Performance Evaluation of Ad Hoc Routing Protocols (DSDV and OLSR) in High Mobility Scenario for MANET

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ABSTRACT
Routing in mobile ad hoc network is important to be efficient due to unpredictably and rapidly changes of network topology in a mobile ad hoc network (MANET). Unexpected node mobility increases the chance of experiencing link breakage. Link breakage detection is key factor to determine whether routing protocols in mobile ad hoc networks are efficient or not. The two certain routing protocols are studied. They are designed for mobile ad hoc network namely Destination-Sequence Distance Vector (DSDV) and Optimized Link State Routing (OLSR). The performance of these two proactive ad hoc routing protocols in handling link breakage in high mobility scenario will be observed. The observation of their respective performance will be evaluated and compared based on the packet delivery ratio, throughput and packet loss ratio. The simulations are performed using NS2 simulator. The studies have shown it is obvious that OLSR outperformed DSDV in all cases. The simulation experiments and analysis details of the results which we have obtained are contained in this paper.

Keywords: performance study, network simulation comparison, link breakage, VANET

1. INTRODUCTION
A mobile ad hoc network (MANET) is consisting of a collection of self organized mobile nodes sharing wireless channel without any centralized administration or fixed communication infrastructures, because of that, Ad Hoc Networks suitable for emergency operations. Since node mobility leads to frequent link breakage and unpredictable and rapid changes of network topology. An example of that in disaster situations such as flooding and earthquake where the rescue teams need to arrange themselves without the availability of fixed communication infrastructures. Routing protocols as an important part of the ad hoc network having the responsibility to lead mobile nodes to discover each other and forward packets correctly between them.

Many researches have been proposed in the past decade to find solutions for MANET routing protocols problems. One of The main challenges in this area is to model an effective routing protocol due to dynamic changes of routing table for nodes when the topology is changed, node power constraints and the properties of the wireless channel. Besides that, it supposed to function at low data rates. The primary importance of ad hoc routing protocols is remaining the node connectivity and decreasing control overhead in the wireless network. Proactive ad hoc routing protocols use several techniques to decrease their control overhead and to gain higher throughput. In this report, the Network Simulator (NS 2) is preferred to be used because the major bugs in it are discovered, fixed and reported to the developers, so it benefits the research community.

The aim of this paper is to evaluate the performance of two protocols in a MANET environment. We have conducted extensive simulations to evaluate the performance of these protocols in high mobility scenario. Through the evaluations, we obtained insights into the effects of the main parameters including high mobility of node movement on the performance. This simulation study is valuable to the application of these protocols in a real network especially regarding vehicular ad hoc networks which is mainly based on high mobility of node motion.

2. RELATED WORK
During the last few years, there were a large number of performance measurement studies on routing protocols of mobile ad hoc networks (MANETs).

Maltz, Hu, Johnson and Jetcheva [1] have come up with an interesting outline to evaluate the performance of routing protocols. This study is one of the earlier protocol performance comparisons. The experiments were conducted to use DSDV, DSR, TORA, and AODV to measure their performance. The simulations were done using number of fifty nodes, ten to thirty traffic sources, various pause times and different movement rates. The NS 2 discrete event simulator [2] was chosen which is developed by the University of California at Berkeley and the VINT project [3] was extended to properly model the physical and MAC layer and behavior of the IEEE 802.11 wireless LAN standard. DSDV has showed good performance when the simulation is done in low node mobility scenario. As a part from that, DSDV has faced some difficulties when the node mobility rate became higher as the mobility increased. On another hand, TORA has showed as the worst performance respecting routing overhead. Besides that, DSR has showed a good performance in various mobility rates and motion speeds. But when it uses source routing led to increase routing overhead bytes needed by the protocol. At last, AODV has performed almost as well as DSR at all mobility rates and motion speeds. It was able to get rid
of DSR’s source routing overhead, but at high rates of nodes’ movement, it is actually more costly than DSR. As you can see, AODV has also produced large packets overhead, but in generally it has the best overall performance for the all scenarios.

Das, Perkens, Royer and Marina[4] have conducted the performance comparison study of two on-demand routing protocols for mobile ad hoc networks. These two protocols are Dynamic Source Routing (DSR) and Ad Hoc On-Demand Distance Vector Routing (AODV). The experiments have done based on the NS-2 network simulator. In spite of the fact that AODV and DSR share a similar on-demand protocol behavior, the differences in the protocol mechanism would lead to substantial performance differences, which are analyzed using different network load, network mobility and network size. According to simulation model, the distributed coordination function (DCF) of IEEE standard 802.11 [5] is used as the MAC layer in wireless lan. The 802.11 DCF utilizes Request to send (RTS) and Clear to send (CTS) control packets [6] which used for unicast packet transmission to the other node. The RTS/CTS be ahead of transmit the data packets and implement a form of virtual carrier sensing and do the reservation of the channel. ACK is followed by packets transmission. In this simulation, CSMA technique with collision avoidance (CSMA/CA) is used to transmit data packets. The radio model uses attributes alike to a commercial radio interface, Lucent’s WaveLAN [7, 8]. WaveLAN is a shared radio environment with a nominal bit-rate of 2 Mb/sec and a nominal radio range of 250 meters. As a part of that, the mobility model which is used is random waypoint model with pause times from 0 to 500 seconds. Two scenarios are used. The first one is used 50 nodes with topology area 1500 meter * 300 meter and the second one is used 100 nodes with topology area 2200 meter * 600 meter. Based on the observations, DSR has done better than AODV when used small number of nodes and low load in terms of mobility. AODV, however, does better than DSR with higher performance gaps when used more number of nodes and higher load in terms of mobility. Besides that, DSR however, regularly produces less routing load than AODV.

3. PERFORMANCE ANALYSIS
3.1. AD HOC ROUTING PROTOCOLS STUDIED
In this section, we briefly describe the key features of the DSDV and OLSR protocols studied in our simulations.

3.1.1. DSDV
DSDV is one of the earliest proactive routing protocols. This protocol is designed for ad hoc networks. The sequence numbers are introduced in order to guarantee accurate routing data and prevent from loops. DSDV is a table-driven routing protocol requires regular updating for its routing table. This may consume unnecessary network resources when the network is stable [9].

3.1.2. OLSR
The other proactive protocol uses shortest path algorithm. OLSR is based on Multipoint Relays (MPRs) concept. Information about the link state and the broadcast messages are exchanged only between the MPRs. Because of that, the route discovery process is optimized as the number of control messages is reduced [10].

3.2. SIMULATION ENVIRONMENT
The simulation experiment is carried out in LINUX (Centos 5.2). The detailed simulation model is based on network simulator 2 (ver 2.29) [2], is used in the evaluation. The NS commands can be used to define the topology structure of the network and the movement mode and the traffic generation of the nodes and then collect trace data generated by the simulations for performing statistical data analysis.

3.2.1. TRAFFIC MODEL
Continuous bit rate (CBR) traffic sources are used. The source destination pairs are spread randomly over the network. The packet Inter arrival time between nodes is 5 packets /sec whereas the packet size is 512 byte. The number of source destination pairs in each pair is varied to change the offered load in the network.

3.2.2. MOBILITY MODEL
The mobility model uses the random waypoint model [11] in a square field. The field configurations used is: 1000 m × 1000 m. To evaluate the impact on the high mobility nodes on simulated protocols, the speed of the nodes is varied using 3 different values of 2, 10 and 40m/s. An increase in the value of speed leads to increase in the node mobility. The node pause-time after the movement is kept at zero second. Zero pause-time has been chosen to simulate a continuous movement of nodes thus giving rise to high mobility scenario and prepare the routing protocols to react with increasing network load and speed of nodes which is the purpose of this simulation study. Besides that, each scenario is duplicated twice for each protocol where the node mobility nodes on simulated protocols, the speed of the node is varied using different network load, network mobility and network size.

4. SIMULATION RESULTS
The simulation results point-out some significant characteristic differences between the routing protocols. The existence of high mobility entails frequent link failures and each routing protocol responds unlikely from each other during the occurrence of link failures. In this section, the result of the simulation studies will be presented in the form of graphs and the discussion is based on three performance metrics which are packet delivery ratio, average throughput, and packet loss ratio of which some of these metrics are suggested by the MANET working group for routing protocol evaluation as mentioned in [12].
4.1. PACKET DELIVERY RATIO

This metric is important as the ratio of delivered packets will in turn affect the maximum throughput that the network can handle. Figure 4.1, Figure 4.2 and Figure 4.3 present the ratio of the data packets each protocol capable to deliver in a variety of mobility speed with frequent link failures as the nodes are constantly moving.

From the figures, the packet delivery ratio of both the protocols decreases as speed increases, but DSDV’s packet delivery ratio decreases in a more steeper and more rapid fashion. This is due to excessive channel used by regular routing table updates. Furthermore, as mobility speed increases, more event-triggered updates are generated, resulting in even more packet delivery ratio decrease.

Finally, in all cases however, it is significant that OLSR has performed particularly better in all three speeds.

4.2. AVERAGE THROUGHPUT

Average throughput is considered as the most straightforward metric to study the performance of MANET routing protocols. The Figure 4.4, Figure 4.5 and Figure 4.6 show the performance of both routing protocols in terms of different node speed and network density.

From the Figure 4.4, Figure 4.5 and Figure 4.6 that were shown, it is evident how OLSR outperformed much better rather than DSDV. OLSR has its highest average throughput. Since DSDV uses the table-driven approach of maintaining routing information, it is hence not as adaptive to the route changes that occur during high speed of node movement hence the result of poor performance. Although the throughput of both the protocols decreases as speed increases, but DSDV’s throughput decreases in a more steeper and more rapid fashion. This is due to excessive routing table updates. Furthermore, as mobility speed increases, more event-triggered updates are generated, resulting in even more throughput decrease. Although this applies to both protocols, OLSR however has a more significant performance in having higher throughput compared to DSDV.
4.3. PACKET LOSS RATIO
The packet loss ratio shows the number of packets that were failed to be delivered among other packets that had been sent. From Figure 4.7, Figure 4.8 and Figure 4.9, it can be clearly summarized that the increase in number of nodes and speed of node movement that causes frequent link failures affect the number of packets loss in the network significantly.

In all three cases with node movement 2, 10 and 40 m/s, the routing protocol DSDV at all time has higher percentage of number of packet losses except at one point where the OLSR has highest packet losses which is at having node of ten at speed 2.

DSDV consistently drops much more data than OLSR. This is due to the reason that DSDV has to wait for a period of time to obtain new information and if in the case where frequent link failure occurs while it is transmitting data, it has to queue the packets until getting available path to the desired destination. In this case, packet drops will happens once the queue is full and this phenomena happens frequently especially at high speeds.

5. CONCLUSION AND FUTURE WORK
This paper evaluates two proactive routing protocol called OLSR and DSDV for ad hoc networks. This simulation research has compared the performance of both routing protocols using NS2 simulations.

This simulation research is meant to discuss the effects of high mobility network and frequent link failures in the performance of the routing protocols chosen.

From previous sections, we observe that OLSR outperformed DSDV in all three measurement of performance. However, the results obtained from the simulation is in coordination with Yadav and Yadav[13] is found that DSDV has less packet delivery ratio when speed set at a high speed. Since finding the route requires more and more routing traffic as speed increases thus making a lesser portion of the channel useful for data transfer.

Deduced from the results, it is clear that the high mobility traffic that causes frequent link failures affects the performance of both protocols significantly.

As you can see, the robustness of OLSR and DSDV in a network of high mobility scenario and frequent link failures is revealed. To the completion of this paper, it is of confidence to mention that the objective of this paper has been achieved.

For future work, a number of critical aspects and more research in certain areas could be done. Are as follows:

1. As we have selected NS2 tool as a network simulator in this paper, it is possible to do the same work through another tool like OPNET. Besides that, selection other performance metrics and parameters or other routing protocols could be useful for the results accuracy of performance evaluation.
2. It would be interesting to observe how the results of this simulations would have changed in the case of altered performance factors including mobility model, traffic load and protocols parameters such as the refresh intervals of routing protocols (i.e. TC interval and HELLO interval for OLSR, and update interval for DSDV) and the variables of the protocols (i.e. MAC layer and physical layer), including transmission ranges.
3. Analyzing protocol performance using a real life Ad hoc network would also be contributory for an area of future work.

In the future, 4G the next generation heterogeneous networks will be deployed. It provides the Integration of different technologies and network types [14]: Ad hoc networks including Vehicular networks [16], Underwater Ad Hoc Networks [15], wireless sensor networks [17] and personal area networks. Because of that, an urgent need to design effective routing protocols to meet the requirements of these future challenges.
REFERENCE:


