International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-9 Issue-2, December, 2019

Efficient Multipath Routing to Increase QoS by Link Estimation and Minimum Interference Path in Manet's

Pradeep Karanje, Ravindra Eklarker

Abstract: ***Many significant techniques have been developed for real time transmission to meet stringent QoS for various applications of wireless sensor network. However routing in MANET's still a challenging issue to achieve QoS due to frequent topology changes and its dynamic nature. For majority MANET applications, on demand multi path data routing protocols have been modelled to transfer data in multiple routes to prove its effectiveness on link disjoints and high packet delivery ratio. However due to mobility and underlying medium, multiple routes are exposed to interference and low power unstable link quality which are essential to guarantee QoS in routing. In this paper we propose link quality estimation and minimum path interference based on Geographic adhoc on demand multi path distance vector (GAOMDV) an adaptation of AOMDV routing protocol. To ensure the reliability of MANET's this adaptation is done by considering routing metrics. GAOMDV selects forwarding neighbour nodes based on link quality and minimum path interference across multiple paths and ensures high stable links between nodes. Extensive simulation is carried on discrete event simulation tool and performance of GAOMDV is analysed in terms of network QoS parameters***.

Keywords **:.** ***Adhoc, Geographic, Link Quality, MANET's, QoS***

I. INTRODUCTION

MANET's are group of dynamic and self organizing wireless nodes that exchanges data among nodes without centralised administration [1]. Wide variety of MANET's applications has been established in battlefield, military, rescue and mission critical networks. MANET's causes frequent topology changes due to its self organizing characteristics. Performance of MANET's depends on routing protocol employed, wherein nodes with limited transmission range relay on neighbour nodes to forward data from source to destination hence routing a crucial issue [2].Complexity of routing fundamentals in MANET's are addressed but still some routing issues are unresolved [3-5]. Issues related to delay and congestion has been discussed and many solutions have been proposed by authors to decrease average delay and high packet data delivery [6-8].

Revised Manuscript Received on December 30, 2019.
* Correspondence Author
Pradeep Karanje*, Department of E&CE, Guru Nanak Dev Engineering College, Bidar, India. Email: pradeepkaranje2012@gmail.com
Dr. Ravindra Eklarker, Department of E&CE, Guru Nanak Dev Engineering College, Bidar, India. Email: reklarker@gmail.com

In past, identifying single path between source and destination was the principle of routing protocol and it was limited with minimum hop counts. While routing in certain scenarios, multipath routing is most effective way for data transfer between source and destination. Multipath routing involves in finding all possible paths from source to destination node to carry data concurrently for efficient data delivery [9-11]. Providing efficient routing for reliable WSN communication is a challenging work because of link failures caused by topology changes in MANET's. QoS in network is to deliver guaranteed level of service for different applications [12]. QoS parameters such as delay, throughput and packet delivery ratio are achieved through efficient routing. However due to multiple constrains and dynamics in WSN's delivering QoS parameters becomes research issues [13].In this paper we propose Geographic adhoc on demand multi path distance vector (GAOMDV) an adaptation of AOMDV routing protocol. This paper mainly concentrates on nodes link quality estimation of multiple paths and minimum interference of nodes disjoints links. Neighbour nodes are selected on minimum routing cost as forwarding node through geographic information. This ensures the high stable links for dynamic nodes to achieve QoS parameter for MANET's. The rest of this paper is organized as follows. In Section II describe problem definition and related work carried out. Section III describes the propose system model. In section IV the performance analysis and relative simulation are conducted. Finally we draw the conclusion on the proposed scheme in section V.

II. PROBLEM DEFINITION AND RELATED WORKS

Due to physical changes in environment low power embedded wireless links are error-prone, unstable and vulnerable to spatial variations [14]. Links are unstable and lossy in such environments due to dynamic characteristics of nodes. To guarantee QoS parameters it is essential to estimate the link quality among nodes to increase the performance of routing protocol. Single path between source and destination was the principle of routing protocol and it was limited with minimum hop counts. In case of route fail, new route is evaluated this led to high communication cost and more resource consumption. Multipath routing provides key solution under various conditions to achieve QoS requirements.

To improve network lifetime and load balance an adaptive greedy multipath routing was proposed [15]. In this protocol walking back and smart greedy routing modes are used. Walking back mode was used when 1-hop neighbour was unavailable and smart greedy mode was used 1-hop neighbour was close to sink. A delay aware routing (CUDAR) [16] was proposed to find better routing paths by exchanging cross layer MAC and network information. Forwarding nodes are selected on high residual energy, minimum hop count and packet service time. During routing phase this protocol discovers nodes having small packet service time and low contention window for possible paths, this provides higher throughput and less delay. However this approach is imperative in achieving QoS requirements. In [17] an energy optimization for multipath reactive routing for AOMDV with fitness function using PSO was proposed to achieve energy efficient routing. In [18] routing in mobile WSN through leader based was proposed, this approach uses local nodes information for any connectivity change and link disjoints due to mobility. LQEAR was proposed [19], this routing protocol discovers forwarding nodes which has stable link based on link quality indicator, high residual energy among 1-hop neighbour node. But this approach fails in accurate link quality estimation.

III. SYSTEM MODEL

We consider mobile nodes here, nodes are randomly deployed. A node knows their geographic location and each node has plenty of neighbour nodes. Link quality estimation is provided by MAC layer. Lost data packets can be obtained by using PRR (packet reception ratio) information. MANET can be represented by an undirected graph $G(V,E)$ where V is number of nodes and E is edges. In path discovery phase, forwarding nodes are selected on routing cost function. For two nodes n_a *and* n_b with transmission range t_r the distance between two nodes is given as

$$Distance_{a,b} = \sqrt{(x_a - x_b)^2 + (y_a - y_b)^2}$$

Signal to noise ratio (SNR) can lead a noisy link, difference in decibel level between pure signal strength and noise floor can be checked to estimate the link quality. Link quality is measured by the strength and quality of received packets.PPR predefined time window estimates ratio of received packets to total number of sent packets transmitted by sender node. Low PPR value indicates low signal strength and high PPR values indicates stable link.

Assume t_{pk} total number of transmitted packets and r_{pk} successful received packets for time window t_w, where$(0 < r_{pk} \leq t_{pk})$. The signal to noise ratio and link quality estimation of each received packet pk are calculated and denoted as SNR_{pk} *and* LQE_{pk} and the mean is calculated as

$$\overline{SNR} = \frac{\sum_{pk=1}^{r_{pk}} SNR_{pk}}{t_{pk}}$$

$$\overline{LQE} = \frac{\sum_{pk=1}^{r_{pk}} LQE_{pk}}{t_{pk}}$$

Proposed Methodology

Neighbour Nodes Discovery

Neighbour nodes discovery is identifying nodes within the transmission range for direct communication between two nodes. After node deployment, each node periodically broadcasts HELLO packets within its transmission range to gather 1-hop neighbours information and stores in Neighbour Table (NT). For error free link disjoints LQE and SNR values are also stored and updated in NT. Every receiver nodes computes the link quality estimation for a predefine window time using

$$LQ_{a\to b} = \sqrt{\overline{SNR}^2 + \overline{LQE}^2}$$

Tiny packet INFO which contains link quality metric and residual energy is unicasted to neighbour nodes. The algorithm for neighbour discovery is given below

Algorithm : Neighbour Nodes Discovery

- proc broadcast_Hello_Packets (n_a)
- if current window_time $<$ predefined window_time
- if Hello_Packet_time expires then
- get Hello_packet which contains
  $ID_a, REngy_a, X_a$ *and* Y_a *coordinates*
- broadcast Hello_Packet
- set new Hello_Packet_time
- end if
- end if
- end proc
- proc recv_Hello_Packets(n_a, Hello_Packet)
- if current window_time $<$ predefined window_time
- if Hello_Packet from new node then get
  $(ID_a, REngy_a, X_a, Y_a, SNR_a$ *and* LQE_a
  store it in NT
- else
- update previously added SNR_a *and* LQE_a of n_a
  in NT
- end if
- end if
- compute link quality estimation $LQ_{a\to b}$ for n_a
- unicast INFO packet containing
  $LQ_{a\to b}$ *Remaning energy* $(,REngy_a)$
  to n_a
- end proc

Energy Consumption Model

Energy model plays a vital role while sending and receiving data packets, less energy consumption improves the network lifetime. Energy aware technique in routing extends network lifetime of sensor nodes. The major components of radio model that drains the energy are transmitter and receiver. The four states of energy are: Idle, sleep, receive and transmit. The consumed energy is calculated as:

$$E_{trans} = P_{trans} \times t_{trans}$$
$$E_{rec} = P_{rec} \times t_{rec}$$
$$E_{idle} = P_{idle} \times t_{idle}$$
$$E_{sleep} = P_{sleep} \times t_{sleep}$$

Energy consumption in transmit, sleep, receive and idle state is represented as E_{trans}, E_{sleep}, E_{rec} and E_{idle}. Nodes state time is represented as $t_{trans}, t_{sleep}, t_{rec}$ and t_{idle}. Power consumption state is represented as $P_{trans}, P_{sleep}, P_{rec}$ and P_{idle}. The total energy consumed for node n_a to transmit and receive packet pk is

$$E_{Engy}(n_a) = E_{trans} + E_{rec} + E_{idle}$$

Weights are associated to represent amount of energy consumed for data transfer between pair of nodes. Each edge in network graph will have weight WE_{ab} representing single hop energy between two nodes n_a and n_b. For single hop energy consumption between two nodes can be calculated as

$$WE_{ab} = E(V_a, V_b)$$

In case path does not exist between pair of nodes $V_{a,b}$. A path $P_{a,b}$ from source node V_a to destination node V_b can have n nodes and $n-1$ multihops where $1 \le n \le V$. The total amount of energy of all nodes participating in multihop is given as :

$$PE_{ab} = \sum_{1=1}^{n-1} E(W_i)$$

Algorithm : Energy Model

- Initiate source and destination
- After Neighbour nodes discovery
- Initiate route discovery through RREQ and RREP messages
- flood RREQ message for seeking routes to destination
- Multiple reverse paths establishes from source node to destination node through intermediate nodes by RREQ propagation.
- RREP message traverse through reverse path from multiple forwarder nodes from destination to source and update it in NT along with link quality.
- update source energy and location information to all the nodes in the network
- GAOMDV optimal route to destination with highest energy level is given as

$$optimal\ path = \frac{\sum e(n) \in rdist(e(n) \in LQ}{\sum e \in E}$$

Where e represents edges link in optimum route r and E represents all edges in network

IV. PERFORMANCE ANALYSIS AND RESULTS

Simulation Parameters

In this section GAOMDV performance is evaluated and compared with existing AOMDV routing protocol. NS2 an event driven simulation tool is used to evaluate different scenarios. In this simulation MANET scenario is utilized, the 60 nodes are randomly place in a network area of 1000m. Traffic source CBR (Constant Bit Rate) is used. Due to nodes mobility topology changes and the link disjoint occurs frequently. The transmission range is set to 250mts. Initial energy 100J is given to all the nodes, the simulation parameter table is given in table. Different scenarios have been analysed and compared with AODV. The packet size is varied in different size of 128, 256 and 512 bytes, mobility speed and simulation time is set to 2m/s and 50sec respectively. In second scenario the node speed is varied 2, 5, and 7 by keeping packet size and simulation time to 256 bytes and 50sec.Finally in third scenario the simulation time is varied to 10, 20, and 30sec by keeping packet size and simulation time to 256 bytes and 50sec

Results and QoS Parameters

- **PDR** (Packet Delivery Ratio)

Is the ratio of successful data packets delivered to destination node to data packets generated by source node. PDR is most important network parameter in evaluating the QoS and performance of routing protocol. Higher the ratio proves the performance of routing protocol.

$$PDR = \frac{number\ of\ received\ packets}{number\ of\ sent\ packet} * 100$$

- In the figure shows the PDR of proposed system by varying mobility speed, as the node speed increases the PDR decreases. The comparison graph shows GAOMDV decreases lesser than AOMDV as the nodes move at different mobility speeds.

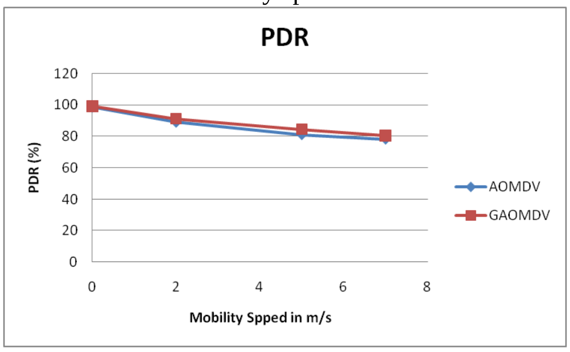

Figure 1(a): PDR graph with mobility speed

In figure 1(b) shows the PDR graph with different packet size. It is obvious that if packet size increases the packet delivery ratio decreases. GAMODV outperforms in delivery packet with reliable routes and also less packet loss.

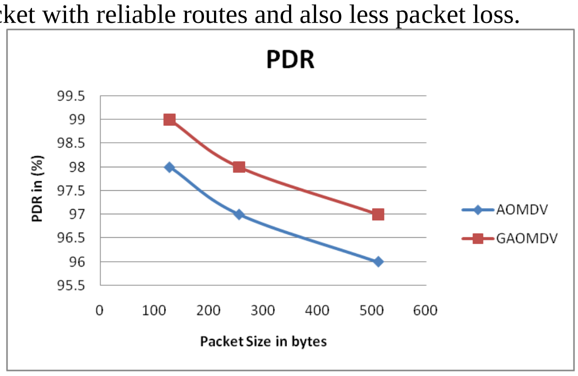

Figure 1(b): PDR graph with different packet size

In figure 1(c) shows the PDR graph by varying simulation time. As the total simulation time increases the PDR increases as the packets are generated more in different time durations.

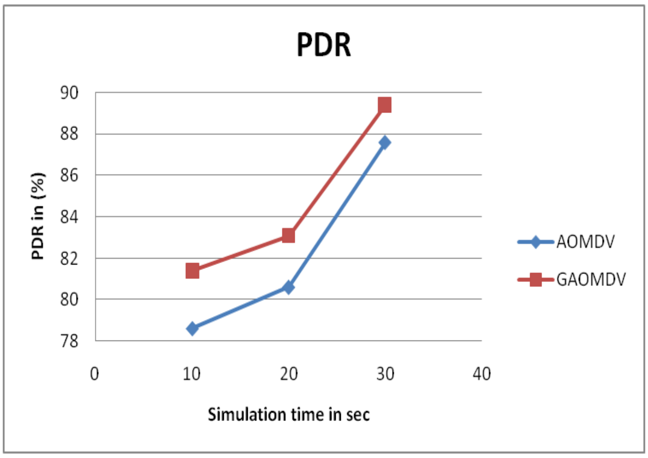

Figure 1(c): PDR graph with simulation time

- **Throughput**

The total number of bits received at destination is throughput, measured in Kbps. Throughput measures routing efficiency in achieving QoS requirements and is calculated as follows:

$$Throughput = (total\ received\ bytes * 8/\ time) * 1000\ Kbps$$

Three scenarios of throughput is shown in below figures, Figure 2(a) shows the throughput graph with varying mobility speeds, as the nodes moves in different speed the throughput decreases. GAOMDV selects reliable routes with high energy to deliver more number of bits to destination. When the packet size are varied throughput decreases as packet size increases. For smaller packet size the processing time is less and delivers more bits, where as for higher packet sizes the packet processing time increases thus reducing the throughput. Figure 2(b) shows throughput of GAOMDV and AOMDV protocol for different packet size. In Figure 2(c) shows the throughput graph by varying simulation time, as the time varies the throughput increases. If the links are stable as long, the throughput increases.

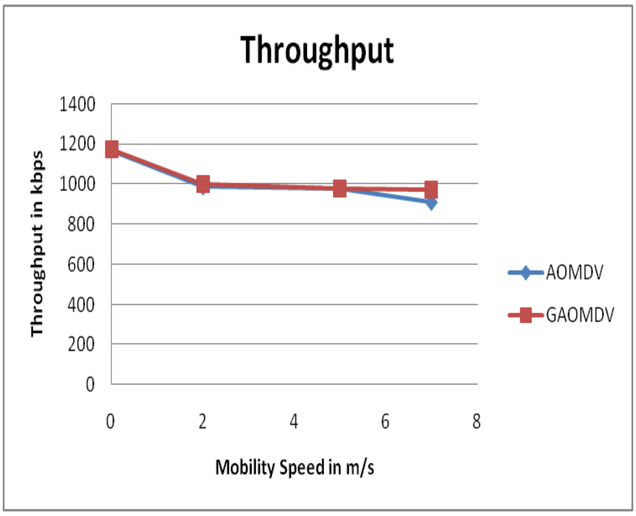

Figure 2(a): Throughput graph with mobility speed

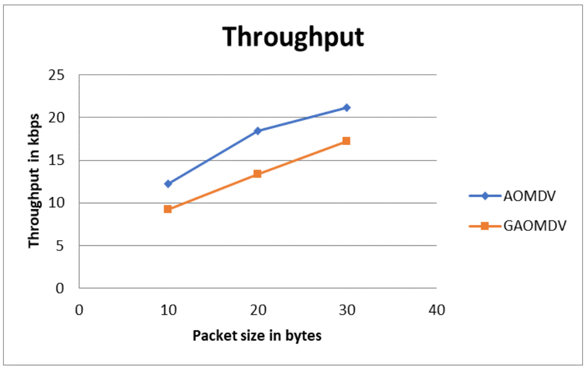

Figure 2(b): Throughput graph with packet size

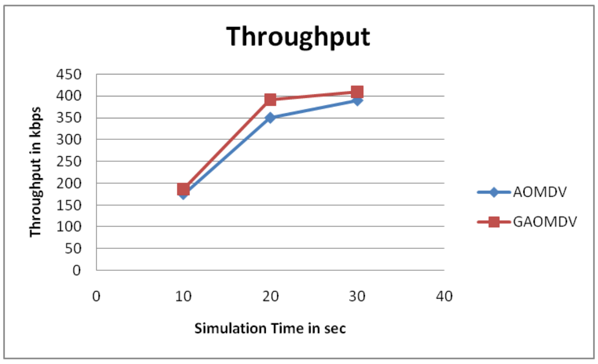

Figure 2(c): Throughput graph with simulation time

- **Average End to End Delay**

Is the average time taken in transmitting data packets through network from source to destination. This includes delay like buffering delay, route discovery delay, interface queue and retransmission delay. Average end to end delay is given as:

$$\sum T_1 - T_2 / N$$

where T_1 first data packet arrived time, T_2 is time first packet sent by source and N is total number of packets sent. Below figures shows the average end to end delay. In figure 3(a) shows the average delay by varying mobility speed of nodes. As the speed increases the channel fading occurs and the link quality becomes weak. By using link quality estimation GAOMDV delivers data with less delay by choosing routes with least distance and minimum hop count. In Figure 3(b) shows the delay graph with different packet sizes. Delay increase as the packet size increases. Finally in Figure 3(c) shows the delay graph at different simulation time.

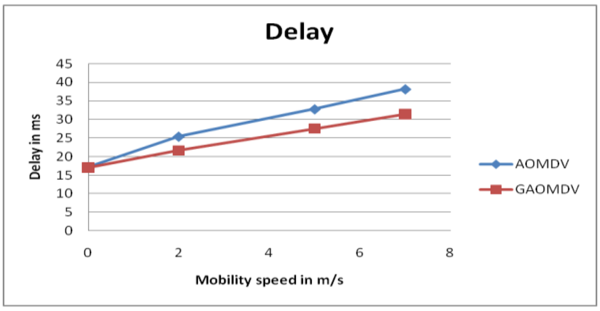

Figure 3(a): Delay graph with mobility speed

Retrieval Number: B2840129219/2019©BEIESP
DOI: 10.35940/ijeat.B2840.129219
Journal Website: www.ijeat.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

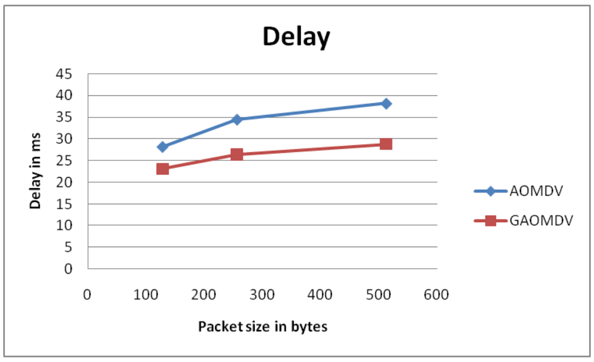

Figure 3(b): Delay graph with different packet size

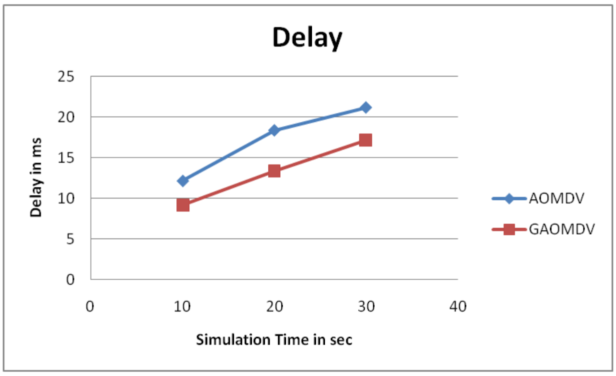

Figure 3(c): Delay graph with simulation time

- **Routing overhead**

Routing efficiency of the node is measured as total number of routing packets divided by overall data packets delivered. It is the average number of route packets which every data packets need to allow, it can be expressed as

$$Routing\ overhead = \frac{N_1}{N_2}$$

where N_1 is routing packets which are sent and forwarded. N_2 is data packets received and measured as bps. Figure 4(a) shows the overhead graph of GAOMDV and AOMDV by varying mobility speed. As the speed increases the routing packets will be generated more to find the multipath to destination. In Figure 4(b) shows overhead graph for different packet size. As the packet size increases the processing of packets consume more computations thus increasing overhead. In Figure 4(c) shows the overhead graph for different simulation time. It is obvious that as time increases routing overhead increases. Finally GAOMDV has less overhead over AOMDV in computing multipath to destinations.

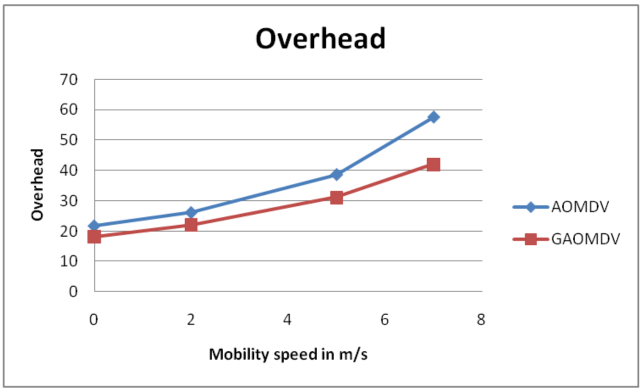

Figure 4(a): Overhead graph with mobility speed

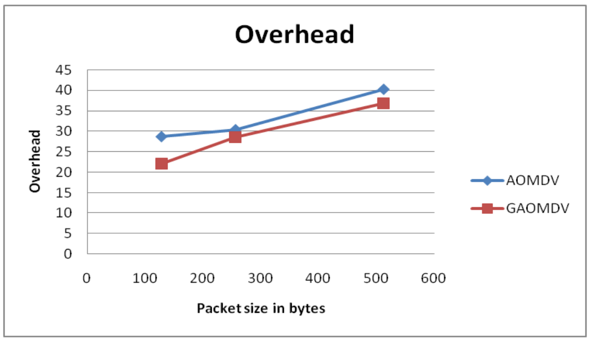

Figure 4(b): Overhead graph with different packet size

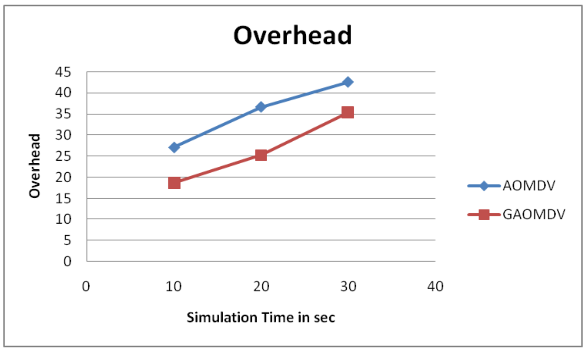

Figure 4(c): Overhead graph with simulation time

- **Energy Consumption**

It is the amount of power consumed by node in transmitting and receiving packets over the network. The energy is calculated at each node level to the end of simulation time. Energy can be expressed as:

$$E_{total} = E_{transmission} + E_{receving} + E_{sleep}$$

In the Figure 5(a) shows the energy consumption graph with different mobility speed. As the node moves at different mobility speed the channel fading occurs and topology changes frequently. This incurs in more energy consumption in finding stable link and nodes having high residual energy. GAOMDV consumes less power than AOMDV as GAOMDV estimates link quality between two nodes before transmitting data. In Figure 5(b) shows the energy graph with different packet size. Energy increases as packet size varies, to process different packet size node consumes more energy. Finally in Figure 5(c) shows the energy consumption graph with different simulation time. GAOMDV finds energy efficient routes to deliver packets than AOMDV.

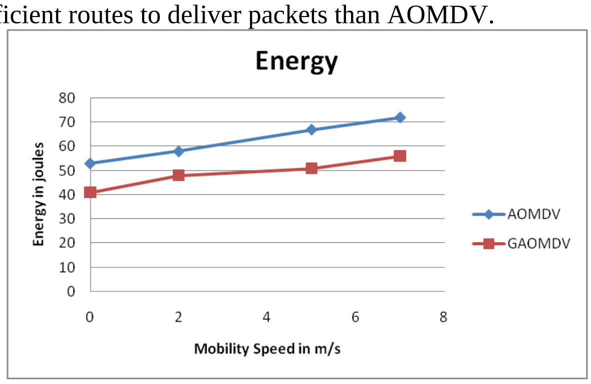

Figure 5(a) : Energy graph with mobility speed

Retrieval Number: B2840129219/2019©BEIESP
DOI: 10.35940/ijeat.B2840.129219
Journal Website: www.ijeat.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

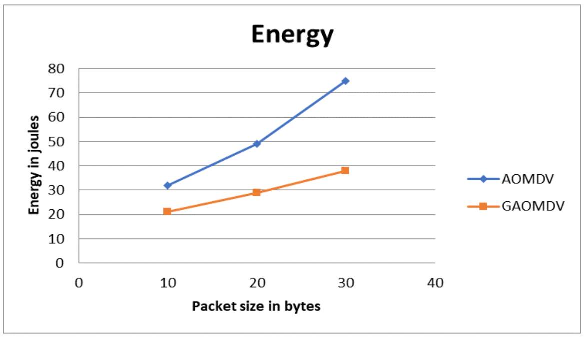

Figure 5(b) : Energy graph with different packet size

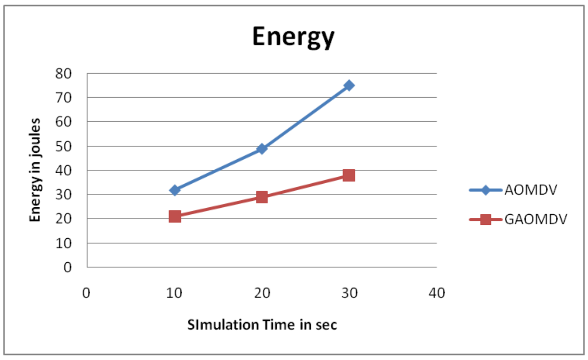

Figure 5(c) : Energy graph with simulation time

V. CONCLUSION

Demand for MANET's in applications makes QoS routing considers most important topic in sensor network. To accomplish QoS, multipath routing is most effective way for data transfer between source and destination. However due to node dynamics network suffers from interference, nodes disjoint and unstable links. This paper proposes efficient link quality estimation with minimum interference to select forwarding nodes based on Geographic ad hoc on demand multi path distance vector (GAOMDV) an adaptation of AOMDV routing protocol. To ensure the reliability of MANET's to achieve QoS parameters. Extensive simulation is carried on NS2 simulator under three scenarios by varying mobility speed, packet size and simulation time. Performance metrics like PDR, throughput, end to end delay, network overhead and energy is analysed. Simulation results shows proposed GAOMDV selects more stable links for reliable data transfer compared to AOMDV and shows better performance in packet delivery ratio, throughput, end to end delay, overhead and energy.

REFERENCES

1. C Hongju, Xiong, AV Vasilakos, Y Laurence Tianruo, C Guolong, Z Xiaofang, Nodes organization for channel assignment with topology preservation in multiradio wireless mesh networks. Ad Hoc Networks 10(5), 60773 (2012).
2. S. Corson, J. Macker, Mobile ad hoc networking (MANET): routing protocol performance issues and evaluation considerations, RFC2501, Naval Research Laboratory, University of Maryland, (1999).
3. Niranjan Potnis, Atulya Mahajan, Mobility models for vehicular ad hoc network simulations, Proceedings of the 44th annual Southeast regional conference, ACM New York, Melbourne, Florida, (2006).
4. E. Royer and C-K. Toh, A review of current routing protocols for ad hoc mobile wireless networks, IEEE Journal Personal Communications, 6(2), 46- 55, (1999).
5. S Marwaha, D Srinivasan, CK Tham, A Vasilakos, Evolutionary fuzzy multi objective routing for wireless mobile ad hoc networks, Evolutionary Computation, in Proceedings of the 2004 Congress on Evolutionary Computation (CEC '04), 2 1964–1971, (2004).
6. D Der-Rong, J Jhong-Yan, Delay-constrained survivable multicast routing problem in WDM networks. Comput Commun 35(10), 1172–1184 (2012).
7. Z Xin Ming, Z Yue, Y Fan, AV Vasilakos, Interference-based topology control algorithm for delay-constrained mobile ad hoc networks, in mobile computing. IEEE Trans 14(4), 742–754 (2015).
8. C Busch, R Kannan, AV Vasilakos, Approximating congestion + dilation in networks via "quality of routing" games. IEEE Trans. Computers 61(9), 12701283 (2012).
9. S Mueller, RP Tsang, D Ghosal, Multipath routing in mobile ad hoc networks: issues and challenges, in Performance tools and applications to networked systems, vol. 2965 of lecture notes in computer science (Springer, Berlin, Germany, 2004), 209–234.
10. Peng Li; Song Guo; Shui Yu; Vasilakos, A.V., CodePipe: an opportunistic feeding and routing protocol for reliable multicast with pipelined network coding, in INFOCOM, 2012 Proceedings IEEE, 100-108, 25-30 (2012).
11. W Lou, W Liu, Y Zhang, Performance optimization using multipath routing in mobile ad hoc and wireless sensor networks. Combinator. Optim. Commun. Netw. 2, 117–146 (2006).
12. F. Xia, "Review qos challenges and opportunities in wireless sensor// actuator networks," Sensors, vol. 8, no. 2, pp. 1099–1110, 2008.
13. F. Kuipers and P. VanMieghem, "Conditions that impact the complexity of qos routing," IEEE/ACM Transactions on Networking, vol. 13, no. 4, pp. 717–730, 2005
14. Ding, X., Sun, G., Yang, G., Shang, X., 2016. Link investigation of IEEE 802.15. 4 Wireless sensor networks in forests. Sensors 16 (7), 987.
15. Medjiah, S., Ahmed, T., Asgari, A.H., 2012. Streaming multimedia over WMSNs: an online multipath routing protocol. Int. J. Sens. Netw. 11 (1), 10–21.
16. Hamid, Z., Hussain, F.B., Pyun, J.Y., 2016. Delay and link utilization aware routing protocol for wireless multimedia sensor networks. Multimedia Tools Appl. 75 (14), 8195–8216.
17. A. Taha, R. Alsaqour, M. Uddin, M. Abdelhaq, and T. Saba, ``Energy efficient multipath routing protocol for mobile ad-hoc network using the fitness function," IEEE Access, vol. 5, pp. 10369_10381, 2017.
18. U. Burgos, U. Amozarrain, C. Gómez-Calzado, and A. Lafuente, ``Routing in mobile wireless sensor networks: A leader-based approach," Sensors, vol. 17, no. 7, p. 1587, 2017.
19. Aswale, S., Ghorpade, V.R., 2017. LQEAR: link quality and energy-aware routing for wireless multimedia sensor networks. Wireless Pers. Commun. 97 (1), 1291–1304.

AUTHORS PROFILE

Pradeep Karanje, received B.E in E&CE and M.Tech in Digital Electronics from Visvesvaraya Technological University, 2011 and 2013 respectively. Currently he is pursuing Ph.D in R&D centre of E&CE department, Guru Nanak Dev Engineering College, Bidar, India. He has about seven years of teaching experience. His area of research interests includes mobile ad hoc networks and wireless sensor networks. He has published over 07 technical papers in reputed journals and conferences.

Dr. Ravindra Eklarker, received B.E. in E&CE from Gulbarga University, Kalaburagi and M.Tech in computer science from Visvesvaraya Technological University in the years 1996 and 2001 respectively. He has earned his Ph.D from the same university in the year 2014. He has about 22 years of experience in teaching and also served as Head of the department of E&CE, Dean Academics and he is currently serving as principal of Guru Nanak Dev Engineering College, Bidar, India. His area of research interests includes mobile ad hoc networks, communication engineering and wireless sensor networks. He has published over 25 technical papers in reputed journals and conferences.