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AODV and OLSR Routing Protocols in MANET

Reza Malekian [1,2] and Aleksandar Karadimce [1]
[1]Department of Computer Science and Engineering
University for Information Science and Technology
"St. Paul the Apostle" Ohrid, Republic of Macedonia
Email: reza.malekian@ieee.org

Abdul Hanan Abdullah [2]
[2]Department of Computer Systems and Communication
Faculty of Computer Science and Information Systems
Universiti Teknologi Malaysia, Johor, Malaysia

***Abstract*—The growing of wireless and mobile technologies has resulted in more and more active researches to be done on scalability, performance, and compatibility of packet routing with minimal changes to the network. In this paper, we review two well known routing protocols in mobile ad hoc networks i.e., Ad hoc On-Demand Distance Vector and Optimized Link State Routing Protocols and compare them in terms of performance.**

***Keywords*—Mobile Ad Hoc, AODV, OLSR, Multipoint Relay, Topology control message.**

I. Introduction

The recent advances in mobile computing and wireless technologies makes new challenges in wireless and mobile networking. In mobile ad hoc, there is a need to rapid deployment of independent mobile nodes and it cannot reply on any fixed infrastructure and organized connectivity. Thus, based on this determinations it is necessary to improve mobile ad hoc networks (MANET) in order to support robust and efficient operation in mobile networks by incorporating routing functionality into mobile nodes.

Routing algorithms can be categorized in two groups: non-adaptive (static) and adaptive algorithms (dynamic). In adaptive routing algorithms, routing is based on traffic measurements and current network conditions such as round-trip times and number of hops, while, non-adaptive routing is not and all the routes from source to destination computed in advance.

Link state algorithms are based on shortest path first algorithm [1], known as Dijkstra algorithm [2]–[4] as well, to find the optimal path from source to destination. In this algorithm, each router shares its link information with its adjacent nodes through sending hello message and updates periodically any changes in routing table with link state update messages [5], [6]. In this way, each node can build up a topology of network and find the next optimal hop to the destination. Finding shortest path is according to following equation:

$$D(v) = min\{D(v), D(w) + c(w, v)\} \tag{1}$$

Where $D(v)$ is current cost of path from source to node v and initially is equal to $D(v) = c(u, v)$ for every node u adjacent to v and it is infinity for non adjacent nodes. Initially, $S = \{u\}$, where u is source node. To update $D(v)$, algorithm should find w which is no listed in S with smallest $D(w)$ and then add w to S.

Despite of link state algorithm, distance vector algorithm only broadcast link information to its adjacent nodes not to all the nodes. Every node in this routing algorithm maintains a routing table with entries to its adjacent nodes.

$$D_x(y) = min\{c(x, v) + D_v(y)\} \quad \forall\, node\ y \in N \tag{2}$$

where, $D_x(y)$ is estimation of minimal cost from x to v and $c(x, v)$ is cost [7] for direct link from x to v and $D_v(y)$ is adjacent distance vectors maintained in node x.

With progress of wireless and mobile technologies, there are efforts to standardize functionalities of IP routing protocols suitable for the new applications. The main challenge of routing protocols in MANET is that each mobile node in this network acts as a routing point and participates in route discovery in form of arbitrary graph [8]–[10]. Besides, the routing methods in MANET should be able to handle large number of nodes with limited resources.

Two well known dynamic routing algorithms in MANET are ad hoc on-demand distance vector (AODV) [11], [12] and optimized link state routing protocol (OLSR) [13], [14]. Both of these routing protocols use dynamic routing algorithms for routing. AODV is a reactive routing protocol [15] which means each node maintains a routing table containing one entry to every node in the region. This entry includes information about the cost and the path to destination. The OLSR protocol is an optimized version of link state protocol. It is a proactive protocol [15] which frequently floods the incoming control messages including routing tables to its neighbors.

The rest of paper is organized as follow. In the next section we describe Multipoint Relay Selector. Then, we identify our Simulation topology and environment. Furthermore, we discuss in details the simulation results. Finally, Section IV will conclude this paper.

II. Multipoint Relay Selector

OLSR backbone consists of Multipoint Relays (MPR) [16], [17] to reduce network overhead of flooding the information exchange and control messages in same regions of the network. It also reduces number of nodes that broadcast the control messages in network. In MPR, each node, from its adjacent nodes, selects its MPRs. When a node boots up, it broadcasts hello message to inform all the adjacent nodes in one hop that it is up now. OLSR uses this message for purpose of composing Multipoint Relay Selector set which indicates adjacent nodes that choose this node as MPR [18].

Figures 1 and 2 shows 1-hop and 2-hop adjacent nodes. In Figure 1 each node broadcast control messages to entire the network, while, in Figure 2 only the MPR nodes broadcast

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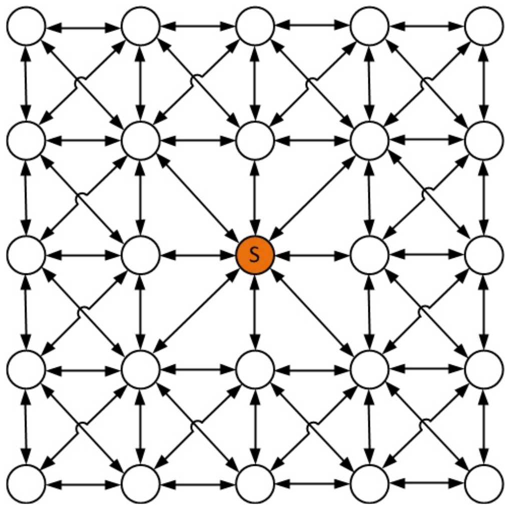

Fig. 1. Flooding without MPR

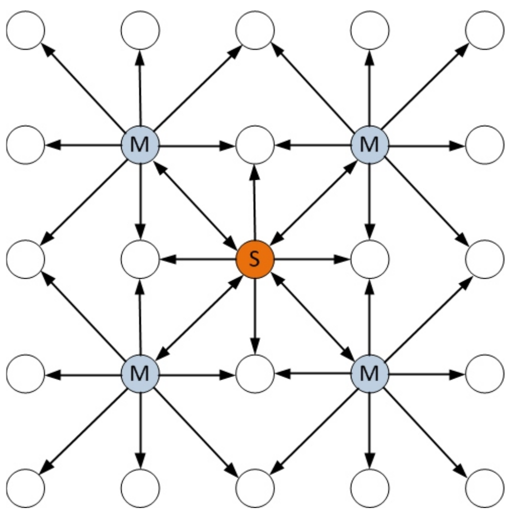

Fig. 2. Flooding with MPR

messages to 2-hop. MPR broadcast topology control (TC) messages to forward data throughout the network.

In flooding with MPR, each node should be aware of 1-hop and 2-hop symmetric adjacent nodes to determine the optimal MPR set. MPR selection algorithm [19], [20] determines optimal number of 1-hop which covers all the 2-hop. $MPR\{N\}$ is set of 1-hop that all the 2-hop adjacent nodes are covered by that node and multipoint relay selector set i.e., $MS\{I\}$ indicated set of nodes that choose node I in their MPR set.

III. Simulation Topology

We consider a Mobile ad hoc scenario, Figure 3, to study the efficiency of AODV and OLSR routing protocols. Simulation environment consists of 50 mobile nodes. Source sends and received video traffics until end of simulation i.e, 1 hour. We added Rx group configuration which speed up the simulation in the network with large number of nodes. In this scenario, it eliminates all the receivers which are out of the circumference of a circle with radius 1200 meter. Data rate is 1 Mbps.

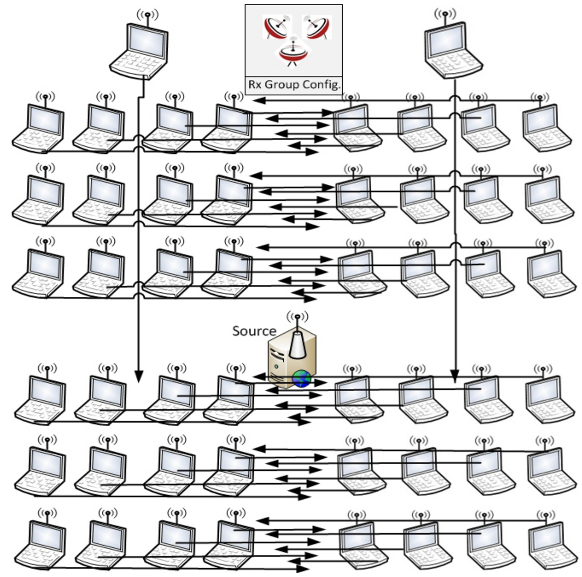

Fig. 3. Simulation Topology

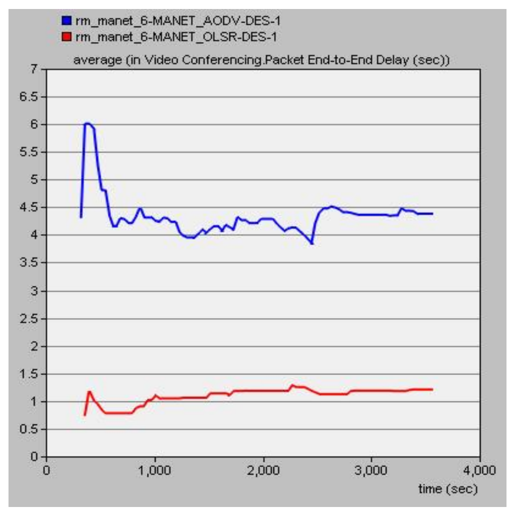

Fig. 4. End-to-end delay

IV. Simulation Results

As Figure 4 shows, OLSR has better end-to-end delay in comparison with AODV. Simulation result in our scenario demonstrates that the OLSR enhances the end-to-end delay at least 22% in comparison with AODV. Latency in discovery of new routes affects on AODV protocol performance; however, OLSR protocol does not need to do extra look up for route discovery. Therefore, OLSR reduces latency of packet transmission and end-to-end delay. From Figure 4, performance of reactive protocols such as AODV can be better than proactive protocols such as OLSR in the networks with high and dynamic traffics and more mobility as well.

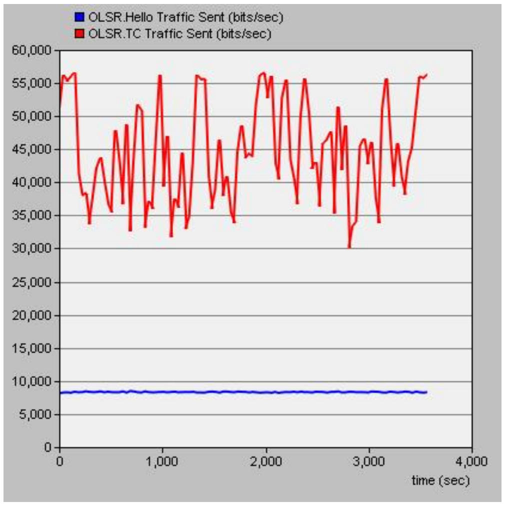

Fig. 5. Hello and TC messages

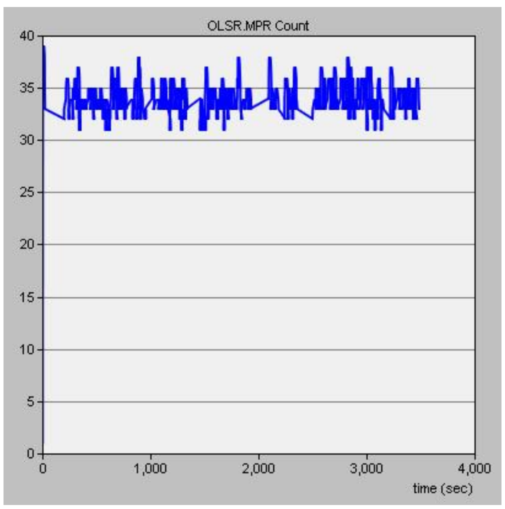

Fig. 6. MPR counts

Figures 5 shows numbers of hello and TC messages have been sent to discover new routes in 1-hop and 2-hop adjacent nodes. Hello messages are sent to only 1-hop adjacent nodes. These messages are used to discover information about new local links and adjacent nodes. However, MPR nodes broadcast TC messages in 2-hop adjacent routers to exchange the topological information.

OLSR reduces overhead of flooding by using MPRs. It reduces number of host that broadcast control messages in MANET. Although, OLSR reduces overhead of network, it needs more resources such as bandwidth than AODV protocol. This is because it must maintain the routing tables for all the possible routes.

V. CONCLUSION

In this paper, two well known routing protocols in MANET are presented and evaluated. AODV is a reactive routing protocol that each node maintains a routing table containing one entry to every node in the region. This entry includes information about the cost and the path to destination. The OLSR protocol is an optimized version of link state protocol. It is a proactive protocol which frequently floods the incoming control messages including routing tables to its neighbors. Simulation results in our proposed scenario demonstrated that the OLSR enhances the end-to-end delay at least 22% in comparison with AODV. Although, OLSR reduces overhead of network, it needs more resources such as bandwidth than AODV protocol since it must maintain the routing tables for all possible routes

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REFERENCES

[1] S. Yanwei, Z. Guangzhu, L. Jian, M. Fan, *A more efficient link-state routing algorithm for telecommunication networks*, In Proceedings of the IEEE symposium in Medicine and Education, vol. 2, pp. 383-386, Guangzhou, China, Dec 2011.

[2] Y. Chao, *developed Dijkstra algorithm and Simulation of urban path*, In proceedings of the IEEE International Conference on Computer Science and Education, pp. 1164-1167, Anhui, China, August 2010.

[3] F. Y. Zhen, *An improved Dijkstra algorithm used on vehicle optimization route planning*, In proceedings of IEEE International conference on computer engineering and technology, pp. 693-696, vol. 2, Chengdu, China, April 2010.

[4] D. Kon, Y. Liang, X. Ma, L. Zhang, *Improved and realization of Dijkstra Algorithm in GIS of Depot*, In proceedings of the IEEE International conference on control, automation and system engineering, pp. 1-4, Singapore, July 2011.

[5] T. Kim, J. J. Yoo, H.W. Jung, H.H. Lee, M. Y. Chung, S.I. Jin, *Link State Update Algorithm considering traffic variation*, In proceedings of the IEEE Advanced Communication Technology, Korea, pp.1271-1274, 2007.

[6] M. Yang, T. Kim, H. Jung, M. H. Jung, S. H. Choi, M. Y. Chung, J. Park, *Adaptive link state update scheme based on link-usage statistics for QoS routing*, ETRI Journal, Vol. 28, No. 6, pp. 815-818, 2006.

[7] K. Ross, *Computer Networking: A top down approach featuring the Internet*, Pearson, 5th edition, 2009.

[8] P. Heggernes, F. Mancini, C. Papadopoulos, *Minimal comparability f arbtrary graph*, Journal Discrete Applied Mathematics, Vol. 156, No. 5, pp. 705-718, 2008.

[9] M. E. J. Newman, S.H. Strogatz, D J. Watts, *Random graphs with arbitrary degree distributions and their applications*, Physical Review E, Vol. 64, No. 2, pp. 1-18, 2001.

[10] F. Chierichetti, J. Kleinberg, A. P. Sapienza, *How to schedule a cascade in an arbitary graph*, In proceedings of ACM conference on electronic commerce, pp. 355-368, Valencia, Spain, 2012.

[11] F. Xian, J. Wang, *An efficient ad hoc on-demand distance vector routing protocol*, In proceedings of IEEE international conference on Educational and ntwork technology, pp.454-458, Qinhuangdao, China, June 2010.

[12] F. Yang, B. Sun, *Ad hoc on-demand distance vector multipath routing protocol with path selection entropy*, In proceedings of IEEE international conferece on consumer electronics, communications and networks, pp. 4715-4718,Xianning, China, April 2011.

[13] S. K. Dhurandher, M. S. Obaidat, M. Gupta, *A reactive optimized link state routing protocol for mobile ad hoc etworks*, In proceedings of IEEE international conference on Electronics, Circuits, and Systems, pp. 367-370, Athens, Greece, December 2010.

[14] R. Song, C. M. Peter, *ROLSR: A robust optimized link state routing protocol for military ad hoc networks*, In proceedings of IEEE international conference on military communications, pp. 1002-1010, San Jose, California, November 2010.

[15] Z. Huawei, Z. Yun, *Comparision and analysis AODV and OLSR routing protocols in ad hoc network*, In proceedings of IEEE international conferece on wireless communications, networking and mobile computing, pp.1-4, Dalian, China, October 2008.

[16] B. Mans, N. Shareshta, *Performance Evaluation of approximation algorithms for multipoint relay selection*, In proceedings of the third annual mediterranean Ad Hoc Networking Workshop, pp. 480- 491, Bodrum, Turkey, 2004.

[17] J. H. Ahn, T. J. Lee , *A multipoint relay selection method for reliable broadcast in ad hoc networks*, In proceedings of the Iinternational conference on ICT convergence, pp. 616-617, Seoul, Korea, September 2011.

[18] A. Huhtonen, *Comparing AODV and OLSR routing protocols*, Helsinki University of Technology, Sjokulla, 2004-04-26/27

[19] A. Laouti, P. Muhlethaler, A. Najid, E. Plakoo, *Simulation results of the OLSR routing protocol for wireless newtork*, In proceedings of the first annual mediterranean Ad Hoc Networking Workshop, Sardega, Italy, 2002.

[20] A. Laouti, A. Qayyum, L. Viennot, *Miltipoint Relaying for flooding broadcast messages in mobile wireless networks*, In proceedings of the 35th annual hawaii international conference on system sciences, pp.3866-3875, Hawaii, USA, Jan 2002.