ISSN: 2278 – 1323
International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
Volume 2 Issue 8, August 2013

A Dynamic Approach to Optimize Energy in RIP, OLSR and Fisheye Routing Protocols using Simulator

Dharam Vir, Dr. S.K.Agarwal, Dr. S.A.Imam

***Abstract*— Energy optimization is an essential issue in wireless sensor network that consumes less energy to give optimum performance under low battery power, limited bandwidth and network life time of each node. In this paper, first we investigate and analyze the impact of receiving energy on nodes and remaining energy in the networks. Analysis and simulation results show that changing receiving energy affects the network life time. This paper proposes a new approach for optimizing energy consumption in wireless sensor networks (WSNs) that consents to maximum life time of nodes while transmitting a packet from the source to destination. It can be implemented by avoiding nodes which has a minimum residual battery power. The proposed approach is implemented by introducing a threshold value on each node and transmitting the equal length of packet on the route. This threshold indicates whether the node should be included in making routing decisions for a packet and length of the packet considered for equal energy consumption. Extensive simulation results are presented to verify the effectiveness of the proposed approach. Considering this importance we made an attempt to study the behavior of three routing protocols in wireless sensor network. Extensive simulations are done on RIP, OLSR and Fisheye to determine the network lifetime at different node mobility and at different network load. Simulation results suggest that OLSR is the most energy efficient protocol as compared to other.**

***Index Terms*—Maximum network lifetime, Threshold value, Energy consumption, Length of Packet, Network lifetime, Routing Protocols**

I. Introduction

A Wireless Sensor Network is an infrastructure comprised of sensing, computing, and communication elements that gives an administrator the ability to observe, and respond to events and phenomena in a specified environment. Wireless technology has strongly influenced our personal and professional lives in the recent time due to its applicability and adaptability in different fields. It enhanced our computing, communication skills and information accessing capabilities through many modern types of equipment. Numerous wireless technologies in form of PDA, cellular phones, blue-tooth devices, and many hand-held computers, are extending the wireless communication to a fully all-encompassing computing environment as a result this is emerging as one of the most enveloping computing technologies [15]. Wireless network can be classified to infrastructure supported network or infrastructure independent networks. The former requires specific network backbone in form of access points or base stations to support communication, while the latter doesn't need such for its operation and popularly known as wireless ad hoc network. Multi hop wireless networks in all their different forms such as mobile ad hoc network (MANET) and vehicular ad hoc network (VANET), wireless sensor network(WSN), wireless mesh network(WMN) [1], etc are coming under this category. In multi-hop ad hoc network destination nodes may be multiple hops away from the source node. This approach provides a number of advantages as compare to single-hop networking solution. Some of its advantages are (i) support for self configuration and adaption at low cost, (ii) support of load balancing for increasing network life, (iii) greater network flexibility, connectivity, etc. However irrespective of these advantages it also suffered with many challenges associated with restricted battery capacity, unpredictable mobility, routing, etc. The basic requirement in MANET is how to deliver packets efficiently among the mobile nodes. Since node's topology changes frequently this makes routing very problematic, bandwidth, limited battery capacity and error prone medium adds further complexity in designing an efficient routing protocol. Estimation of end-to-end delays, efficient utilization of bandwidth, and proper use of available resource are the most common requirements as resource allocation; capacity planning, file sharing, etc depend on them. Also power managements is very much necessary as nodes are battery operated and it is always a cumbersome task to recharge or replace the battery as the network is deployed in such environments where it is neither feasible nor economical to perform that task. Bad carrier sensing, retransmission due to collision of packets, exchange of large number of control message to find paths are some of the major cause of energy consumption. With a proper analysis of battery consumptions, light weight applications, efficient network protocol and interface power consumption of wireless network can be properly addressed. Flooding based routing protocols rely on message forwarding by broadcasting the message [2] [16] [17]. This mechanism consumes a major portion of battery power at node level also affect the longevity of the network.

***Manuscript received August, 2013*.**

Dharam Vir, *Electronics Engineering Department, YMCA University of Science & Technology, Faridabad, India 121006*
Mobile No. 09999067810
Dr.S.K.Agarwal, *Electronics Engineering Department, YMCA University of Science & Technology, Faridabad, India 121006*
Mobile No. 09953393520
Dr. S.A.Imam, *Electronics & Comm. Engineering Department, Jamia Millia Islamia (Central University) New Delhi -110025*
Mobile No. 09818732747

Energy efficient routing protocols apply some techniques to reduce flooding mechanism by some probabilistic and heuristic based approach but are suffered with increase end-to-end delay and decrease network throughput. For this reason there must be some threshold between power consumptions and other network parameters while designing routing protocols for MANET. In the literature different techniques are proposed to find the energy efficiency of routing protocol, but network lifetime is not properly addressed at different network traffic, load and mobility. Focusing on these three parameters we made an attempt to determine the network lifetime of RIP, OLSR and Fisheye at variable speed and load. RIP and OLSR represent the reactive category of routing mechanism and Fisheye represent the hybrid approach of routings routing in ad hoc network [3].

There are four basic components in a wireless sensor network:

- An assembly of distributed or localized sensors,
- An interconnecting network (usually, but not always, wireless-based),
- A central point of information clustering,
- A set of computing resources at the central point to handle data mining, data correlation, event trending, and status querying [17].

Due to advances in wireless communications and electronics over the last few years, the development of networks of low-cost, low-power, multifunctional sensors has received increasing attention. These sensors are small in size and able to sense, process data, and communicate with each other, typically over an RF (radio frequency) channel [3] [17].

A. Different issues in wireless sensor networks:

1. *Energy Efficiency:* In sensor networks, it is of vital importance to consume nodes' energy wisely and efficiently. Since wireless sensor nodes are normally equipped with non-chargeable batteries with limited energy supply, a sensor network cannot function well after a fraction of nodes run out of energy [4] [17].
2. *Network Scalability:* In many large scale wireless network applications, the number of sensor nodes in a sensor network may be in the order of thousands, tens of thousands, or even millions. In such large-scale networks, scalability is a critical factor, so that the network performance does not significantly corrupt as the network size increases [5] [17].
3. *Fault Tolerance:* Node failure rate may be very high if they are deployed in friendly environments. Fault tolerance should be included in the design and implementation of algorithms for sensor networks such that the network performance is not sensitive to individual node failures [5].
4. *Data Accuracy:* Obtaining accurate information is the main task of sensor networks. Accuracy can be improved through joint signal processing by cooperative sensors [13] [17].
5. *Network Autonomy:* Sensor nodes can be either deterministic placed or randomly scattered into a field of interests. In such cases, the untended nodes should self-organize into an autonomous network to decide the structure and topology of the network. Such an autonomous network should be able to schedule sensing tasks and to arrange delivery routes all by itself.
6. *Information Security:* Information security, which is a common requirement in almost all types of networks, requires that sensing data should be accessed, transmitted, and processed securely.

The rest of the paper is organised as follows. In Section 2, we present related work, In Section 3, proposed energy optimization model and routing protocols of MANET. In Section 4, we discuss the network lifetime parameter and simulation environments. In Section 5, simulation setup parameters. In Section 6, Simulation results are discussed at different network conditions. In Section 6, we end our discussion with conclusion and thought for future work on this topic.

II. Related Work

In this section we discussed some existing approaches for optimizing power consumption as well as to maximize the network lifetime. In WSN while creating correct and efficient routes between pair of nodes, one important purpose of a routing protocol is to maximize the lifetime of network. As discussed in the introduction, this objective can be proficient by optimizing the energy of mobile nodes not only when they are inactive but also when they are in active communication. Transmission power control, power management and load distribution are the approaches to minimize the active communication energy and sleep/power-down mode is used to minimize energy during immobility.

P.K.Sahoo et al, (2007), suggested an approach to minimize power consumption in idle mode of mobile nodes. They proposed an idea to change mode of the mobile nodes from Idle to Sleep, i.e nodes neither transmit nor receive data packets, but in Idle mode the node can consume power as consume in receiving mode. They take two ad hoc on-demands routing protocols and implemented this approach and concluded the power consumed by these routing protocols, with this mechanism is less than power consumed.

The authors Canan Aydogdu and Ezhan Karasan (2010) proposed an analytical model for the IEEE 802.11 DCF in multi-hop wireless networks that they considers hidden terminals and accurately works for a large range of traffic load that are used to analyze the energy consumption of various relaying strategies. They gave fact of the existing analytical models of IEEE 802.11 DCF systems were insufficient for an energy efficiency analysis in wireless multi-hop networks. They concluded that this analytical model is accurate in predicting the energy-efficiency over a wide range of scenarios. The given results show that the energy efficient routing strategy depends not only on the processing power but also depends on the traffic load.

Author Seung Hwan Lee (2011), projected an energy efficient power Control mechanism for base station in mobile communication systems and an efficient sector power control based on distance between base station and mobile node. They also proposed a sleep mode energy control mechanism. In sleep mode energy saving protocol, each sector monitors the number of user in sector cell. They proposed, if number of mobile node falls down a given threshold in sector cell, base station shuts down power. They also proposed an algorithm and demonstrated the tradeoff between energy saving and cell coverage in order to enhance efficient use of base station Transmission power.

The PAMAS (Power Aware Multi-Access protocol with Signalling) (Li Q, AslamJ, Rus D, 2001), protocol consent to a host to sleep mode when it has no packet to transmit/receive or any of its neighbours is receiving packets, but it required a separate signaling channel to inquiry the status of neighbouring hosts. Hence this protocol provides best results in dense networks but the power saving is low in small network.

MTPR (Minimum Total Transmission Power Routing) (Dongkyun Kim, 2002) is an approach to minimize total transmission power consumption by all nodes. MTPR calculates the total transmission power for all routes between source and destination. Among all routes it will select the route with minimum total transmission power. The total transmission power of route is calculated using the formula

$$P_{(R)} = \sum_{i=0}^{D-1} T(n_i, n_i+1)$$

Where i refer the number of nodes appears in the route from source to destination. But this decision increases the end-end delay in the transmission. This approach also increases the number of hops in the route. The lifetime of the network also not considered in this approach because the selected routes are via specific host, the battery of this host will be exhausted quickly [6].

MMBCR (Min-Max Battery Cost Routing) suggested by Reinaldo C.M. Gomes (2006), is an approach by selecting nodes with more residual-battery capacities in a route. With the intention that in this approach the battery of each host will be used more fairly than in previous scheme. But it can consume more power to transmit user traffic and there is no guarantee that minimum total transmission path will be selected always. This approach is not paying attention to maximize the lifetime of all nodes [7].

Tseng et al. have presented power saving protocol, which supports low-power sleep mode to operate across multiple hops. Lee et al. have focused on joint opportunistic power scheduling and end-to-end rate power consumption control scheme to save power for wireless ad-hoc network.

Dong et al. have described that dynamic selection of the nodes to consume less power and the network never fails. Ebert et al. have proposed new scheme which is based on reducing transmission power to save power. Wu et al. have proposed power consumption control protocol, which uses one control channel and multiple data channels. Tseng et al. have explained about power level at which nodes in transmission range can receive and decode packet correctly. Song et al. have presented the minimal achievable broadcast energy consumption scheme to save energy in network. Jang et al. have stated that joint power scheduling and rate control algorithm is used to increase the life time of network. Abusalah et al. stated that ad-hoc networks have to meet the requirements like confidentiality, integrity, authentication, non-repudiation and availability. Wu et al. have explained that adaptive searching range routing algorithm is used to reduce power consumption by adjusting the link distance in the routes [8].

A. Optimal Power Consumption

Our algorithm transmits the message as an equal length of packets in favour of equal power consumption by all the nodes in the route. Periodical invigilation is carried out to make sure the residual energy of each node is not away from the required level. If the node goes beyond the threshold value, revolutionized it into sleep mode and selects an alternate node for transmission.

The key point in the above discussion is to minimize power consumption and maximize lifetime of the entire network. The proposed algorithm is as follows [9] [10]:

1. At the source node, Divide the message into equal length of packets and select a node i where min (Ei > Thi) from the entire neighboring node.
2. Establish a route to destination wherein the energy level of all the nodes is greater than its threshold value.
3. Repeat the following steps in periodical interval t
4. Calculate the residual energy of each node in the route with the equation

   E Res = E – Ec (t)

   Where E, the initial energy of a node,

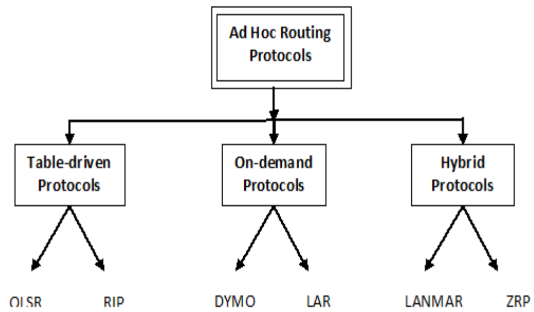
   Ec (t), energy consumed in periodical interval t and

   E Res, Residual energy of a node.
5. Energy consumption of a node after time t is calculated using the following equation

   Ec(t) = Nt *a + Nr * b Where Ec(t) ,energy consumed by a node after time t, Nt , number of packets transmitted by the node after time t and Nr , number of packets received by the node after time t. a and b are constant factors having a value between 0 and 1.
6. If E Res > Threshold value Continue the transmission through the same node
7. Else dynamically find an alternate route for further transmission which satisfies the constraint outlined in our approach.

B. Protocols under Consideration

A wireless sensor network consists of a set of mobile node that is connected by wireless links. The network topology in such a network may keep changing randomly. Routing protocols that find a path to be followed by data packets from a source node to a destination node used in traditional wired networks cannot be directly applied in ad hoc wireless networks due to their higher dynamic topology, absence of established infrastructure for centralized administration [1].



1) Optimized Link State Protocol (OLSR):

The Optimized Link State Routing (OLSR) protocol, developed by the French National Institute for Research in Computer Science and Control (INRIA), was developed for mobile ad-hoc networks. It operates in a table-driven and proactive manner, i.e., topology information is exchanged between the nodes on periodic basis. Its main objective is to minimize the control traffic by selecting a small number of nodes, known as Multi Point Relays (MPR) for flooding topological information. In route calculation, these MPR nodes are used to form an optimal route from a given node to any destination in the network. This routing protocol is particularly suited for a large and dense network. OLSR generally proposes four types of periodic control messages, namely [10]:

- Hello messages
- Topology Control (TC) messages
- Multiple Interface Declaration (MID) messages, and
- Host and Network Association (HNA) messages.

Hello messages are periodically exchanged within the one-hop neighborhood to obtain the neighborhood information. Using this neighborhood information, each node in the network selects a subset of one-hop away neighbors known as the MPR set. In the MPR set, all two-hop away neighbors are reachable through any member of the MPR set. TC messages are generated and retransmitted for flooding topological information in the whole network only through MPR nodes. Also, MID and HNA messages are relayed only by MPR nodes. Therefore, OLSR optimizes the control traffic overhead by minimizing the size of the MPR set. An MPR member generates and retransmits TC messages. These messages provide each node in the network with sufficient link-state information to allow route calculation. MID messages are generated by an OLSR node with multiple OLSR interfaces to notify other OLSR nodes about its interfaces participating in the OLSR routing domain [17].

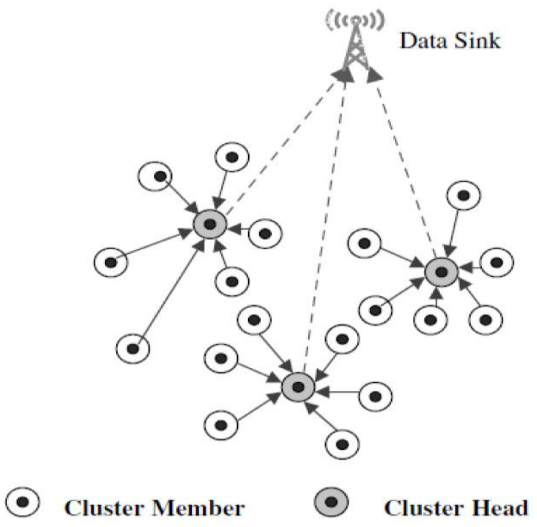


Figure 1. Network model for RIP protocol.

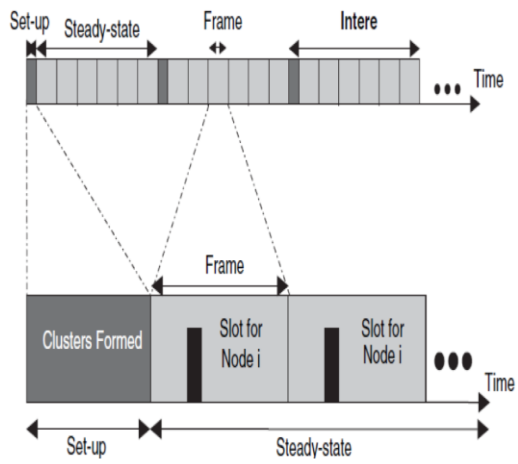


Figure 2. TDMA/CDMA schedule for RIP protocol.

2) Routing Information Protocol (RIP):

RIP or RIPv2 are internet standard implementations of the Bellman-Ford (a.k.a. Ford Fulkerson) routing algorithm. It is a distance vector routing algorithm using the User Datagram Protocol (UDP) protocol for control packet transmission. Routing Information Protocol (RIP) is an Interior Gateway Protocol used to exchange routing information within a domain or autonomous system. RIP lets routers exchange information about destinations for the purpose of computing routes throughout the network. Destinations may be individual hosts, networks, or special destinations used to convey a default route. RIP is based on the Bellman-Ford or the distance-vector algorithm. This means RIP makes routing decisions based on the hop count between a router and a destination. RIP does not alter IP packets; it routes them based on destination address only. The router makes this decision by consulting a forwarding table. The fundamental problem of routing is: How do routers acquire the information in their forwarding tables. Routing algorithms are required to build the routing tables and hence forwarding tables. The basic problem of routing is to find the lowest-cost path between any two nodes, where the cost of a path equals the sum of the costs of all the edges that make up the path. Routing is achieved in most practical networks by running routing protocols among the nodes. The protocols provide a distributed, dynamic way to solve the problem of finding the lowest-cost path in the presence of link and node failures and changing edge costs [17] [15] [16].

3) Location Aided Routing (LAR):

Location-Aided Routing (LAR) is an on-demand routing protocol that exploits location information. It is similar to DSR, but with the additional requirement of GPS information. In scheme 1 (which is implemented here), the source defines a circular area in which the destination may be located and determined by the following information [11] [12]:

- The destination location known to the source
- The time instant when the destination was located at that position
- The average moving speed of the destination.

The smallest rectangular area that includes this circle and the source is the request zone. This information is attached to a ROUTE REQUEST by the source and only nodes inside the request zone propagate the packet. If no ROUTE REPLY is received within the timeout period, the source retransmits a ROUTE REQUEST via pure flooding. Location aided routing, is an enhancement to flooding algorithms to reduce flooding overhead. Most on-demand methods, including DSR and AODV use flooding to obtain a route to the destination. LAR aims to reduce the overhead to send the route requests only into a specific area, which is likely to contain the destination [12] [16].

III. Proposed Energy Optimisation Model

Energy management is required to determine energy consumption of nodes in a mobile ad-hoc network. Ad-hoc on demand distant vector protocol is used for routing between source and destination. Route Request (RREQ), Route Reply (RREP) and Route Error (RRER) messages are used for route discovery and maintenance in network. Link distance is adjusted according to the transmission power and remaining energy. A node broadcasts RRER packets when a link to the next hop is broken. Node's energy management mode is decided by the control header of medium access control layer data units. The state switching functions are shown in fig.1. Mobile node has two mode of operation like active mode or power-save mode. In active mode, a node is awake and may receive data at any time. In power-save mode, a node is sleeping most of the time and wakes up periodically to check for pending messages. Controls messages like route reply messages are used to switch to active mode. RREPs are collected by the source node and start a timer as shown in Fig.1 Protocol adjusts transmission power for per-hop and selects the feasible routes based on remaining energy and transmission power of nodes so as to improve the overall performance of network [17].

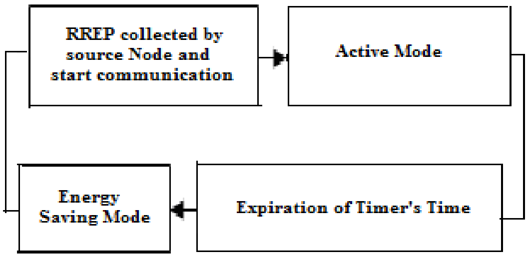


Figure 3. Energy Management Model

Transmission Energy Etx, receive energy Erx, and remaining energy of node Re are added in RREQ. Node is able to estimate the link attenuation with the knowledge of Etx and Erx [17].

IV. Simulation Setup

This section provides the simulation setup and shows the effectiveness of the proposed algorithm compared to the existing algorithms like, MTPR and MMBCR. The proposed scheme is simulated using network simulator QualNet 5.0. Network scenarios have been setup for 25, 45, 65, 85 and 100 nodes in an area of 1500 * 1500 m. In the different scenarios, value for packet delivery ratio has been observed by varying pause times from 0 to 100 seconds. Fig.4 depicts the simulation scenario for implementing proposed algorithm with 45 numbers of nodes. Experiment has been performed for different set of mobile nodes with different speed to check Energy Consumption in three modes Transmit, Receive and Idle Modes, average jitter and End to End delay [17].

Equal lengths of packets are sent from source to destination with simulation time of 30Sec. and power consumption is calculated for different number of nodes like, 5, 10, 15, 20, 25, 30, 35, 40, and 45. It is clear from Fig. 4. That initially the proposed approach MPML and MTPR slightly differs. But when the number of nodes increased, the power consumption is high. This is because the selected routes are via specific host, the battery of this host will be exhausted quickly in MTPR and at the same time the total power consumption is high. But in the case of MMBCR initially it consumes more power to transmit user traffic, however in conclusion the battery of each host will be used more fairly than in previous scheme. It is observed from the graph that energy consumption optimizes in the case of proposed scheme when the number of nodes increases [19].

1) Parameters Selection for Simulation:

Table1.

Parameters	**Value**
QualNet	5.0
Channel Type	channel/wireless channel
Antenna Type	Omni-directional Antenna
Network Layer	PHY wireless
MAC protocol	Mac/802.11
Network interface type	Physical/ Wireless Phy
No of Nodes	45
Topological area	1500 x 1500 sq. m
Simulation time	300 sec.
Energy Model	MICA-MOTES
Radio type	802.11b Radio
Packet Reception Model	PHY 802.11b Reception Model
Data Rate	10 Mbps
Mobility Model	Random Way Point
Pause Time	30 sec.
Battery Model	Linear Model
Physical (Radio Propagation)	Free space, Two-Ray
Data Link (MAC)	CSMA, MACA, TSMA, 802.11
Network (Routing)	OLSR,RIP, LAR
Transport	TCP, UDP
Application	VBR,FTP and CBR

V. Simulation Results

Simulation scenarios and parameters are given in Table 1. Values for transmit, receive and idle power have been used directly as mentioned in energy model proposed by Feeney L.M., Nilsson.M. (2001).

ISSN: 2278 – 1323
International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
Volume 2 Issue 8, August 2013

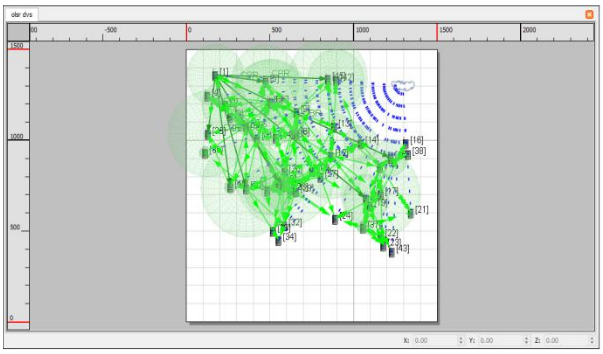


Figure 4. Snapshot of running designed scenario for energy consumed in transmit mode using OLSR routing protocol.

A. *Average Jitter:*

As the packets transmit from source to destination will reach the destination with different delays. A packet's delay varies with its position in the queues of the routers along the path between source and destination and this position can vary randomly. This variation in delay is known as Jitter. The jitter increases at switches along the path of a connection due to many factors, such as conflicts with other packets wishing to use the same links, and non deterministic propagation delay in the data-link layer. A network could possibly average zero Jitter. Jitter for respective precedence bits are calculated and compared [17].

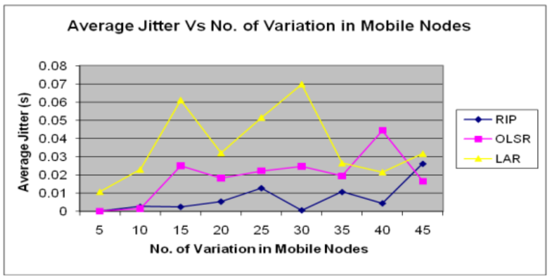


Figure 5. Shows the Average Jitter Vs number of variation in mobile nodes OlSR shows better result compare to RIP and LAR.

B. *End-to-end delay:*

The average end-to-end specifies the packet is transmitting from source to destination and calculates the difference between send times and received times. Delays due to route discovery, queuing, propagation and transfer time are included in the delay metric [17].

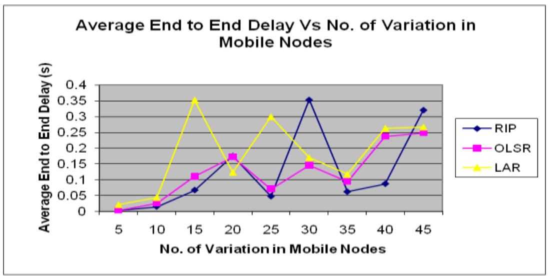


Figure 6. Shows the Average End to End Delay Vs number of variation in mobile nodes OlSR shows better result compare to RIP and LAR.

C. *Energy Consumed in Transmit mode:*

A node is said to be in transmission mode when it sends data packet to other nodes in network. These nodes require energy to transmit data packet, such energy is called Transmission Energy (T_x), of that nodes. Transmission energy is depended on size of data packet (in Bits), means when the size of a data packet is increased the required transmission energy is also increased. The transmission energy can be formulated as:

$$T_x = (330*P_{length})/2*10^6$$

or

$$P_T = T_x / T_t$$

Where T_x is transmission Energy, PT is Transmission Power, T_t is time taken to transmit data packet and P_{length} is length of data packet in Bits [17].

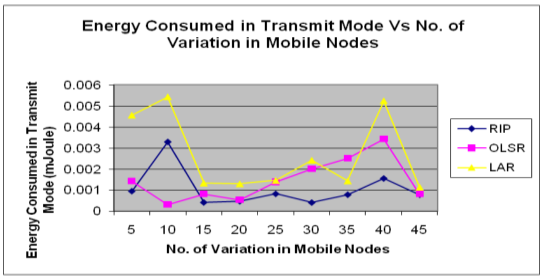


Figure 7. Shows the Energy Consumed in Transmit Mode Vs number of variation in mobile nodes RIP shows better result compare to OLSR and LAR.

D. *Energy Consumed in Receive Mode:*

When a node receives a data packet from other nodes then it said to be in Reception Mode and the energy taken to receive packet is called Reception Energy (R_x), then Reception Energy can be given as:

$$R_x = (230* P_{length})/2*10^6$$

Or

$$P_R = R_x / T_r$$

Where Rx is a Reception Energy, P_R is a Reception Power, T_r is a time taken to receive data packet, and P_{length} is length of data packet in Bits.

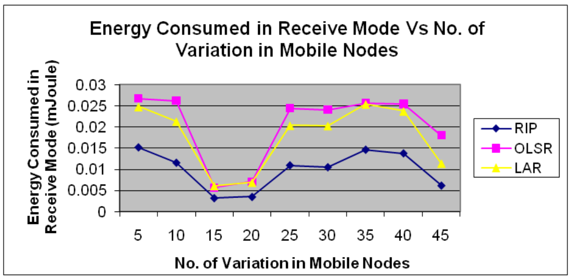


Figure 8. Shows the Energy Consumed in Receive Mode Vs number of variation in mobile nodes RIP shows better result compare to LAR than OLSR.

E. *Energy Consumed in Idle Mode:*

The node is neither transmitting nor receiving any data packets. But this mode consumes power because the nodes have to listen to the wireless medium continuously in order to detect a packet that it should receive, so that the node can then switch into receive mode from idle mode.

$$P_I = P_R$$

Where P_I is power consumed in Idle Mode and P_R is power consumed in Reception Mode.

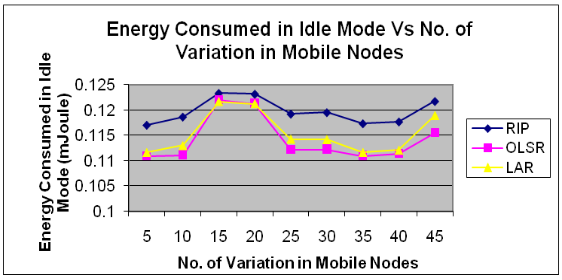


Figure 9. Shows the Energy Consumed in Idle Mode Vs number of variation in mobile nodes OLSR shows better result compare to LAR than RIP.

VI. Conclusion and Future Work

In this paper we try to approach of optimizing energy in RIP OLSR and Fisheye routing protocols using QualNet simulator and also power management in WSN with characteristics like, unpredictable mobility and multi-hop communication is discussed in detail. It is found that the two important issues, the power optimization and maximize network lifetime can be resolved by introducing a threshold value. The dynamic route discovery forces the node into sleep mode to retain the minimum energy level. Energy optimization model is proposed to estimate the remaining energy due to energy consumption in receiving. Equivalent simulator parameters have been used as inputs to achieve good generalization capability for network. Graphical simulation results have been shown above and proposed approach can save lot of energy with realistic route establishment prospect. The average energy is analyzed and compared with the LEACH protocol and static cluster routing protocol with the given network parameters. Static cluster routing is proposed as better energy efficient than basic protocol. In power saving mode results shows that OLSR is better RIP and Fisheye routing protocols and also the results from this scheme may use in prediction of the remaining energy of nodes within the range of the and control energy consumption in wireless network.

REFERENCES

[1] Ashwani Kush, Phalguni Gupta, Ram Kumar, “Performance Comparison of Wireless Routing Protocols”, *Journal of the CSI*, Vol. 35 No.2, April-June 2005

[2] Nikolaos A. Pantazis, and Dimitrios D. Vergados,. “A Survey on Power Control Issues in Wireless Sensor Networks”, *IEEE Communications Surveys & Tutorials*, VOL, NO.4, pp.86-107S. 2007

[3] Dongkyun Kim,.”Performance Analysis of Power Aware Route Selection Protocols in Mobile Adhoc Networks”, *World Scientific* on June 2002.

[4] Wang Y, Tsai C et al. HMRP: “hierarchy-based multipath routing protocol for wireless sensor networks”, *Tamkang Journal of Science and Engineering*, vol 9, No. 3, 255–264, 2006.

[5] Muhamad W W, Dimyati K et al. “Evaluation of Stable Cluster Head Election (SCHE) routing protocol for wireless sensor networks”, *International MultiConferance of Engineers and Computer Scientist*, Hong Kong, vol 2, 2010.

[6] Tseng, Y., C., Hsu, C., S., Hsieh, T., Y., “Power Saving Protocols for IEEE 802.11-Based Multi-Hop Ad-Hoc Networks,” *Computer Networks, Elsevier Science Pub.* vol. 43, issue3, pp.317-337, 2003.

[7] Song, Liang, Dimitrios, Hatzinakos, “Broadcasting Energy Efficiency Limits in Wireless Networks,” *IEEE transaction on wireless communications*, vol.7,issue7, pp.2502-2511,2008.

[8] Ebert, J., P., Stremmel, B., Wiederhold, E., Wolisz, A., “An Energy-efficient Power Control Approach for WLANs,” *Journal of Communications and Networks*, vol.2, issue3, pp.197-206, 2000.

[9] Laura Marie Feeney and Martin Nilsson, "Investigating the energy consumption of a wireless network interface in an ad hoc networking environment", *IEEE Conference on Computer Communications (INFOCOM)*, Vol. 3, April 2001, 1548-1557.

[10] S. Cui, A. Goldsmith and A. Bahai, "Energy-constrained Modulation Optimization", *IEEE Transactions on Wireless Communications*, Vol. 4, Sept. 2005, 2349-2360.

[11] Y.B.Ko and N.H.Vaidya, “Location Aided Routing (LAR) in MANET”, In *mobile computing and Networking (MOBICOM)* 98, Dallas.TX, USA, 1998, PP.66-75.

[12] Young-Bae Ko and Nitin H. Vaidya, “Location-aided routing (lar) in mobile ad hoc networks”. *Technical report, Department of Computer Science Texas A&M University*, College Station, TX 77843-3112. 1998.

[13] J.Broch, D.A.Maltz, David B.Johnson, Y. Hu and J.Jetcheva. “A Performance Comparison of Multi-Hop Wireless Ad-hoc Network Routing Protocols”, *Proceedings of the Fourth Annual ACM/IEEE International Conference on Mobile Computing and Networking, MobiCom*’98, 25-30. 1998.

[14] Mittal N, Singh D P et al. (2010). Improved leach communication protocol for WSN, *National Conference on Computational Instrumentation*, 153–156.

[15] Lu K, Zheng Z et al. (2010). A cell based clustering algorithm in large wireless sensor networks, International Conference on Communications and Mobile Computing, vol 3, 182–187.

[16] A.K.Dewivedi, Sunita Khushwaha, O.P.Vyas, “Performance of Routing Protocols for MANETs & WSN:A Comparative Study”, *Int.J.of recent trands in Engineering*, Vol.2, No.4, Nov.2009.

[17] Wikipedia, “The free encyclopedia-, Mobile ad-hoc Network”, http://en.wikipedia.org/wiki/Mobile_ad-hoc_ network, Oct-2004.

[18] QualNet Network Simulator; http://www. scalable-networks.com

[19] Wireless routing protocols, http://www.wikipedia.com

Authors:

DharamVir received the M.Tech Degree form MDU Rothak (Haryana) and B.E Degree in Electronics and Communication Engg. from Jamia Millia Islamia, Central University, New Delhi 2008, 2004 respectively. He started his carrier as R&D Engineer in the field of computers and networking, since 1992, he is the part of YMCA University of Science & Technology as Head of Section (Electronics & Inst. Control) in the Department of Electronics Engineering. He is pursuing Ph.D in the field of Power aware routing in Mobile Ad hoc Networks.

Dr. S.K. Agarwal received the M.Tech Degree from Delhi Technical University.New Delhi and PhD degree in Electronics Engg. From Jamia Millia Islamia, Central University, New Delhi in 1998 and 2008, respectively,since 1990. He has been part of YMCA University of Science & Technology Faridabad (Haryana), as Dean and Chairman in Department of Electronics Engineering.

Dr. Sayed Akthar Imam received the B.E Engg. degree (Electrical Engg) from Jamia Millia Islamia, M. Tech (Instrumentation & Control System) from AMU, Aligarh and PhD degree in Electronics & Comm. Engg from Jamia Millia Islamia (a Central University), New Delhi, in 1990, 1998, and 2008, respectively. Since 1990, he has been part of Jamia Millia Islamia (Central University), where he is Assistant Professor in the Department of Electronics and Comm. Engineering.