AQuantitative Performance Comparison of Adhoc Routing Protocols for MANETs

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Abstract-Wireless Networks are independent group of mobile nodes that communicate over reasonably slow wireless links. Designing and implementing MANETs can be quite complex due to the inherent nature of wireless communications and adverse effects, such as routing failures, channel capacity variations, and unpredictable power control which can cause chaos with these implementations. In recent years, a variety of routing protocols targeted specifically at this environment have been developed and some performance comparisons are made. However, one major imperfection in existing protocols is that the time-varying nature of the wireless channels among the mobile terminals is ignored. This could be a severe design drawback because the varying channel quality can lead to very poor overall route quality in turn, resulting in low data throughput. This paper systematically discuss the performance evaluation and comparison of four typical routing protocols of ad hoc networks with the different simulation parameters and drew valuable conclusions to identify future research directions.

Keywords- MANET, AODV, DSR, OLSR, GRP, OPNET.

I. INTRODUCTION

MANETs are unique in communications in that no base infrastructure is required for connectivity and communication. Wireless MANETs, consistent with the Institute of Electronic and Electrical Engineers (IEEE) 802.11 standard; have received considerable interest among academic and industrial sectors. Designing and implementing these MANETs can be quite demanding and complex due to the nature of wireless communications. The routing challenges include designing ad hoc routing protocols that can perform well in the following two aspects: Connectivity: The protocol can promptly identify feasible routes for connecting peer ad hoc network hosts and Link Quality: The protocol is able to select links that have high bandwidth to form the routes and, more importantly, to rebuild the routes when the channel quality of some links has already deteriorated. Many efficient routing protocols have been proposed for MANETs. In the rest of the paper, we first discuss some relevant previous work in Section 2 and we describe the functions of four native reactive routing protocols. In Section 3, we evaluate the efficacy of the protocols through extensive simulations. Analysis of the results is carried out in Section 4 with the concluding remarks.

Routing protocols for mobile ad hoc networks (MANETs) have been explored extensively in recent years. Much of the work is besieged at finding a feasible route from a source to a destination while considering the current network traffic, bandwidth constraints, energy consumption and the security requirements. These algorithms differ in the approach used for searching a new route and modifying a known route, when nodes move. The ad hoc routing protocols may be generally categorized as table-driven and source initiated on-demand driven. They include admission control policies and protocols, QoS preservation and handling different failure conditions. However, there are some major imperfections in existing protocols such as guarantee the delivery of the data even in the presence of nodes failures and channel interruptions.

II. STUDY OF AD HOC PROTOCOLS

Recently, there have been several attempts to design ad hoc routing protocols that meet the above challenges ([6], [15], [16], [19] and [20]).We attempt revisiting the routing protocols applicable in MANETs to carry out a systematic performance study for three typical routing protocols, which are AODV, OLSR, DSR and GRP. Performance analysis and comparison encompasses packet delivery fraction, end-to-end delay and routing protocol overhead with respect to different node speeds and network size.

A. DSR (Dynamic Source Routing)

The Dynamic Source Routing protocol (DSR) [21] is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure or administration. The protocol is composed of the two mechanisms of Route Discovery and Route Maintenance, which work together to allow nodes to discover and maintain source routes to arbitrary destinations in the ad hoc network. The use of source routing allows packet routing to be trivially loop-free, avoids the need for up-to-date routing information in the intermediate nodes through which packets are forwarded, and allows nodes forwarding or overhearing packets to cache the routing information in them for their own future use. All aspects of the protocol operate entirely on-demand, allowing the routing packet overhead of DSR to scale automatically to only that needed to react to changes in the routes currently in use. DSR supports for Heterogeneous Networks and Mobile IP in configuring and deploying an ad hoc network, in many cases, all nodes will be equipped with the same type of wireless network interfaces, allowing simple routing between nodes over arbitrary sequences of network hops.

B. OLSR (Optimized Link State Routing Protocol)

The optimized link state routing protocol, named OLSR[22], for mobile wireless networks. The protocol is based on the link state algorithm and it is proactive (or table-driven) in nature. It employs periodic exchange of messages to maintain topology information of the network at each node. OLSR is an optimization over a pure link state protocol as it compacts the size of information sent in the messages, and furthermore, reduces the number of retransmissions to flood these messages in an entire network. For this purpose, the protocol uses the multipoint relaying technique to efficiently and economically flood its control messages. It provides optimal routes in terms of number of hops, which are immediately available when needed. OLSR reduces the control traffic overhead by using Multipoint Relays (MPR), which is the key idea behind OLSR. A MPR is a node's one-hop neighbour which has been chosen to forward packets. Instead of pure flooding of the network, packets are just forwarded by a node's MPRs. This delimits the network overhead, thus being more efficient than pure link state routing protocols. OLSR is well suited to large and dense mobile networks. Because of the use of MPRs, the larger and more dense a network, the more optimized link state routing is achieved. MPRs help providing the shortest path to a destination. The only requirement is that all MPRs declare the link information for their MPR selectors (i.e., the nodes who has chosen them as MPRs).The network topology information is maintained periodically by exchange link state information. If more reactivity to topological changes is required, the time interval for exchanging of link state information can be reduced.

C. AODV

Ad hoc On-Demand Distance Vector Routing Protocol (AODV) [1],[2],[4] is inherently a distance vector routing protocol that has been optimized for ad hoc wireless networks. AODV makes extensive use of sequence numbers in control packets to avoid routing loops. When a source node intends communicating with a destination node whose route is not known, it broadcasts a ROUTE REQUEST packet. Each ROUTE REQUEST packet contains an ID, source and destination node IP addresses and sequence numbers, together with a hop count and control flags. The ID field uniquely identifies the ROUTE REQUEST packet; the sequence numbers indicate the freshness of control packets and the hop-count maintains the number of nodes between the source and the destination. Each recipient of the ROUTE REQUEST packet that has not seen the Source IP and ID pair or doesn’t maintain a fresher (with a larger sequence number) route to the destination rebroadcasts the same packet after incrementing the hop-count. When the ROUTE REQUEST packet reaches the destination node or any node that has a fresher route to the destination, a ROUTE REPLY packet is generated and unicast back to the source of the ROUTE REQUEST packet. Each ROUTE REPLY packet contains the destination sequence number, the source and destination IP addresses, and route lifetime, together with a hop count and control flags. Each intermediate node that receives the ROUTE REPLY packet increments the hop count, establishes a FORWARD ROUTE to the source of the packet and transmits the packet on the REVERSE ROUTE. In order to facilitate multipath support in AODV, a number of extensions [8], [9], [10], [11] have been proposed.

D. GRP

A Geographical Routing Protocol(GRP) [23] for mobile ad hoc networks is presented. The idea is based on shortest geographical distance between a source node and destination. Each uses GPS to identify its own position. Node can equip promising routes on the basis of the collected information, thereby continuously transmitting data packets even if the current route is disconnected. It results in achieving fast (packet) transfer delay without unduly compromising on (control) overhead performance.

E. SIMULATION ENVIRONMENT

OPNET modeler v14.5 has been used as a simulation tool to implement these set of experiments. In this project we choose 800 by 800 MANET Area to assess the performance of these four routing protocols. In addition, the delay and throughput are the key metrics given in these experiments. Fig 1 shows the simulation environment with cluster head and Fig2. shows the simulation environment without cluster head

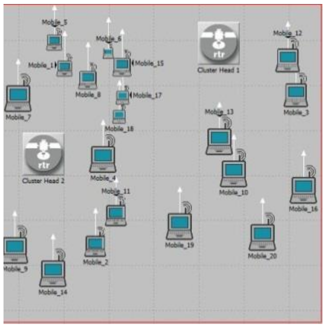

Fig.1: Simulation Environment with CH

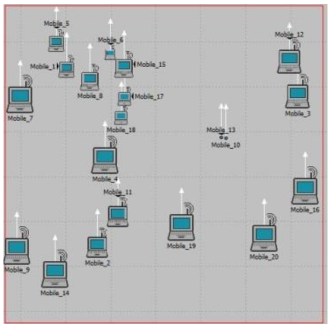

Fig.2: Simulation Environment without CH

III. EXPERIMENTAL RESULTS AND COMPARISON

In this section, we present the results obtained in our simulations comparing the four algorithms considered in this paper**.** To evaluate the routing algorithms, we compare them using three major metrics: Throughput, Network Load with and without Cluster Head,Average End-to-End Delay (AED).

Simulation Parameters

Mobility Model	Random Waypoint Model
Number of nodes	20,with cluster and without cluster
Vector	Random
MANET Area	800*800 meter
Protocols	AODV,OLSR,DSR,GRP
Time Duration	600min

A. Average End-to-End Delay (AED)

In the first experiment, we have investigated average end-to-end (e2e) delay of data packets. We observed one interesting phenomenon in that, when mobility is low, GRP outperforms AODV. However, when mobility is high, AODV outperforms GRP in terms of end-to-end delay. For lower speed values, AODV suffers from higher delays. The performance of OLSR is shown in the graph below as compared to other protocols. This happens because AODV has periodic activities (exchange of HELLO messages) and does not use cache to store the routes. With the increase of speed, the routes change more frequently and there is a strong need of finding new routes in DSR as well.

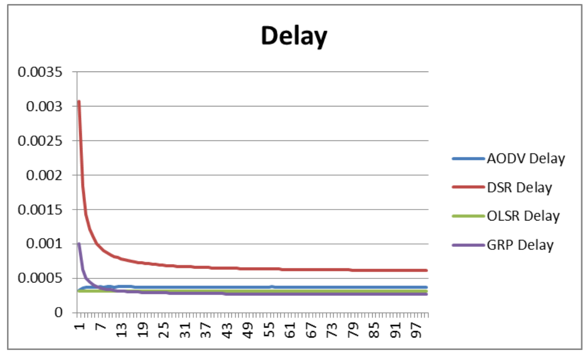

Fig.3: Average end-to-end delays

B. Throughput

This is the ratio of total number of packets successfully received by the destination nodes to the number of packets sent by the

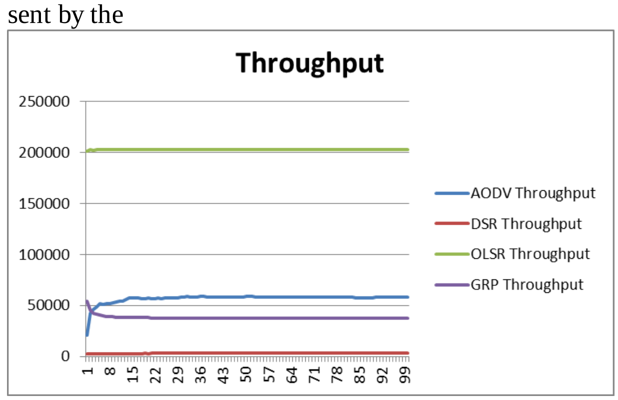

Fig.4: Throughput

source nodes. A high value of Throughput indicates that most of the packets are being delivered to the higher layers and is a good indicator of the protocol performance.By extensive simulation as shown in the above graph that OLSR shows highest throughput as compared to the other three protocols. DSR indicates the lowest throughput; there are two main causes of data loss: link congestion and not enough data buffer, and link breakage.AODV performs better than GRP and DSR because the routes are more robust.

C. Network Load with and without CH

Network load represents the total load in bit/sec forwarded in the network the higher the Network load is, it decreases the performance of the network. It is clear from the simulation results that both OLSR protocol and the AODV protocol shows higher Network Load without Cluster Head as compared to with Cluster Head as shown below in graphs in the Figure 5 andFigure 6, using the amount of routing overhead in AODV as a baseline. On the other side, AODV and OLSR protocols show higher performance with the Cluster Head. The exchange is present in case of lower and higher mobility

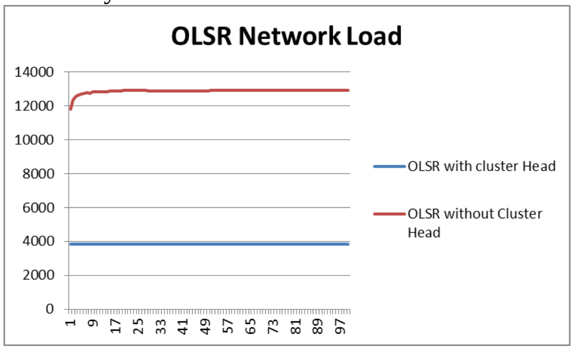

Fig.5: OLSR Network Load

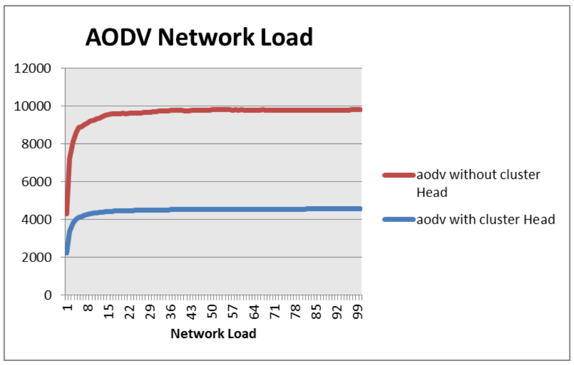

Fig.6: AODV Network Load

IV. CONCLUSION

In this paper, we study the behaviour and performance of ad hoc routing protocols. We compared the performance of classical ad hoc routing protocol AODV with that of three routing protocols, calledDSR (Dynamic Source Routing), OLSR (Optimized Link State Routing Protocol) protocol and GRP (Geographical Routing Protocol). In our extensive study, we found that both the OLSR and AODV protocols outperform with cluster formation in random mobility. Furthermore, the performance of AODV is slightly better than that of GRP. However, as the system scales up, OLSR outperformsthe other three protocols because the latter has a higher routing overhead. Furthermore, from extensive simulation it can be said that DSR may suffer from long delays for route searching before they can forward data packets. Hence cannot be suitable for some relative applications, it would be interesting to note the behaviour of these protocols on a real time basis that depends on the requirements of the routing environment of systems. As most previous studies, we observe that AODV has a higher throughput than GRP and DSR under most mobility patterns with high or moderate link duration (like Random Waypoint model or RPGM). However, we observe that DSR performs worse than ABR under the random mobility patterns with extremely low link duration and weak route stability.

Future work should be focused to extending set of the experiments by taking into contemplation different propagation models and MANET protocols and energy-consumption reduction. In the future, we plan to study the impact of our results on the performance of other ad hoc network protocols. It would help us recognize the impact of mobility intensely. We can consider different parameters such as node density, traffic patterns of nodes which may affect the routing performance and there is a need to analyze them further.

V. REFERENCES

[1]. FaseeUllah, Muhammad Amin and Hamid ulGhaffar, "Simulating AODV and DSDV for A dynamic Wireless Sensor Networks" IJCSNS International Journal of Computer Science and Network Security, VOL.10, No.7, July 2010.

[2]. AsmaTuteja , Rajneesh Gujrl and Sunil Thalia, "Comparative Performance Analysis of DSDV, AODV and DSR Routing Protocols in MANET using NS2", International Conference on Advances in Computer Engineering, vol. 4, no. 1, pp. 36-45, Feb, 2010.

[3]. Md. ArafaturRahman, Farhat Anwar, JannatulNaeem and Md. Sharif MinhazulAbedin, "A Simulation Based Performance Comparison of Routing Protocol on Mobile Ad-hoc Network (Proactive, Reactive and Hybrid)", International Conference on Computer and Communication Engineering (ICCCE 2010), 11-13 May 2010, Kuala Lumpur, Malaysia.

[4]. Sapna S. Kaushik1 & P.R.Deshmukh2, "Comparison of effectiveness of AODV, DSDV and DSR routing protocols in Mobile Ad-Hoc Network" International Journal of Information Technology and Knowledge Management , Volume 2, No. 2, July-December 2009.

[5]. P. Udayakumar and AshaAmbhaikar, "Experimenatal comparison of AODV and DSR protocols, International J. of Engg. Research &Indu.Appls. (IJERIA) ISSN 0974-1518, Vol.2, No. III , 2009

[6]. Nor SurayatiMohamadUsop, Azizol Abdullah and Ahmad Faisal AmriAbidin, "Performance Evaluation of AODV, DSDV & DSR Routing Protocol in Grid Environment", IJCSNS International Journal of Computer Science and Network Security, VOL.9 NO.7, July 2009.

[7]. David Oliver Jorg, "Performance Comparison of MANET Routing Protocols In Different Network Sizes", University of Berne, Switzerland, 2003.

[8]. T.B.ReddyI.Karthigeyan, B.Manoj and C.S.R.Murthy, "Quality of service provisioning in ad hoc wireless networks: a survey of issues and solutions." Vol.4, pp.83-124, 2006.

[9]. Abradou and W.Zhuang, "A priority based QoS routing scheme for UWB mobile ad hoc networks" IEEE J.Select.AreasCommun., vol.24, pp.850-856, 2006.

[10]. S.H.Shah, K. Nahrstedt, "LRAODV: *Predictive location routing-based QoS routing in mobile ad-hoc networks*", in: Proceeding of IEEE ICC 2002, vol.2, pp.1022-1027, 2002.

[11]. J.Stine and G.de Veciana, "*A improved paradigm for QoS in wireless ad hoc networks using synchronoussignaling and node state*", IEEE J.Select.AreasCommun., vol.17, pp.1454-1465, 1999.

[12]. J.Biswas, M.Barai, S.K.Nandy, "Energy *Efficient hybrid QoS routing protocol for ad-hoc wirelessnetworks, local computer networks*", in: 29thAnnual IEEEE International Conference on Nov.2004, pp.180-187.

[13]. R. Dube, C.D. Rais, and S.K. Tripathi, "Improving NFS Performance over Wireless Links," IEEE Trans. Computers, vol. 46, no. 3, pp. 290-298, Mar. 1997.

[14]. R. Dube, K.-Y. Wang, C.D. Rais, and S.K. Tripathi, "Signal Stability Based Adaptive Routing (SSA) for Ad Hoc Mobile Networks," IEEE Personal Comm., vol. 4, no. 1, pp. 36-45, Feb. 1997.

[15]. J.J. Garcia-Luna-Aceves and S. Murthy, "A Path-Finding Algorithm for Loop-Free Routing," IEEE/ACM Trans. Networking, vol. 5, no. 1, pp. 148-160, Feb. 1997.

[16]. T. Goff, N. Abu-Ghazaleh, D. Phatak, and R. Kahvecioglu, "Preemptive Routing in Ad Hoc Networks," Proc. MOBICOM '01, pp. 43-52, July 2001.

[17]. H.-Y. Hsieh and R. Sivakumar, "Routing: On Using the Ad Hoc Network Model in Cellular Packet Data Networks," Proc. ACM MOBIHOC '02, pp. 35-47, June 2002.

[18]. Broch, D.A. Maltz, D.B. Johnson, Y.-C. Hu, and J. Jetcheva, "A Performance Comparison of Multi-Hop Wireless Ad Hoc Network Routing Protocols," Proc. MOBICOM '98, pp. 85-97, July 1998.

[19]. X.-H. Lin, Y.-K. Kwok, and V.K.N. Lau, "RICA: A Receiver-Initiated Approach for Channel-Adaptive On-Demand Routing in Ad Hoc Mobile Computing Networks," Proc. 22nd IEEE Int'l Conf. Distributed Computing Systems (ICDCS '02), pp. 84-91, July 2002.

[20]. Y.-K. Kwok and V.K.-N. Lau, "A Novel Channel-Adaptive Uplink Access Control Protocol for Nomadic Computing," IEEE Trans. Parallel and Distributed Systems, vol. 13, no. 11, pp. 1150-1165, Nov. 2002.

[21]. David B. Johnson ,David A. Maltz, Josh Broch,"DSR: The Dynamic Source Routing Protocol for Multi-Hop Wireless Ad Hoc Networks",http://www.monarch.cs.cmu.edu/.

[22]. Philippe Jacquet, Paul Muhlethaler,"Optimized Link State Routing Protocol for Ad Hoc Networks",Conference: Conference: Multi Topic Conference, 2001. IEEE INMIC 2001. Technology for the 21st Century. Proceedings.IEEE International.

[23]. Chang WookAhn , "Geographical-based routing protocol in mobile ad hoc networks",Computer Communications Volume 30, Issue 1, 15 December 2006, Pages 202-206