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PERFORMANCE EVALUATION OF ROUTING PROTOCOLS WITH VARIATION IN NODE SPEED FOR MOBILE AD-HOC NETWORKS

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ABSTRACT

Mobile Ad-Hoc Networks (MANET) holds the promise of the future, with the capability of self-configuration at any place and at any time, without the need of any pre-existing infrastructure. One of the important characteristics of these networks is the node mobility, which will change the network topology very frequently, hence making the network dynamic. Thus achieving an efficient routing protocol with frequent mobility becomes a challenging issue in MANETs. In this paper, we analyze the effect of mobility on different routing protocols using QualNet Simulator. The mobility model for nodes is being captured by Random Waypoint Mobility Model (RWP). The performance of AODV, DSR, ZRP, FSR, LANMAR & OLSR are compared and analyzed with variation in node speed. The metrics used for the performance evaluation include packet delivery ratio, average jitter, throughput and average end-to-end delay. Experimental results illustrate that performance of the routing protocol varies with variation in node speed.

KEYWORDS: Routing Protocols, Node Speed, RWP, AODV, DSR, ZRP, FSR, LANMAR & OLSR

INTRODUCTION

Recently, the progress in communication technology has made wireless devices smaller, easily available, less expensive and more powerful. Availability of such devices has spurred a great interest in wireless networks such as MANETs.

A MANET is a collection of wireless mobile nodes which communicate with each other without the need of any pre-existing network infrastructure or any centralized administration. Each node in the networks also acts as a router, forwarding data packets for other nodes [14]. The nodes are generally mobile, they are free to move arbitrarily resulting in frequently and drastic changes in the network topology.

Because of the freedom of mobility, the set of application for MANETs is diverse, ranging from small networks like conference rooms, meetings etc. to large-scale, sensitive networks like military communications by soldiers, search and rescue operations [14]. A key challenge in ad-hoc network design is to develop a correct, effective, efficient and reliable routing protocol to have communication between mobile nodes. The routing protocol must be capable to handle the high degree of node mobility that frequently changes the network topology drastically and unpredictably. Hence, the protocols must be adaptive and able to maintain routes despite the change in the topology of the network, caused by mobility of nodes.

There are many ways to classify MANET routing protocols, depending on how the packet is delivered from source to destination. They can be broadly classified as proactive, reactive and hybrid routing [1]. In the proactive routing approach, every node maintains one or more tables to provide information about the routes to establish communication between any two nodes of the network. Some of the existing proactive routing algorithms are DSDV [6], Optimized link

state routing (OLSR) [8] and Fisheye state routing (FSR) [4]. In reactive routing, information is collected only when it is needed, which include the Dynamic Source Routing (DSR) [3], Ad-hoc On Demand Distance Vector (AODV) [2]. Hybrid protocols are the combinations of both the reactive and proactive approach of routing and exhibit advantages of these two protocols. They include Zone Routing Protocol (ZRP) [5] and Landmark Ad Hoc Routing (LANMAR) [7].

Section II presents the related work & motivation required for this study. Kindly refer paper from the references section to get an insight into the detailed working of these protocols. Section III enumerates the different parameters used in the simulation. We describe the performance metrics used in our study and simulation based results in Section IV. Conclusion and future work is presented in Section V.

RELATED WORK

One of the main issues associated with routing in mobile ad-hoc networks is dynamic topology. The nodes inside the network move around randomly and have no restriction on their distance from other nodes. As a result, the whole topology is changing in an unpredictable manner. Since routes between communicating nodes can change rapidly, the mobility can affect not only the communicating nodes but also the intermediate nodes and thus can have a significant influence on the network's topology and hence the performance of routing protocols.

This paper is definitely not the first one to analyze the effect of mobility on MANETs. A large number of extensive simulation studies on various MANET routing protocols have been performed [10-15]. The motivation of this research originates from the fact that previous evaluation studies have not focused on such a large number of routing protocols and thus were not able to reveal their performances with respect to mobility. However, this paper has made an attempt to study the effect of node speed (factor affecting mobility) and hence provide a comparative evaluation of a large number of the existing routing protocols using QualNet 5.0.2 [9]. In addition to the simulation results, we explore the causes for performance degradation.

SIMULATION ENVIRONMENT

The objective of this study is to analyze the performance of different routing protocols in a mobile ad-hoc environment. The simulations have been performed using QualNet 5.0.2 [9]. The mobility model for nodes is being captured by Random Waypoint Mobility Model (RWP). In RWP, each node chooses a random destination within the simulated area and a speed between some minimum and maximum bounds. The node pauses for a fixed period of time (specified by Pause Time value in our study) and then moves towards the destination. We have done comprehensive simulation of routing protocols by varying the speed of nodes using RWP mobility model. We created different mobility scenarios with different mobility speed for each protocol studied. Mobility is an important issue affecting the performance and scalability of MANETs. To investigate the effect of node mobility, we ran simulation of 6 different protocols by varying speed, with the following parameters (Table 1)

Table 1: Simulation Parameters

Parameters	Value
Protocols	AODV, DSR, ZRP, FSR, LANMAR & OLSR
Simulation Area	500 x 500 m
Simulation Time	300 sec
Number of Nodes	30
Traffic pattern	CBR
Mobility Model	Random Waypoint
Pause Time	20 s
Speed of nodes	2, 4, 6, 8, 10 mps

PERFORMANCE METRICS & SIMULATION RESULTS

We have investigated the performance metrics of different routing protocols by varying speed from 2mps to 10mps. The results obtained from simulations are presented in figures 1 to 4.

To evaluate the efficiency of a routing protocol in MANET, we have evaluated the following metrics in our study:

Throughput

It is the ratio of the total amount of data that reaches a receiver from a sender to the time it takes for the receiver to get the last packet. It measures the effectiveness of a routing protocol.

As seen in figure 1, the throughput value of both AODV & DSR is constant throughout as the speed of the node increases. However, there is a decline in the throughput of OLSR, ZRP & FSR, as the speed increases; this is due to their proactive nature. Hence, DSR shows better performance with respect to throughput among these protocols as it delivers data packets at higher rate.

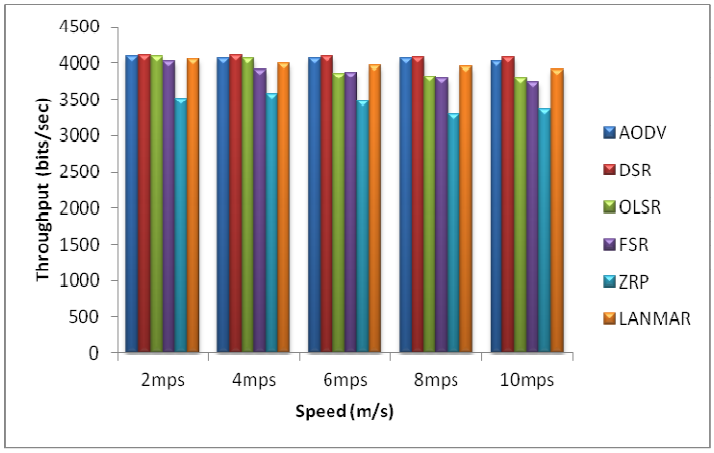

Figure 1: Effect of Node Speed on Throughput of AODV, DSR, OLSR, FSR, ZRP & LANMAR

Average End-to-End Delay

The end-to-end delay is the average time a packet takes to traverse through the network. It includes all possible delays such as buffer queues, transmission time and delays causes by routing activities. It is averaged over all successfully received data packets. It represents the reliability of the routing protocol.

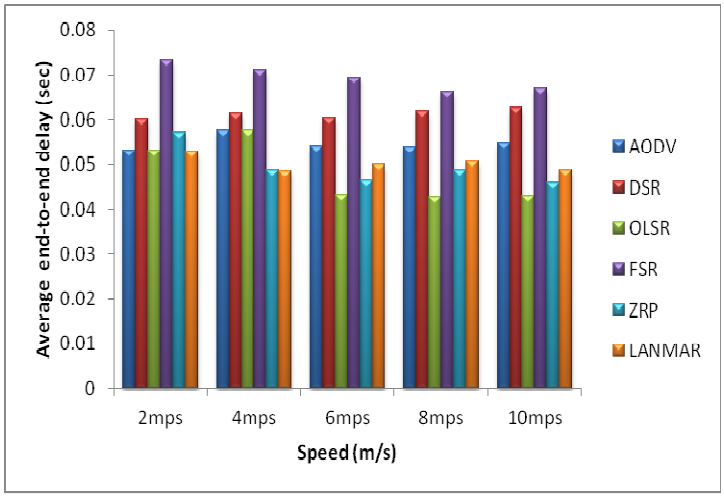

Figure 2: Effect of Node Speed on Average End-to-End Delay of AODV, DSR, OLSR, FSR, ZRP & LANMAR

It is clear that (figure 2) , FSR has the highest average end-to-end delay. As the node traverses with higher speed, OLSR show the shortest delay. However, the speed variation has shown a negative effect on end-to-end delay of AODV & DSR.

Packet Delivery Ratio

It is the ratio of the number of packets transmitted by a traffic source and the number of packets received by traffic sink. It is a measure of both the correctness as well as efficiency of routing protocols.

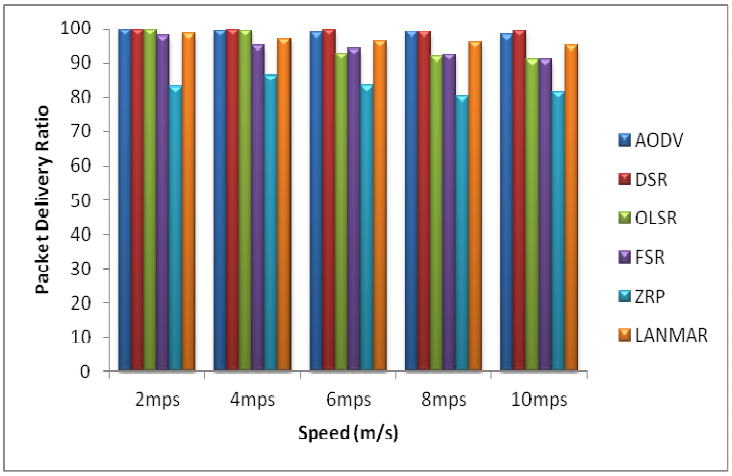

Figure 3: Effect of Node Speed on Packet Delivery Ratio of AODV, DSR, OLSR, FSR, ZRP & LANMAR

Figure 3 illustrates the effect of node speed on packet delivery ratio (PDR). It has been observed that DSR and AODV maintain a stable PDR value with variation in node speed. Similarly, the PDR value of ZRP increases initially and decreases as the speed increases. However, LANMAR has shown a decline in packet delivery ratio.

Average Jitter

As the packets from source to destination will reach the destination with different delays, a packet's delay varies with its position along the path between source and destination and this position can vary unpredictably. This variation in delay is known as Jitter.

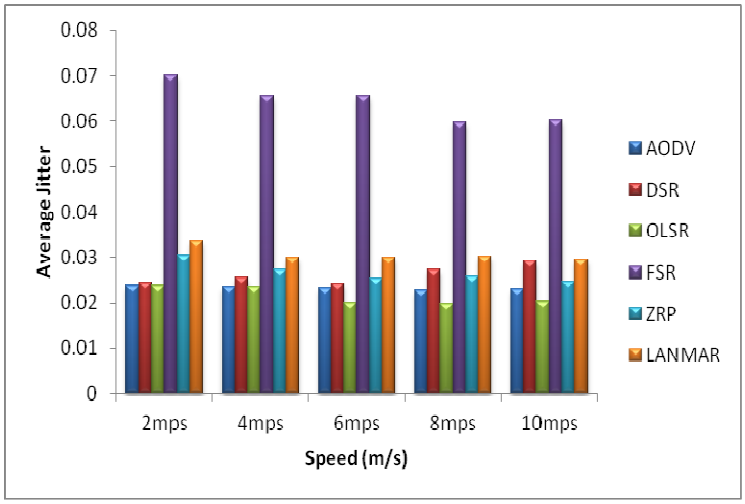

Figure 4: Effect of Node Speed on Average Jitter of AODV, DSR, OLSR, FSR, ZRP & LANMAR

The effect of variation of node speed on the average jitter of the six routing protocols described earlier is shown in figure. 4. As seen in the figure, jitter of FSR is worst. It is higher than that of AODV, DSR, ZRP, LANMAR & OLSR The value of jitter remains constant initially for ZRP & LANMAR & increases with increase in speed. From figure 4, it has

been observed that with respect to jitter performance of AODV is better at smaller values of speed but as the node traverses with higher spped OLSR is better.

CONCLUSIONS

A simulation study was carried out to analyze the performances of these protocols with QualNet 5.0.2 simulator by creating a scenario of 25 nodes with RWP mobility model. The observations are made with variation in node speed. This study provides a realistic qualitative and quantitative comparison of the six routing protocols described.

The current study gave a fundamental understanding of the variation of specific performance parameters with mobility for a wide spectrum of MANET routing algorithms. For our further work, we intend to study the scalability aspect of these protocols to assess the impact on network performance as the network size and coverage increases. We plan to use different mobility models.

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REFERENCES

1. S. Basagni, M. Conti, S. Giordano, and I. Stojmenovic, *Mobile ad hoc networking.* Piscataway, NJ: IEEE Press, Wiley Interscience, Inc., 2004.
2. S. Das, C. Perkins, E. Royer, Ad hoc on demand distance vector (AODV) routing, Internet Draft, draft-ietf-manetaodv-11.txt, work in progress, 2002.
3. D. Johnson, D. A. Maltz, Dynamic source routing in ad hoc wireless networks, in Mobile Computing (T. Imielinski and H. Korth, eds.), Kluwer Acad. Publ., 1996.
4. M. Gerla, Fisheye state routing protocol (FSR) for ad hoc networks, Internet Draft, draft-ietf-manet-aodv-03.txt, work in progress, 2002.
5. Z.J. Hass, R. Pearlman, Zone routing protocol for ad-hoc networks, Internet Draft, draft-ietf-manet-zrp-02.txt, work in progress, 1999.
6. C.E. Perkins, T.J. Watson, Highly dynamic destination sequenced distance vector routing (DSDV) for mobile computers, in: ACM SIGCOMM_94 Conference on Communications Architectures, London, UK, 1994.
7. G. Pei, M. Gerla, and X. Hong, LANMAR: Landmark routing for large scale wireless ad hoc networks with group mobility. In Proceedings of the ACM Symposium on Mobile Ad Hoc Networking and Computing (MOBIHOC), pages 11-18, 2000.
8. T. Clausen and P. Jacquet, "Optimized link state routing protocol (OLSR)," *IETF RFC 3626,* Oct. 2003.
9. QualNet, "QualNet 5.0 Simulator", http://www.scalable-networks.com
10. S. R. Das, R. Castaneda and J. Yan, 1998. "Simulation Based Performance Evaluation of Mobile Ad Hoc Network Routing Protocols", In Proceedings of Seventh International Conference on Computer Communications and Networks.
11. E.M.Royer and C.K.Toh, 1999. "A Review of Current Routing Protocols for Ad-Hoc Mobile Wireless Networks", IEEE Personal Comm. Magazine, 46-55.

12. J.Broch, D.A.Maltz, David B.Johnson, Y. Hu and J. Jetcheva, 1998. "A Performance Comparison of Multi-Hop Wireless Ad-hoc Network Routing Protocols", Proceedings of the Fourth Annual ACM/IEEE International Conference on Mobile Computing and Networking, MobiCom'98, 25-30.

13. C. Perkins, E.M. Royer, S.R. Das, and M.K. Marina, "Performance Comparison of Two Ondemand Routing Protocols for Ad Hoc Networks," IEEE Personal Communications, pp. 16-28, Feb. 2001.

14. Mehran Abolhasan, Tadeusz Wysocki, Eryk Dutkiewicz, "A review of routing protocols for mobile ad hoc networks", Elsevier 2003.

15. Changling Liu, Jörg Kaiser, "A Survey of Mobile Ad Hoc network Routing Protocols", MINEMA, University of Magdeburg, October 2005.