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An enhanced AODV routing protocol for MANETs

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Abstract

In this paper, a new routing protocol for Mobile Ad-Hoc networks (MANETs) is presented; the proposed power-hop based Ad-hoc on demand Distance Vector (AODV) is named PH-AODV, it uses the node power and the hop count parameters to select the best routing path. This paper compares the performance of the proposed PH-AODV in terms of average delay, average dropped packets and average throughput. Results reveal that PH-AODV is much better than AODV.

Keywords: *Ad-hoc network, AODV routing algorithm, power aware routing protocol.*

1. Introduction

In the last few years, many studies have been performed in MANETs, especially in unicast routing protocols [1]. Route selection is a key function in routing for MANETs. Nowadays, a lot of applications require high bandwidth for transmission voice, video, and data, so the need for routing protocols that provide high flow rates and very small transfer delay is essential. In the literatures, there is a wide variety of ad hoc routing protocols: on-demand routing protocols are very popular, they discover and maintain routes only when needed and they reduces routing overhead. AODV routing protocol is probably the most cited routing protocols for MANETs in literature. Recently, there has been substantial work done in the field of developing efficient energy and reliable routing protocols for enhancing the performance in MANETs [2,3].

A major drawback of the most existing ad hoc routing protocols is that they do use only one metric during route setup. Hence they cannot adapt to the dynamic MANET environment. In this paper, we proposed a new variant of AODV routing protocol, called PH-AODV, which combines the power coefficient and the hop count parameter to improve Quality of Service (QoS) in the MANET and to select better routing paths.

The rest of this paper is organized as follows: section 2 presents QoS in MANETs, section 3 presents AODV routing protocol, section 4 presents related work that may improve the AODV performance, section 5 presents the proposed PH-AODV routing algorithm, sections 6 presents simulation results, and finally, section 7 concludes the paper.

2. QoS in the MANET

QoS means that the network should provide some kind of guarantee or assurance about the level or grade of service provided to an application [4]. The QoS is characterized by a certain number of parameters (throughput, latency, jitter and loss, etc.) and it can be defined as the degree of user satisfaction. QoS model defines an architecture that may provide the possible best service. This model must take into consideration all challenges imposed by Ad-hoc networks, like network topology change due to the mobility of its nodes, constraints of reliability and energy consumption, so it describes a set of services that allows users to select a number of safeguards (guarantees) that govern such properties as time and reliability [5]. The Integrated Services (Intserv) architecture provides a means for the delivery of end-to-end QoS to applications over heterogeneous networks, the Resource ReSerVation Protocol (RSVP) defines the Resource reSerVation Protocol that can be used by applications to request resources from the network, the network responds by explicitly admitting or rejecting these RSVP requests [6], as a result, IntServ/RSVP model is not suitable for MANETs due to the resource limitation in MANETs, and the service differentiation (DiffServ) is not also suitable for MANETs because the concept of Service Level Agreement (SLA) does not exist in MANETs [7]. However, a flexible QoS model for MANETs (FQMM) considers the characteristics of MANETs and combines the high quality QoS of IntServ and Diff-Serv [8].

3. Overview of AODV

The AODV protocol is a reactive routing protocol based on the distance vector Principle, it supports unicast and multicast routing, it does not require nodes to maintain routes to destinations that are not in active communication and it allows mobile nodes to respond to link breakages and changes in network topology in a timely manner. One distinguishing feature of AODV is its use of a destination sequence number for each route entry to ensure loop freedom [9]. AODV protocol works in two main phases: (i) Path Discovery and (ii) Path Maintenance. The path discovery process is initiated whenever a source node needs to communicate with another node for which it has no routing information in its table. The source node initiates path discovery by broadcasting a route request (RREQ) packet to its neighbors. Each neighbor either satisfies the RREQ by sending a route reply (RREP) packet back to the source, or rebroadcasts the RREQ to its own neighbors after increasing the hop count. As the RREQ travels from source to destination reverse path is set up automatically and when the RREP travels back to the source, each node along the path sets up a forward pointer to the node from which RREP came [9]. If the source node moves during an active session, it can reinitiate the route discovery procedure to establish a new route to the destination. When either the destination or some intermediate node moves, a special RREP is sent to the affected source nodes. Periodic hello messages can be used to ensure symmetric links, as well as to detect link failures [9].

4. Related work

To improve the saving energy performance of AODV routing protocol in MANETs, the power controlled mechanism was adopted to adjust the emission power of node dynamically and presented a novel saving energy routing protocol (ES-AODV) [10], ES-AODV protocol focuses on the local repair as it minimizes the probability of using source node for the route rebuild, it comprehensively evaluates excess energy of nodes; each node in the link calculates its weight which is in inverse proportion with its energy. The routing protocol always chooses the smallest cost link for data transmission. Energy consumption of nodes in the network could be effectively balanced and the average survival time of nodes in the network can be improved.

In Robust AODV protocol [11], where the active route is maintained by locally updating active route information to 1-hop neighbors, multiple backup routes are built and the highest priority backup route is switched to become the new active route when the current active route breaks or when it's less preferred. Maintaining the active route by locally updating active routing information allows routes to adapt to topology variations, makes them robust against mobility, and enables them to reach local optimum. The adaptation to mobility is especially obvious when the source/destination node keeps moving. In Robust AODV, the overhead is low compared with proactive routing protocols because only the active route is maintained and the route update message is only broadcasted locally to 1-hop neighbors. Its overhead is almost not affected by speed while the original AODV overhead obviously increases when the speed increases.

The Improving AODV Routing Protocol with Priority and Power Efficiency (AODV-PP) [12] has a capability to determine battery of intermediate node along with the priority of the application as it selects a node with a high remaining energy to increase the lifespan of the node.

The Modified Reverse Ad Hoc On Demand Distance Vector (MRAODV) routing algorithm [13] presents an algorithm to select maximum suitable path between source and destination on the basis of energy of nodes, stability of nodes and hop-count of paths.

In Optimized AODV (OAODV) routing protocol [14], the node does not forward RREQ unless there is sufficient energy (battery lifetime), and until the node density in its surrounding exceeds a particular threshold.

5. PH-AODV routing algorithm

Comparing with AODV, the proposed PH-AODV protocol aims to achieve better throughput, better average end to end delay and better average drop packets. PH-AODV is a distance vector reactive routing protocol that combines the node power level and the hop count parameters to select better routing path. Similar to AODV, When a source node that seeks sending data packets to a destination node, PH-AODV checks the source route table for a valid route to the destination node, if exists, it forwards the data packets to the next hop along the way to the destination. On the other hand, if a valid route is not existing in the route table of the source node, it starts a route discovery process by broadcasting a RREQ (The RREQ contains the internet protocol (IP) addresses of the source and destination nodes, current sequence number, the last known sequence number, node power level and hop-count) to its neighbors, Its neighbors forward the RREQ to their neighbors until the RREQ reaches the destination or an intermediate node that has fresh route information. Nodes receiving this packet update their routing table for the source node and set up backwards path to the source node, the route cost is calculated using the following equation:

$$rout\_cost = w1 * \frac{1}{hopcount} + w2 * \sum \frac{node\_power\_level}{hopcount}$$

Noting that the weighting parameters, w1 and w2 are set experimentally to 0.5. The recorded information shall be used to construct the reverse path for the route reply packet, if the same route reply packet arrives later on, it is discarded. The destination or intermediate which knows the route to the destination node will send a route reply packet (RREP) to the source node along the path from which the first copy of the RREQ is received, it should be noted that the intermediate node replies to the RREP only if it has a destination sequence number that is greater than or equal to the number contained in the RREP. When the RREP arrives from the destination or the intermediate node, the nodes forward it along the established reverse path and store the forward route entry in their route table by the use of symmetric links. When receiving a route with a better route_cost, the routing table of a node is updated to ensure using the best power_hopcount route for transmitting data packets. If the destination or the intermediate node moves away a route maintenance process is initialized and performed by sending a link failure notification message to each of its upstream neighbors to ensure the deletion of that particular part of the route. Once the link failure notification message reaches source node, it restarts a new route discovery process.

6. Simulation results

The proposed PH-AODV routing protocol is simulated using Glomosim network simulator [15] and compared to AODV routing algorithm. Table 1 shows the Glomosim simulation parameters. The aim of these simulation runs is to analyze the performance of the proposed PH-AODV protocol and to compare its performance with the original AODV. Performance is compared in terms of average throughput, average delay and average drop packets. Average dropped packets is the ratio for the packets not delivered to destination node, throughputs is defined as the ratio of number of packets received to that of the number of packets sent and the end to end delay is the overall average delay experienced by a packet from the source to that of the destination.

Table 1: Simulation parameters

Seed	1-10
Terrain Dimentions	(400,400) (600,600) (800,800) (1200,1200) (1400,1400)
Simulation time	150s
Number of nodes	10,25,75,100,150
Node placement	unifrom
Mobility min speed	0
Mobility max speed	10,25,75,100 and 150m/s
Routing protocol	Original-AODV, PH-AODV

To compare the performance of the proposed PH-AODV with the original AODV, we run many simulation experiments: Figures 1 and 2 show the throughput simulation results evaluated over different number of node and different terrain dimensions. It is obvious that the throughput of PH-AODV is better than the original AODV. Figures 3 and 4 show the average drop packets evaluated over different number of node and different mobility speeds. It is also obvious that PH-AODV works much better that the original AODV. Lastly, Figures 5, 6 and 7 show the average delay evaluated over different number of node, different terrain dimensions and different mobility speeds. It is obvious that PH-AODV works much better that the original AODV in terms of average delay, however, AODV works better for small areas.

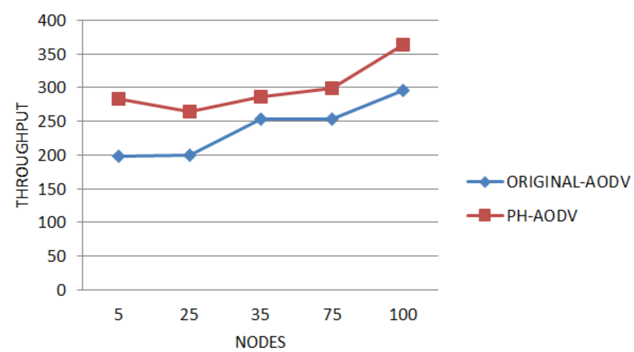

Fig. 1: Throughput result comparison evaluated over different number of nodes.

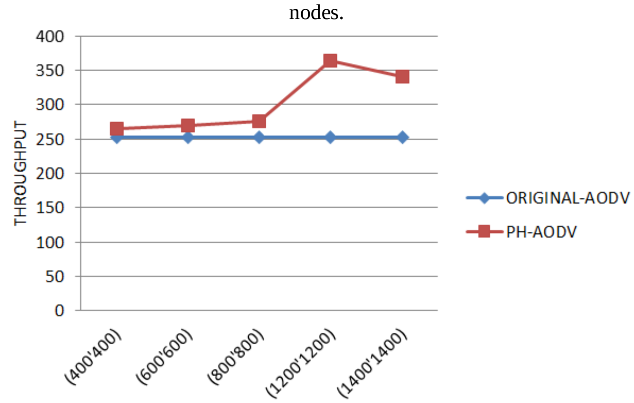

Fig. 2: Throughput result comparison evaluated over different terrain areas.

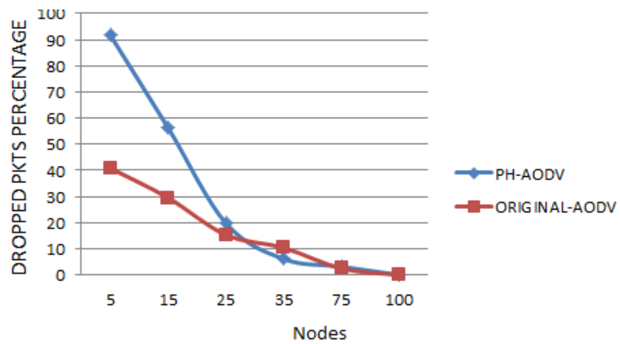

Fig. 3: Average drop packet results evaluated over different number of nodes.

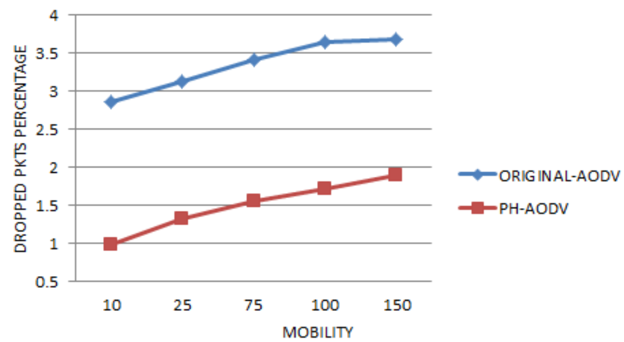

Fig. 4: Average drop packet results evaluated over different mobility speeds.

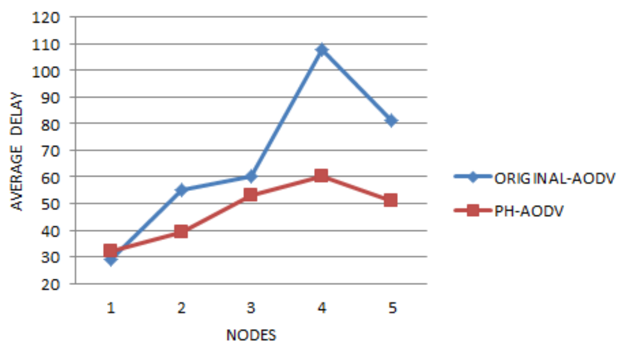

Figure 5: Average delay results evaluated over different number of nodes.

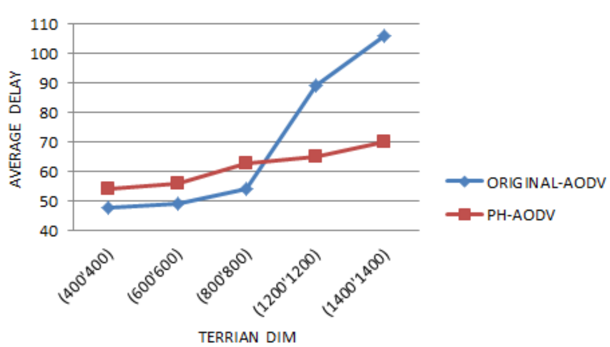

Fig. 6: Average delay results evaluated over different terrain areas.

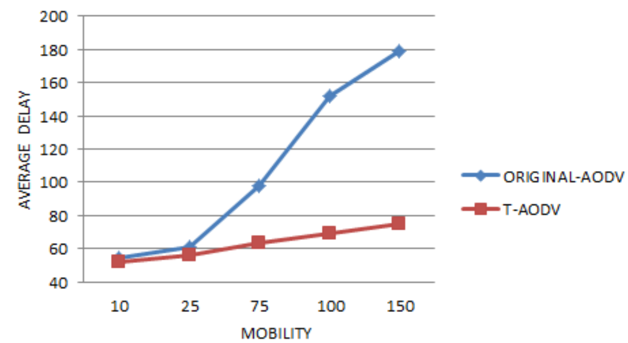

Fig. 7: Average delay results evaluated over different mobility speeds.

7. CONCLUSION

In this paper, a PH-AODV routing protocol is proposed, it is a modified version of AODV. The proposed protocol combines the power coefficient and the hop count parameter to improve the performance of AODV. And it is compared with AODV in terms of throughput, end to end delay and number of drop packets. It is observed that the new protocol is much better than original AODV.

References

[1] T. Mohammed, et al. "Survey of multipath routing protocols for mobile ad hoc networks." Journal of Network and Computer Applications vol. 32.6, 2009, pp. 1125-1143.

[2] A. Dhatrak, A. Deshmukh and R. Dhadge. "Modified AODV Protocols: A Survey". IJCA Proceedings on 2nd National Conference on Information and Communication Technology NCICT(3), 2011, pp.25-28.

[3]L. Hanzo, R. Tafazolli, "A Survey of QoS Routing Solution For Mobile Ad hoc Networks", IEEE Communications Surveys & Tutorials, Vol. 9, Issue: 2, 2007.

[4] M. Lakshmi, and S. Venkatachalam. "Comparative analysis of QoS routing protocols in MANETS: Unicast &Multicast." International Journal of Emerging Technology and Advanced Engineering Vol 2, Issue 4, 2012, pp. 242-250

[5] S. Maamar, A. Bilami, and M. Benmohamed. "M-AODV: AODV variant to improve quality of service in MANETs." IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 1, 2011, pp. 429-436

[6] Le Faucheur, F., Ed., "Aggregation of Resource ReSerVation Protocol (RSVP) Reservations over MPLS TE/DS-TE Tunnels", RFC 4804, 2007. [Online]. http://tools.ietf.org/html/rfc4804.txt.

[7] W. Kui, and J. Harms. "QoS support in mobile ad hoc networks." Crossing Boundaries-the GSA Journal of University of Alberta 1.1, 2001, pp. 92-106.

[8] Xiao, Hannan, et al. "A flexible quality of service model for mobile ad-hoc networks." Vehicular Technology Conference Proceedings, 2000. VTC 2000-Spring Tokyo. 2000 IEEE 51st. Vol. 1. IEEE, 2000, pp. 445-449

[9] C. E. Perkins, E. M. Royer and S. R. Das, "Ad hoc On-Demand Distance Vector (AODV) Routing," IETF RFC-3561, MANET Working group, 2003.

[10] Tang, S., & Zhang, B. (2004, August). "A robust AODV protocol with local update". In Communications, 2004 and the 5th International Symposium on Multi-Dimensional Mobile Communications Proceedings. The 2004 Joint Conference of the 10th Asia-Pacific Conference on Vol. 1, pp. 418-422.

[11] X. Wang, Q. Liu, and N. Xu, The energy-saving routing protocol based on AODV. In Natural Computation, 2008. ICNC'08. Fourth International Conference on Vol. 5, 2008 pp. 276-280.

[12] S. Sharma, and P. Patheja. "Improving AODV Routing Protocol with Priority and Power Efficiency in Mobile Ad hoc WiMAX Network." International Journal of Computer Technology and Electronics Engineering (IJCTEE) Vol 2, Issue 1, 2012, pp.87-93.

[13] P. Kumar , R.t Kumar, and S. Kumar, "Improved Modified Reverse AODV Protocol", International Journal of Computer Applications (IJCA)Volume 12– No.4, 2010, pp. 22-26.

[14] P. Bhatsangave, and R. Chirchi, "OAODV Routing Algorithm for Improving Energy Efficiency in MANET", International Journal of Computer Applications, Vol. 51, 2012, pp. 15-22.

[15] M. Takai, L. Bajaj, R. Ahuja, R., Bagrodia and M. Gerla, GloMoSim, "A Scalable Network Simulation Environment", Technical Report 990027. UCLA, Computer Science Department. 1999.

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