluster Head	Neighbors
9	3,5,6,11,12,13,14,15,18

3.2 PLGP-M Algorithm

This algorithm mainly used for avoiding the power draining for selecting the optimal path after path failure as early discussed in the route maintenance. PLGP-M supports minimum hop-count routing by defining a "HOP" metric, shown in the Table 1. Each of these metrics represents a different notion of what constitutes good link quality.

3.2.1 Finding Minimal hop Node by PLGP-M version Algorithm:

Pseudo code for finding small hops
do { x= randomly select a node
/ where x! = src, x! =dest & x does not equal to a previous rejected nodes */*
total no of hops= shortest _path from src to x + shortest path from dest to x;
} while (total no of hops < max);

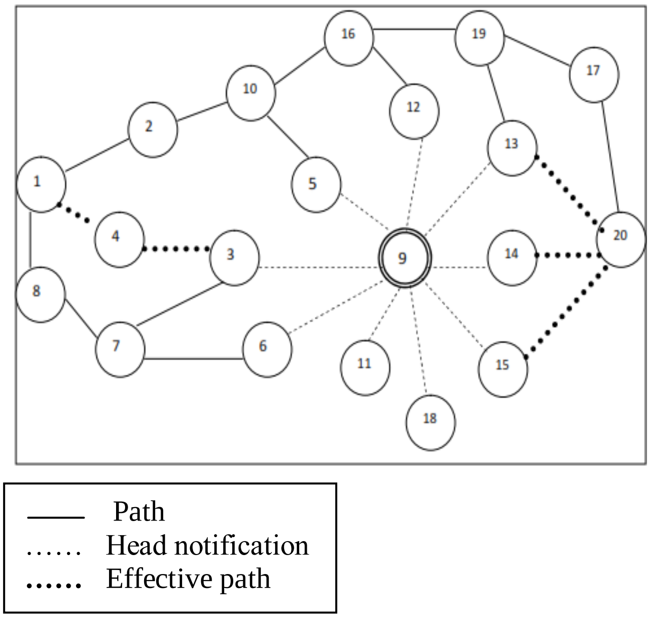

Figure 2. Data Transmission via minimal hops

In our method, each node only satisfies the limited number of hop count as specified earlier. Construct the table for hop count up to the limited range. The routing takes place only up to this range of hops. Each node is signed by the originator. Every node is authenticated by the server. If it exceeds, it will inform it to the server. The goal of the algorithm is to produce a route for source to reach its destination while keeping a length within pre-defined minimum number of hops. This is the way to find the shortest path with minimum energy consumption. An ad-hoc network is a group of wireless mobile nodes, in which all the nodes cooperate by sending the packets to each other. These networks do not require any fixed infrastructure and initial setup.

Ad-hoc network routing schemes, are challenging to design and secure ones are even so on. Wired network routing techniques are not suited for ad-hoc mobile networks because of rapid node mobility and topology changes nature in ad-hoc networks. In our scheme, routing tables are dynamically established for each node using the techniques to consume the resources. The memory overhead for routing technique is small; each node stores one routing entry, representing the next hop as neighbor node to move towards the final node. These routing techniques provide the better performance and network survivability. These schemes are typically used to find the minimum energy path to optimize the energy aware routing in MANETs. The number of hops between the source and the destination nodes is the major feature in analyzing the multi-hop ad-hoc network. This paper presents a study for the expected number of hops between any numbers of hops between any random source destination pair in multi-hop adhoc networks where nodes move according to the mobility model.

The network parameters such as network density, size of the network and node transmission range are taken into consideration. In PLGP, the limited number of hops only allowed to take part in the transmission. By that criterion, this PLGP-M assumed that the nodes are only passing through within the 7 hops to reach its destination.

4 Results and Discussion:

The result has shown the analysis of route establishment and packet delivery at range 20 node experiments. These tables shows the detailed statistics with 20 nodes, which is the constructed routing table from different source to different destination by considering 6 hops and maximum number of neighboring nodes, considering packet size as 512 bytes. We simulated a work with 20 nodes within the range (i.e) coverage area 1500 * 2000 sq.m. The clustering algorithm provides the energy efficient and increases the network lifetime. Every effort has been made to provide complete survey on this energy efficient clustering algorithm. The figure 6 shown that, all the available paths from source 1 to destination 20 are connected with dotted and straight lines. According to our Cluster Head Selection Algorithm, the shortest path is founded that which follows the cluster head as an intermediate. That has been also a minimal hop count path from all other available paths. Such that our cluster Head Selection with PLGP-M provides shortest and minimal path. Table 6 has shown the individual hop counts for all nodes. The hop count for the experimental scenario has only 6 hop values.

The graphs shown the comparison of the PLGP and PLGP-M with CHS, the overall performances are 85% and 93% respectively. Due to the Cluster Head Selection algorithm along with PLGP-M has the better performance than the other two. It is also evidentially proved in table 4, in which the energy level is improved by PLGP-M algorithm. It is inferred that the result of PLGP-M gives the better performance and improves the energy level by decreasing the end to end delay of nodes which has been shown in figure 4. The delay experienced by a packet from the time it was sent by a source till the time it was received at the destination. Figure shows the End-End Delay for the CHS&PLGP-M and PLGP protocols as a function of the number of nodes the performance of PLGP-M is better than PLGP for varying number of nodes especially 5,10,15,20. Throughput of the PLGP-M with CHS has a effective and improvement than the PLGP in terms of useful packets that received at all the destination nodes in the level of 5,10,15,20 nodes. The unit of throughput is KB/s. The throughput delay values obtained for the simulation parameters of table-II. The graph shown in Figure 5 indicates the throughput delay comparison of PLGP-M and PLGP.

Table 4. No. of Hello Packets Transmitted from source to destination

No. of Hello Packets Transmitted	Energy Level in CHS & PLGP-M (in KJ)	Energy Level in PLGP (in KJ)
1000	9.3	9.3
2000	8.7	8
3000	7.8	6.8
4000	6.8	5.5
5000	6.2	5
6000	5.8	4.2
7000	5.6	3.8
8000	5.5	3.3
9000	5.4	2.6
10000	5.3	1.9
11000	5.2	0.8

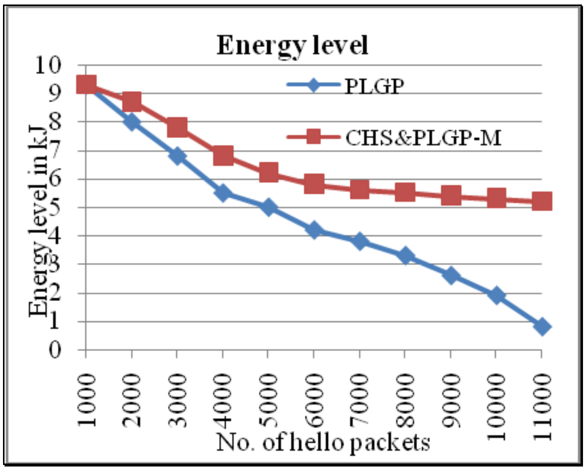

Figure 3. Energy level variations in node discovery phase

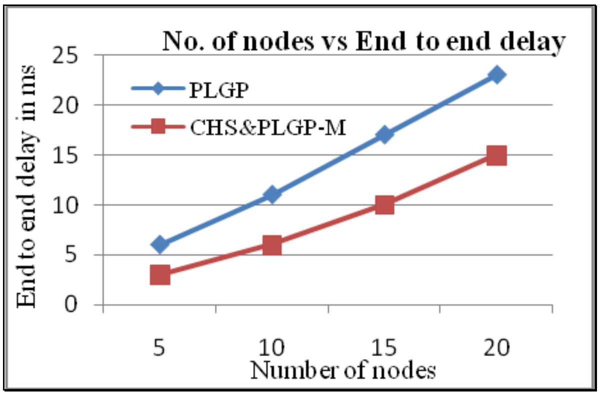

Figure 4. End to end time delay in different node scenario

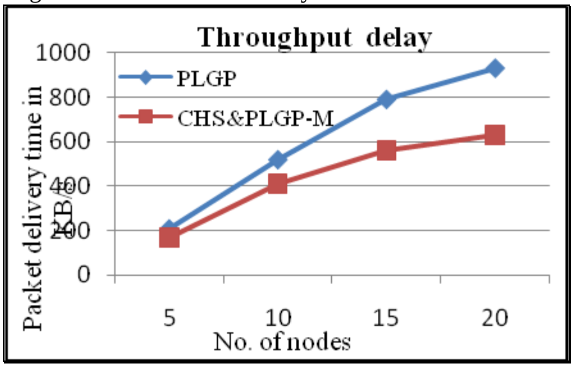

Figure 5. Calibration of throughput delay

4 Conclusions and Future enhancement

This paper has presented an optimization framework to simultaneously maximize lifetime and minimize the average number of packet hops for Mobile Ad-hoc networks. The study has an impact on the topology construction, route establishment methodology to save the energy. The goal of our CH selection and PLGP-M algorithms are to deploy primary nodes, so that lifetime is maximized. These methods consume energy with topology route establishment phase but minimize the energy usage during the transmission. These algorithms improve the number of throughput and decrease the energy consumption by 10% with PLGP. These methodologies also provide reliability and prevent the early failure of the node with consuming less energy. The algorithm of nodes selection based on energy consumption is essential in improving the lifetime of network nodes by considering the individual energy. This algorithm can prevent the early failure of a node and reflected to reliability of route path. By results, the proposed schemes provide the best optimal route establishment by considering the energy. It is found to bring significant changes as compared to the default model along with no collisions or interferences. The overall system performance has increased from 85 % to 93%.

In future, this CHS&PLGP-M can be extended in ATCP thin layer in between the TCP and network layers to provide more reliable packet scheduling scheme for shared medium access.

References

[1] Abdelaziz Araar, Hakim Khali and Riyadh Mahdi,“A Simulation Study of a Reliable Dynamic Multicast Environment,” *International Arab Journal of Information Technology*, vol.2, pp.135-140, 2005.

[2] Abu-Baker A., Huang H., Johnson E., Misra S., AsoreyCacheda R. and Balakrishnan M.,“Maximizing α-Lifetime of Wireless Sensor Networks with Solar Energy Sources,”*proceedings of the IEEE Military Communications Conference*, pp. 125–129, 2010.

[3] Adrian P. Lauf, Richard A. Peters, William H. Robinson,“A distributed intrusion detection system for resource-constrained devices in ad-hoc networks,” *Ad Hoc Networks* , vol.8, pp. 253–266, 2010.

[4] Azim M.A., Kibria M.R., Jamalipour A., “An optimized forwarding protocol for lifetime extension of wireless sensor networks,”*wireless communication mobile computing*,vol. 9, pp.103–115, 2009.

[5] Basagni S., Elia M. and Ghosh R.,“ViBES: Virtual Backbone for Energy Saving in Wireless Sensor Networks,” *proceedings of the IEEE Military Communications Conference*, pp. 1240–1246, 2004.

[6] Gupta P. and Kumar P.R., “The Capacity of Wireless Networks,” *IEEE Transactions on InformationTheory*,vol.46, pp.388–404, 2000.

[7] Hedrick C., “Routing Information Protocol” *Internet Request For Comments 1058* , 1988.

[8] Hongqiang Zhai , Jianfeng Wang, Xiang Chen and Yuguang Fang, “Medium access control in mobile ad hoc networks: challenges and solutions,” *Wireless Communications And Mobile Computing*, Ad Hoc Wireless Networks, vol.6, pp. 151–170, 2006.

[9] Iranli A., Maleki M. and Pedram M., “Energy Efficient Strategies for Deployment of a Two-level Wireless Sensor Network,” *proceedings of the 2005 International Symposiumon Low PowerElectronicsandDesign*,pp.233–238, 2005.

[10] Kacimi R., Dhaou R., Beylor A.L., “Load balancing techniques for lifetime maximization of wireless sensor networks,” *Ad Hoc Networks*, 2013.

[11] Kim J., Lin X., Shroff N.B., Sinha P., “Minimizing delay and maximizing lifetime for wireless sensor networks with anycast,” *IEEE/ACM Transaction on Networking*, vol 18, pp. 515–528, 2010.

[12] La Porta T., PetrioliC., and SpenzaD., “Sensor-mission Assignment in Wireless Sensor Networks with Energy Harvesting,” *proceedings of the 2011 8th Annual IEEE Communications Society Conference on Sensor,Mesh and Ad Hoc Communications and Networks*,pp27–30 , 2011.

[13] Long H., Liu Y., Wang Y., Dick R.P. and Yang H., “Battery Allocation for Wireless Sensor Network Lifetime Maximization Under Cost Constraints,” *proceedings of the International Conference on Computer Aid Design*, pp. 2–5, 2009.

[14] Mao S., Cheung M.H. and Wong, V.W.S., “An Optimal Energy Allocation Algorithm for Energy Harvesting Wireless Sensor Networks,” *proceedings of the IEEE International Conference on Communications*,pp.10–15,2012.

[15] Moy, J. “OSPF Version 2” *Internet Request For Comments 1247*, 1991.

[16] Naghshegar A., Darehshoorzadeh A., Dana A. and Dehghan M., “Dynamic Topology Control Scheme in MANETs for AODV Routing,” *Telecommunication Networks and Applications Conference, ATNAC 2008*, pp.246 – 251, 2008.

[17] Niyato D., Hossain E., Rashid M.M., Bhargava V.K., “Wireless sensor networks with energy harvesting technologies: A game-theoretic approach to optimal energy management,” *IEEE Wireless Communication*, vol.14, pp. 90–96, 2007.

[18] Pering T., Agarwal Y., Gupta R., and Want R., “CoolSpots Reducing the Power Consumption of Wireless Mobile Devices with Multiple Radio Interfaces,” *proceedings of the 4th international conference on Mobile systems, applications and services*, pp. 220–232, 2006.

[19] Perkins C.E. and Royer E.M., “Ad-hoc On-Demand Distance Vector Routing,” *proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications*,1999.

[20] Priyanka Goyal, Vinti Parmar, Rahul Rishi, “MANET: Vulnerabilities, Challenges, Attacks, Application,”*IJCEM International Journal of ComputationalEngineering & Management*, vol. 11, pp.32-37, 2011.

[21] Rajiullah M. and Shimamoto S., “An Energy-Aware Periodical Data Gathering Protocol Using Deterministic Clustering in Wireless Sensor Networks (WSN),” *proceedings of the*

IEEE Wireless Communications and Networking Conference, pp. 3014–3018, 2007.

[22] Reise G., Matamoros J., Anton-Haro C., and Matz G., "MSE-Optimal Power Allocation in Wireless Sensor Networks for Field Reconstruction Based on Shift-Invariant Spaces," *proceedings of the Conference Record of the Forty Fifth Asilomar Conference on Signals, Systems and Computers*, pp. 702–707, 2011.

[23] Tarkeshwari kaul, kapoor R.K., "Mobility Contrast Effect on Environment in Manet as Mobility Model," *IOSR Journal of Computer Engineering (IOSR-JCE)*, vol.13, pp.59-67, 2013.

[24] Ting C.K. and Liao C.C., "A memetic algorithm for extending wireless sensor network lifetime," *Information Science*, vol.180, pp.4818–4833, 2010.

[25] Wang D., Xie B., Agrawal D.P., "Coverage and lifetime optimization of wireless sensor networks with gaussian distribution," *IEEE Transaction on Mobile Computing*, vol. 7, pp. 1444–1458, 2008.

[26] Wang Z.M., Basagni S., Melachrinoudis E., Petrioli C., "Exploiting Sink Mobility for Maximizing Sensor Networks Lifetime," *proceedings of the International Conference on System Sciences*, pp.3–6, 2005.

[27] Wu X., Chen G. and Das S.K., "Avoiding energy holes in wireless sensor networks with non uniform node distribution," *IEEE Transaction on Parallel Distributed System*, vol. 19, pp.710– 721, 2008.

[28] Xiang M., Shi W.R., Jiang C.J., Zhang Y., "Energy efficient clustering algorithm for maximizing lifetime of wireless sensor networks," *International Journal Electronic Communication*, 2009.

[29] Younis O., Krunz M., Ramasubramanian S., "Node clustering in wireless sensor networks: Recent developments and deployment challenges," *IEEE Networking*, vol. 20, pp. 20–25, 2006.

[30] Zhao Y., Wu L., Li F., Lu S., "On Maximizing thelifetime of wireless sensor networks using virtual backbonescheduling," *IEEE Transactionon Parallel Distribution Process*, vol. 23, pp.1528–1535, 2012.

[31] Zhixiang D., Bensheng Q., "Three-layered Routing Protocol for WSN based on LEACH Algorithm" *proceedings of the IET Conference on Wireless, Mobile & Sensor Networks*, pp. 72–75, 2007.

W.R.Salem Jeyaseelan is an Assistant Professor [SE-G] in Department of Information Technology, J.J. College of Engineering and Technology, Tiruchirappalli, Tamilnadu, India. He received Bachelor degree in Electrical and Electronics Engineering from Madurai Kamaraj University in 2003 and Master degree in the field of Computer Science and Engineering from Anna University, in 2007. He is doing Ph.D. in the area of Wireless Networks. He is a member of ISTE and has 9 years of experience in teaching. His research interests include AdHoc Networks, Wireless Communication, and MANET.

Dr.S.Hariharan received his B.E degree specialized in Computer Science and Engineering from Madurai Kamaraj University, Madurai, India in 2002, M.E degree specialized in the field of Computer Science and Engineering from Anna University, Chennai, India in 2004. He holds his Ph.D degree in the area of Information Retrieval from Anna University, Chennai, India. He is a member of IAENG, IACSIT, ISTE, CSTA and has 12 years of experience in teaching. Currently he is working as Associate Professor in Department of Computer Science and Engineering, TRP Engineering College, India. His research interests include Information Retrieval, Data mining, Opinion Mining, Web mining. He has to his credit several papers in referred journals and conferences. He also serves as editorial board member and as program committee member for several international journals and conferences.