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An Optimised Multi Hop Routing Strategy for Mobile Adhoc Network

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Abstract— Majority of the research work done in the recent years focuses on routing protocols in Mobile Adhoc Network (MANET) that improves the overall energy and lifetime of the network. Majority of the traditional routing protocols are discovering the shortest path between source and destination without considering crucial parameters like energy level, quality of link, estimation of link expiry, location of nodes etc. which may result into poor packet delivery fraction, throughput, end to end delay and network routing load. To improve the overall network lifetime along with the packet delivery fraction and normalized routing load, this paper proposes an optimised multihop routing protocol (OMR-AODV) as an extension of Adhoc On-demand Distance Vector (AODV) by introducing threshold limit on residual battery of mobile node and quality of link during route establishment phase. AODV and OMR-AODV are simulated using NS2 with various parameters and results show that OMR-AODV performs better than AODV for overall network lifetime along with packet delivery fraction and normalized routing load.

Index Terms— MANET, AODV, Energy Efficiency, Link Quality

1 INTRODUCTION

A mobile ad-hoc network (MANET) is a set of mobile nodes connected with each other over wires links without having any infrastructural support. MANET is known as self-configuring and self-organizing network [1]. Each mobile node of a MANET freely moves anywhere and will result in change of network topology frequently. Each mobile node works as a router also and therefore is responsible to forward packets further. Fundamental challenge in constructing a MANET is preparing each node to retain up to date information for direct traffic accordingly. It is a kind of networks either function by their own or linked with the Internet. Diverse transceivers may be used between nodes which results in an extremely vigorous and independent topology. In MANET, on top of a link layer, routable network environment resides [2]. Conventional routing strategies of wired networks is not applicable in MANET because of its self-formation, self-configuration and peer to peer nature.

Key challenges like mobility, limited resources, error-prone channel, hidden and exposed terminals are required to be considered during designing a routing protocol for MANET. As nodes are operated by battery, improving its lifetime is one the primary objectives and extensive research work is going on to reflect energy aware based protocols for MANET. To establish communication between various nodes, each node works as a router to route a traffic and loss of even a small number of nodes because of energy exhaustion results into interruption of service in the whole network and can lead to network partition. The orthodox on-demand routing algorithms like AODV, ABR, DSR and LAR [3] are not aware about residual energy of nodes and begins connections among nodes by considering route as shortest path which may turn in a rapid exhaustion of node's energy among frequently used routes in the network. This research paper endeavors to amend one of the widespread on-demand routing protocols named AODV. A modified route establishment procedure that takes care of residual battery life along with quality of links added to traditional AODV that rises energy lifetime of node and also improves normalized routing load along with packet delivery fraction.

The remaining of this paper is structured as follows. Section 2 highlights a survey of different energy efficient and link quality aware routing protocols for MANET. Section 3 demonstrates proposed algorithm. Section 4 covers simulations and performance analysis and conclusion is covered in Section 5.

2 RELATED WORK

Deployment of MANET preliminarily focuses on overall lifetime of network that is restricted by energy in mobile nodes. Energy depletion of nodes can disturb communication and even cause network partitioning that proves why energy efficiency is critical for implementation of network protocols. Network link failure of active path introduces additional control packets for route establishment which decreases network performance due to additional control overhead. It also reduces overall network lifetime. Many different routing protocols have been proposed recently that focuses on energy of nodes and quality of links to improve overall network's lifetime. AODV based Energy Efficient Routing Protocol for Maximum Lifetime in MANET [4] suggested an improvement in AODV to improve lifetime of network. MMRE-AOMDV [5] suggested multipath routing protocol for MANET that

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extends AOMDV routing protocol and it finds minimal node remaining energy of each route in process of opting path and arranging multi-route by descending node remaining energy. Integrated Energy-Aware Mechanism [6] suggested load balancing mechanism along with controlled transmission power as a technique to increase effectiveness of on-demand routing with energy proficiency. SQ-AODV [7] suggested a cross layering approach to change information related to residual energy of mobile nodes to perform QoS. Adaptive link timeout with energy aware mechanism [8] proposed a novice method to set a path's time-out. A path is treated out of order once a node leaves by following exhaustion of its energy. Energy aware routing for low energy ad hoc sensor networks [9] proposed a method that combines residual energy and the expectable propagation energy loss acquired from sensing received signal strength. Reducing message overhead of AODV routing protocol in urban area by using link availability prediction [10] suggested different types of work which aim to decrease AODV's overhead to achieve energy efficiency by expecting links availability. CPC-AODV [11] suggested an enhancement in AODV through cross-layer power control by considering the geographical location of mobile nodes and packet transmission's energy. EAODV [12] proposed a mechanism of energy-aware routing which is based on traditional AODV with backup routing strategy. The route which devotes a smaller amount of energy and retains greater capacity is selected by synthetic investigation. Minimum Energy Routing Schemes for a Wireless Ad Hoc Network [13] proposed Minimum Energy Routing that addresses problems of gaining precise energy information, maintenance of the efficient energy routes, related overheads and implements the transmission power control mechanism in IEEE 802.11 MAC protocol. Link-quality aware ad hoc on demand distance vector routing protocol [14] proposed an enhancement in AODV by accounting quality of link during selection of the route. Avoid link Breakage in On-Demand Ad-hoc Network Using Packet's Received Time Prediction [15] focused on prediction of the link by considering received time of packet to expect signal power of link which helps further to guess failure of link. It initiates route maintenance if link is about to break. Replication decision algorithm based on link evaluation services in MANET [16] considered link quality metric estimation during selection of route. Modified DSR [17] focused on primary and secondary establishment of routes and secondary route becomes active if primary route is expected to break. The routing protocol AODV based on link failure prediction [18] focused on signal intensity threshold. According to received signal intensity, it calculates relative velocity with neighbour node and predicts failure of link and further route maintenance initiated if needed.

3 Proposed Work

Proposed work (OMR-AODV) mainly focuses on improvement of packet delivery fraction, normalized routing load and overall network lifetime. It provides optimized multihop routing by considering residual energy and received signal strength of source and destination nodes. Whenever source wishes to transfer packets to destination, first it establishes a path because of an on demand routing protocol and to establish a path for destination, it initiates route discovery process by broadcasting route request packet (RREQ) to all its neighbors same as AODV as illustrated in Fig 1 and Fig 2 respectively. When an intermediate node in AODV receives RREQ packets then it sets a reverse path entry in its routing table to remember path of source node and re-broadcasts same to all its neighbors further as shown in Fig 3 while an intermediate node in OMR-AODV receives RREQ, it evaluates its residual energy along with received signal strength with predefined threshold values. If intermediate node qualifies threshold values then it sets a reverse path entry in its routing table to remember path of source node and re-broadcast same to all its neighbors further else node concludes that its residual energy and/or received signal strength is not enough to participate in ongoing route establishment process and node will discard received RREQ packet as shown in Fig 4. Same process repeats in both AODV and OMR-AODV till destination receives RREQ initiated from source. Once destination node gets the first RREQ packet, it transmits a route reply packet (RREP) towards source node in AODV as shown in Fig 5 which always focuses on shortest path while in case of OMR-AODV, It focuses on stronger path as shown in Fig 6. Once source node receives RREP, it initiates transmission of actual data packets similarly in AODV and OMR-AODV.

Fig 7 shows detailed OMR-AODV algorithm.

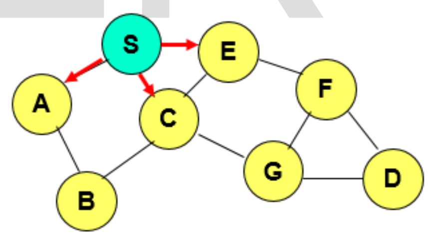

Fig 1: OMR-AODV: Source initiates RREQ

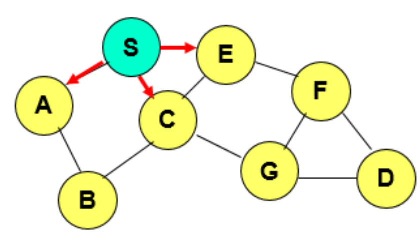

Fig 2: AODV: Source initiates RREQ

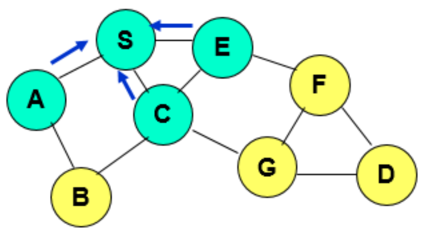

Fig 3: AODV: Intermediate nodes establish reverse path to Source

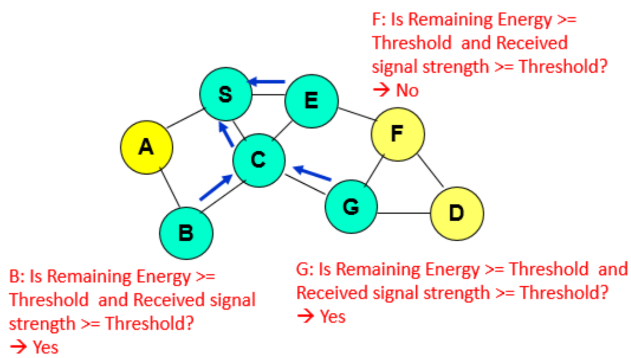

Fig 4: OMR-AODV: Intermediate node checks remaining energy with threshold value

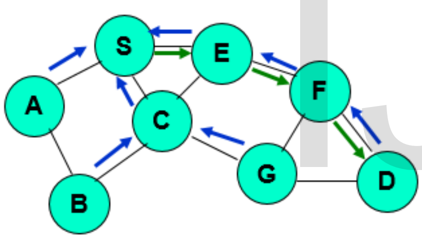

Fig 5: AODV: Source selects path to Destination

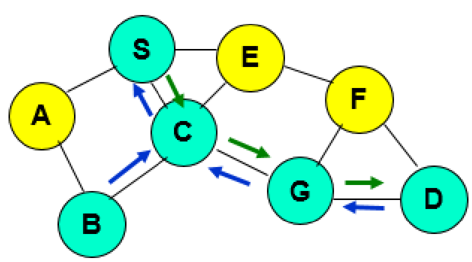

Fig 6: OMR-AODV: Source selects path to Destination

Begin
Step 1. Source initiates Route Request process to find route to destination.
Step 2. Source broadcasts RREQ packet to neighbors.
Step 3. Node verifies following upon in receipt of RREQ packet
Is Remaining Energy >= Threshold and Received signal strength >= Threshold?
If yes, it broadcast the same packet to own neighbors
Else it discards RREQ packet.
Step 4. Repeat Step 3 until RREQ packet reaches to its Destination.
Step5. Destination replies to Source through RREP via established same reverse path.
Step6. Upon receiving RREP at Source, It initiates actual data transmission.
End

Fig 7: OMR-AODV – Algorithm

4 SIMULATION AND RESULTS

Simulation of AODV and OMR-AODV has been carried out using ns-2 simulator with random direction mobility model. Within L X L area, nodes are initially positioned randomly in each simulation. Data rate of simulations is set to 2 Mb/sec and data packet size is 64 bytes. Free space propagation model has been used and each simulation was executed for node movement speed ranging from 1 m/s to 10 m/s. Ten simulation runs were accomplished for each movement speed, with different initial configuration and its results were be an average of to generate resulting graphs. Each simulation ran for 300 seconds. Table 1 shows detailed simulation parameters used to produce resulting graphs. The key objective of these simulations is to demonstrate the effectiveness of proposed algorithm OMR-AODV over traditional algorithm AODV for parameters like average network life time, packet delivery fraction, throughput, normalized routing load and overall route repairs.

Packet Delivery Fraction (PDF) can be defined as the total packets received at receiver to total packets sent from sender. As OMR-AODV focuses on stronger path by considering remaining energy of participating node along with strength of signal, significant improvement is recorded in PDF. Fig 8 shows improvement in packet delivery fraction in OMR-AODV over traditional AODV for nodes 50, 100, 250 and 500. OMR-AODV performs better as number of nodes increased from 50 to 500 due to lesser number of route failure. AODV focuses on shorter path and as a result OMR-AODV performs even better in case of high mobility as its considering signal strength and not hop count.

TABLE 1: SIMULATION PARAMETERS FOR AODV AND OMR-AODV

Parameter	Value	
Number of Nodes	50	100
Room Size	1000 X 1000 meter2	1500 X 1500 meter2
Number of Nodes	250	500
Room Size	2400 X 2400 meter2	3450 X 3450 meter2
Maximum Connection	20	
Transmission Range	250m	
Bandwidth	2 Mbps	

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Node Movement Speed	1,5 & 10 m/s
Mobility Model	Random Direction
Nodes Placement	Random
Routing Protocol	AODV
Packet Size	64 Bytes
Simulation Time	300 Seconds
Packet Rate	4 Packets/sec
Pause Time	10 ms
Initial Energy	100 J
txPower	1.5 w
rxPower	1 w
idlePower	0.1 w
sleepPower	0.5 w

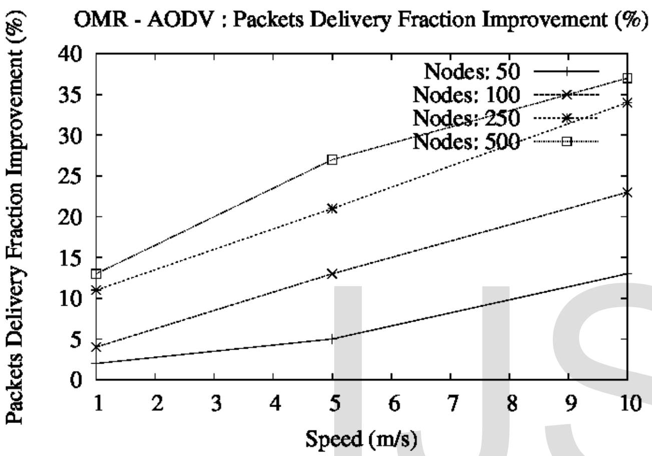

Fig 8: Packet Delivery Fraction Improvement (%)

Average remaining energy is defined as remaining energy of network. OMR-AODV allows node to participate in route only if its remaining energy is above predefined threshold value and ultimately it helps to improve average remaining energy of overall network. Fig 9 shows improvement in average remaining energy in OMR-AODV over traditional AODV for nodes 50,100,250 and 500. OMR-AODV is not allowing node to participate in route if node is not having sufficient remaining energy and as a result the overall average network lifetime increases significantly.

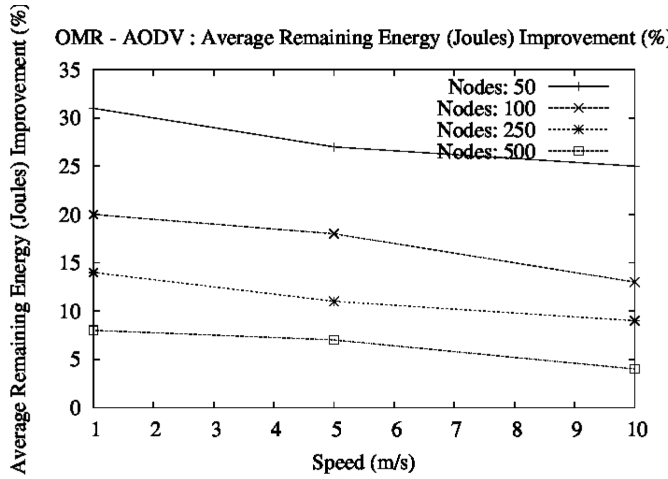

Fig 9: Average Remaining Energy (Joules) Improvement (%)

Normalized Routing Load (NRL) is defined as total routing packets transmitted per data packet delivered at the destination. OMR-AODV focuses on stronger path by considering remaining energy of intermediate nodes along with signal strength that results into lesser route failure and better normalized routing load. Fig 10 shows improvement in normalized routing load in OMR-AODV over traditional AODV for nodes 50, 100, 250 and 500. AODV is not considering strength of link and remaining energy of intermediate node and as a result if node participating in route with low quality of link and/or less remaining energy then route may break after some time and as a result needed to find alternative route that increase normalized routing load. OMR-AODV considers both remaining energy of intermediate node and quality of link which avoids weaker route and improves performance of OMR-AODV.

Throughput is defined as the amount of data received by destination. Throughput is proportional to packet delivery fraction. As OMR-AODV focuses on stronger path, throughput is improved as compare to traditional AODV. Fig 11 shows improvement in throughput in OMR-AODV over AODV for nodes 50, 100, 250 and 500.

Route repair is defined as maintenance of route in case of its failure. OMR-AODV tries to reduce route repairs by considering strong routes. Fig 12 shows improvement in route repairs in OMR-AODV over traditional AODV for nodes 50, 100, 250 and 500. OMR-AODV avoids node to take participation in establishment of route if it violates threshold value of remaining energy and/or link quality and as a result established path becomes stronger and requires less repairing of route in future.

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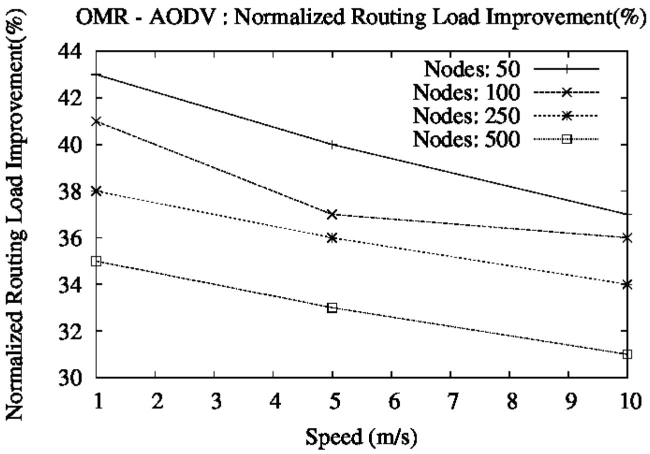

Fig 10: Normalized Routing Load Improvement (%)

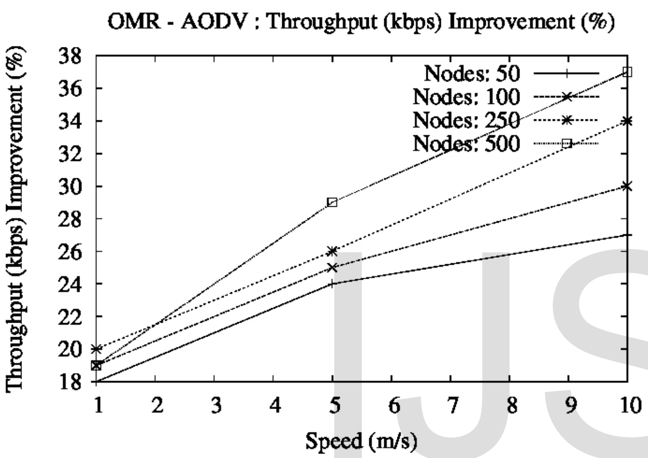

Fig 11: Throughput (kbps) Improvement (%)

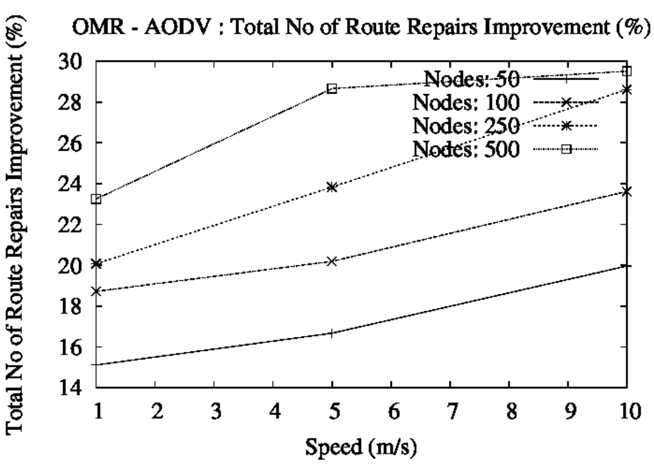

Fig 12: Total No of Route Repairs Improvement (%)

5 CONCLUSION

Mobile adhoc network consists of mobile nodes and having no support of existing infrastructure. Mobile nodes are equipped with limited battery and energy efficiency is one of the key challenges for enhancement of routing algorithm. This paper has proposed OMR-AODV as an enhancement of AODV by considering the residual energy of each intermediate node along with received signal strength during route establishment process. Proposed modification is not considering shorter path like AODV but establishes stronger path among source and destination and same leads to improvement of overall network life time, packet delivery fraction, throughput, total route repairs, and normalized routing load because it avoids node with critical energy level and weaker link to take part in to selection of route between source and destination.

REFERENCES

[1] Tomas Krag and Sebastian Buettrich. "Wireless Mesh Networking". O'Reilly Wireless Dev Center.

[2] Morteza Mohammadi Zanjireh et al, “Analytical Modelling of ANCH Clustering Algorithm for WSNs”, ICN 2014, The Thirteenth International Conference on Networks, pp: 68 – 73.

[3] Mehran Abolhasan et al, “A review of routing protocols for mobile ad hoc networks”. Technical report, Telecommunication and Information Research Institute, University of Wollongong, Wollongong, NSW 2522; Motorola Australia Research Centre, 12 Lord St., Botany, NSW 2525, Australia, 2003.

[4] Jin-Man Kim, Jong-Wook Jang, “AODV based Energy Efficient Routing Protocol for Maximum Lifetime in MANET”, IEEE 2006.

[5] Liu, Lili Guo,HuizhuMa, Tao Jiang, “Energy Efficient on–demand Multipath Routing Protocol for Multi-hop Ad Hoc Networks”, IEEE 2008.

[6] M. Tamilarasi, T.G. Palanivelu, “Integrated Energy-Aware Mechanism for MANETs using On demand Routing”, International Journal of Computer and Information Engineering, 2008.

[7] M. Veerayya, V. Sharma, A. Karandikar, “SQ-AODV: A novel energy aware stability based routing protocol for enhanced QOS in wireless ad-hoc networks”, MILCOM 2008.

[8] M. Tamilarasi, T.G. Palanivelu, “Adaptive link timeout with energy aware mechanism for on demand routing in MANETs”, Ubiquitous Computing and Communication Journal, 2010.

[9] R.C.Shah,J.M. Rabaey, “Energy aware routing for low energy ad hoc sensor networks”, WCN, 2002.

[10] R. Ghanbarzadeh, M. R. Meybodi, “Reducing message overhead of AODV routing protocol in urban area by using link availability prediction”, Second International Conference on Computer Research and Development, 2010.

[11] H. Huang, G. Hu, F. Yu, “A Routing Algorithm Based on Cross-layer Power Control in Wireless Ad Hoc Networks”, Communications and Networking in China (CHINACOM), 2010.

[12] Zhang Zhaoxiao, Pei Tingrui, Zeng Wenli, "Modified Energy-Aware AODV Routing for Ad hoc Networks", IEEE 2009.

[13] Doshi S, Brown TX, "Minimum Energy Routing Schemes for a Wireless Ad Hoc Network" Proceedings of the Conference on Computer Communications, 2002.

[14] Tsai H. – M., Wisitpongphan, N., Tonguz, O. K. "Link-quality aware ad hoc on demand distance vector routing protocol", International Symposium on Wireless Pervasive Computing 2006.

[15] Naif Alsharabi, Ya ping Lin, Waleed Rajeh, "Avoid link Breakage in On-Demand Ad hoc Network Using Packet's Received Time Prediction", Proceedings of 19th European Conference on Modelling and Simulation, ECMS 2005.

[16] Hauspie, M., Simplot, D., Carle, J., "Replication decision algorithm based on link evaluation services in MANET", CNRS UPRESA 8022 — LIFL University Lille 2002.

[17] Ramesh, V., Subbaiah, P., and Supriya, K., "Modified DSR (preemptive) to reduce link breakage and routing overhead for MANET using proactive route maintenance (PRM)", Global Journal of Computer Science and Technology, Vol. 9. Issue 5, 124-129, 2010.

[18] Li, Q., Liu, c., and Jiang, H., "The routing protocol AODV based on link failure prediction", ICSP IEEE. 2008.