Performance Metric Comparison of AODV and DSR Routing Protocols in MANETS

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Abstract— The mobile Ad hoc network is a dynamic network in which a temporary network is formed dynamically by the mobile nodes without any centralized administration. There are a no. of existing routing protocols which are classified mainly into table-driven and on-demand routing protocols. Among all on-demand routing protocols, AODV and DSR routing protocols are the most efficient routing protocols which are designed particularly for wireless ad hoc networks comprising of mobile nodes. These protocols have quick adaptation to changes in topology, low network usage, less memory and processing issues in the ad hoc network. In this paper an effort has been made to compare the performance of AODV and DSR on the basis of varying node velocity. To measure the performance, three commonly used network performance metrics are used that are packet delivery ratio (PDR), throughput and average end-to-end delay. The simulation experiments are done using the NS-2 network simulator that is in use to run wired and wireless ad hoc simulations. The trace files are studied and analysed using awk scripts (delay.awk and throughput.awk). Oracle VM Virtual Box is used to run the network simulator.

Key words: MANET, AODV, DSR, Node Velocity

I. INTRODUCTION

A mobile ad-hoc network is a collection of mobile nodes that create a dynamic infrastructure-less communication network wherever it is required. The lack of a fixed infrastructure means that the communicating nodes in the network must also perform routing. Quick and easy establishment of such networks make them practical to use in disaster area recovery, military and in other environments where no infrastructure is present or it has been destroyed. In such networks routing is well studied feature because mobile nodes may move freely in various directions, which can break existing links and the new routes can be formed. The performance of routing protocols is affected by the mobility of mobile nodes. Routes between two communicating nodes may consist of multiple hops through other nodes in the network. Thus, discovering and maintaining routes in MANET is significant.

The reactive protocols are the most famous routing approach in mobile ad-hoc networks and the most famous on-demand routing algorithms are Ad-hoc On-Demand Distance Vector routing (AODV) [1] and Dynamic Source Routing (DSR) [2]. So, since they are widely used, this paper discusses the impact of variation in node velocities on the performance of AODV and DSR. The network simulator NS-2 [3] provide better understanding of simulation environment and node links in MANET protocol evaluation. So, NS-2.35 is used for all simulation results in this study.

II. RELATED WORK

A number of MANET routing protocols have been designed and comparisons have been done between these protocols based on various parameters. The performance of existing reactive and proactive routing protocols (i.e. AODV, DSR, DSDV and TORA) is compared by Broach et.al. [4], the original authors of the simulation model. Though, they used less no. of mobile nodes and low traffic loads. Packet delivery fraction, distribution of path lengths, number of routing packets were used as performance metrics. DSR performed better than AODV. Therefore, it was concluded that, at low loads with small number of nodes, DSR is better than AODV. Johansson et.al. [5], extended the above work by using new mobility models. In spite of taking absolute speeds and pause times, relative speed of nodes was introduced. Again, no. of nodes was less. Throughput, delay and routing load were measured. Although the model implementations were different, the overall observation was similar to the above work. At low loads, DSR is more effective, while AODV is more effective at higher loads. A. Boukerche [6] presented a simulation study to compare on-demand routing protocols, using a variety of workload such as mobility, load and size of ad hoc networks. It was concluded that in all the testing scenarios, DSR has very high throughput while AODV has short end-to-end delay of data packets. Also DSR has less routing overhead than AODV.

R. Mishra and C.R. Mandal [7] compared the reactive protocols in constrained environment (congestion). In normal cases AODV performs better than DSR using various performance metrics. But it was observed that DSR worked better than AODV in constrained situation of several CBR traffic sources. M.D. Vimalapriya and Dr. S.S. Baboo [8] evaluated the performance of AODV and DSR in Randomwaypoint and Randomwalk Mobility Models. AODV and DSR protocols produce less routing load in Randomwaypoint than in Randomwalk. As Randomwalk produced high routing load due to change in node direction and speed. DSR has slight variation in routing load for both mobility models. AODV showed efficiency in routing and performed better than DSR in Randomwaypoint mobility model but in contrast DSR performed better in Randomwalk mobility model.

So far, a no. of comparisons has been done between on-demand routing protocols based on a no. of parameters (i.e. node density, load, node mobility). But a few comparisons have been done on the basis of node velocity. Therefore, this paper is based on the performance comparison of on-demand routing protocols (i.e. AODV and DSR) with variation in node speed.

III. ROUTING PROTOCOLS IN MANET

According to routing strategy MANET routing protocols are classified as in the figure below.

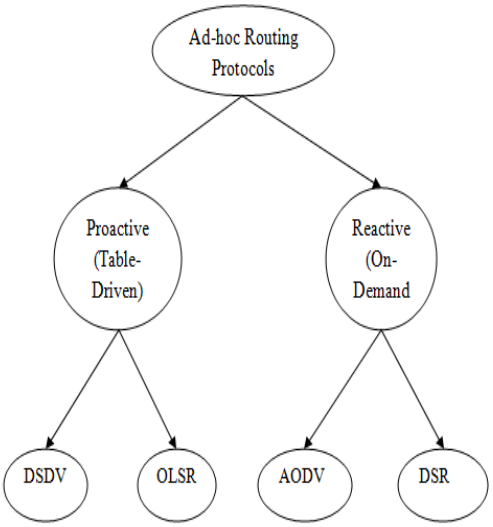

Fig 1: Classification of Ad-hoc Routing Protocols

In MANET there are no fixed links as in wired networks, because nodes can move freely within the network. Due to this frequent change in location of nodes, routing overhead is increased in MANET as compared to wired networks. Routing packets between a pair of nodes becomes a difficult task. A path might not work a few moments later that was considered optimal at a given point of time. Moreover, the unpredictability properties of the wireless channels add to the uncertainty of path quality [9]. The existing routing protocols can be divided into two classes based on routing strategy. One is proactive routing also known as table driven routing and other is reactive routing also known as on-demand routing. There is one common thing in both routing strategies that each participating node in the routing plays an equal role. In proactive routing protocols, routes to all nodes are maintained including those to which no packet is being sent. Also a periodic update of routing table is required in proactive routing. On the other hand reactive routes are established in on-demand routing which specifies that routes are created only when a node require to send packets to the other node. So, no periodic update of routing table is required. Our major concern in this paper is on-demand routing protocols that are DSR and AODV. Therefore, a brief overview of both these protocols is given below.

A. Dynamic State Routing (DSR)

Each packet in DSR protocol [10, 11, 12] carry the full address i.e. every hop in the route from source to the destination. In large networks, this protocol is not effective due to increase in overhead of carrying full information of route in the packet. Therefore, in highly dynamic and big networks, most of network bandwidth is consumed due to this overhead. The other disadvantage of DSR is that broken links are not locally repaired by the route maintenance mechanism. But a major advantage of this protocol is that, there is no need to periodically flood the table update messages in the network. Therefore nodes can enter in sleep mode for power saving. In small to moderately size networks, DSR protocol performs better. Also, in this protocol nodes can use route cache to store multiple routes, so that before initiating route discovery, source node can check its route cache for a valid route and if a route is found there is no need for route discovery.

B. Ad hoc On-demand Distance Vector Routing (AODV)

The AODV routing protocol is the combination of DSR and DSDV algorithm [13, 14, 15]. It uses the sequence numbering and periodic beaconing of DSDV and a route discovery procedure similar to DSR. However, AODV differs from DSR in two aspects. The major one is that in DSR, each packet carries full routing information, whereas in AODV, only the destination address is carried by the packets. It means there is less routing overhead in AODV than in DSR. The other difference is that the route replies in DSR carry the address of every node along the route, whereas in AODV only the destination IP address and the sequence number is carried by the route replies. The major advantage of AODV is that it performs better in highly dynamic networks. However, during route construction node may experience large delays and link breakage may initiate another route discovery, which further increases delay and as the size of the network increases nodes consumes more bandwidth.

IV. SIMULATION ENVIRONMENT

The routing protocols are compared based on the following three performance metrics:

- Packet Delivery Ratio: The ratio of received packets by the destination to the sent packets by the source.
- Average End-to-end delay: The time taken by the packet to be transmitted across a network from sender to the receiver.
- Throughput: The throughput is defined as the total amount of data a destination node receives from the source node divided by the time it takes for destination node to get the last packet.

V. SIMULATION

A. Simulation Parameters

Studied protocols	AODV, DSR
Simulation time	80 seconds
Simulation area	500 X 500
No. of nodes	8
Node velocity	0, 10, 20, 80m/s
Traffic	CBR(Constant Bit Rate)

Table 1: Simulation Parameter Values

B. Simulation Method

Experiments are carried out in Network Simulator 2 (NS2 [16]). It is an object oriented simulator, which is written in C++ and OTCL. It not only supports various IP protocols

that are commonly used but also supports the users for implementing and extending their own protocols. Two output files with *.nam (network animator file) and *.tr (trace file) extension are created after executing the tcl scripy. NAM is a Tcl based animation tool for viewing simulation environment. Trace files (with *.tr extension) can be analyzed by awk scripts (with *.awk extension). Using these awk scripts three network parameters i.e. packet delivery ratio, average end-to-end delay and throughput are calculated for AODV and DSR protocols.

C. Simulation Results

As the nodes velocity is increased, routes are changed frequently. Older routes are broken and new routes are formed by both protocols. Due to this frequent change in routes, packet delivery ratio, throughput and delay are also changed.

1) Comparison of AODV and DSR

Comparison of AODV and DSR on the basis of Node Velocity is shown in Table 2 below.

Metric/Node velocity	0	10	20	80
Packet delivery ratio (AODV)	61.08	56.03	55.74	56.66
(DSR)	61.03	63.28	51.81	55.64
Avg. end-to-end delay (AODV)	273.25	262.67	269.20	261.03
(DSR)	275.73	224.30	220.59	271.33
Throughput (AODV)	1205.88	1106.03	1100.52	1118.57
(DSR)	1205.55	1077.34	1103.67	1100.48

Table 2: Performance Metric Values Of Aodv And Dsr Vs. Node Velocity

2) Graphical Results

Behavior of AODV and DSR protocols is studied by executing tcl scripts on various node speeds. In the beginning of simulation, random motion of all nodes is disabled. After that node speed is increased uniformly and performance of both protocols is measured on varying node velocities (at 10m/s, 20m/s and 80m/s).

The data in Table 2 are plotted in MS Excel.

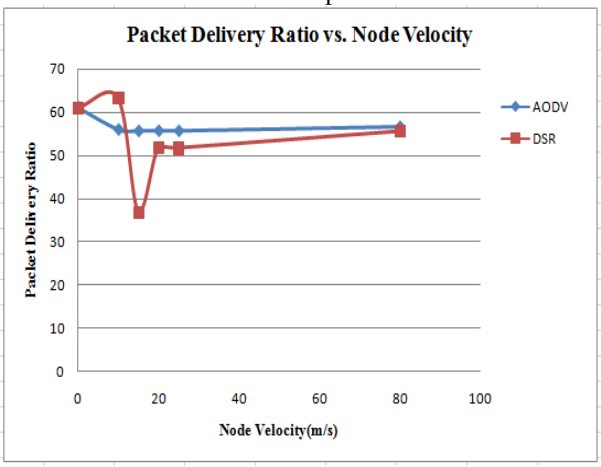

Fig. 2: Plot of packet delivery ratio vs. node velocity

From fig 2, it is clear that at moderate node speed, DSR gives higher packet delivery ratio than AODV. But at higher node speed performance of DSR degrades and packet delivery ratio falls sharply. So at higher node velocity AODV performs better than DSR with respect to packet delivery ratio.

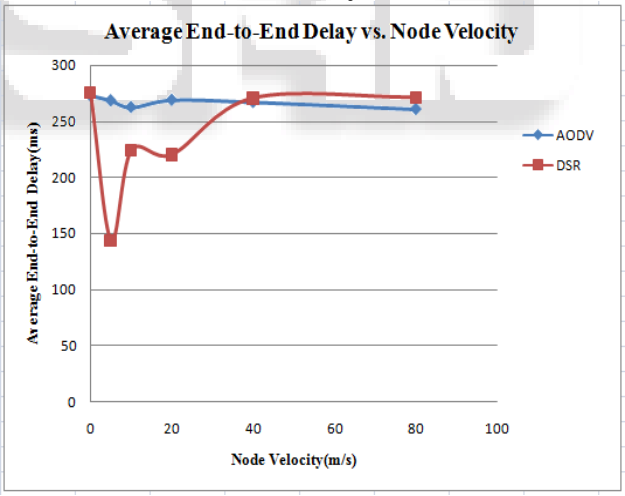

Fig. 3: Plot of average end-to-end delay vs. node velocity

From fig 3, it is clear that at moderate node speed, average end-to-end delay of DSR is less as compared to AODV. But at higher node speed AODV has less delay and performs better than DSR.

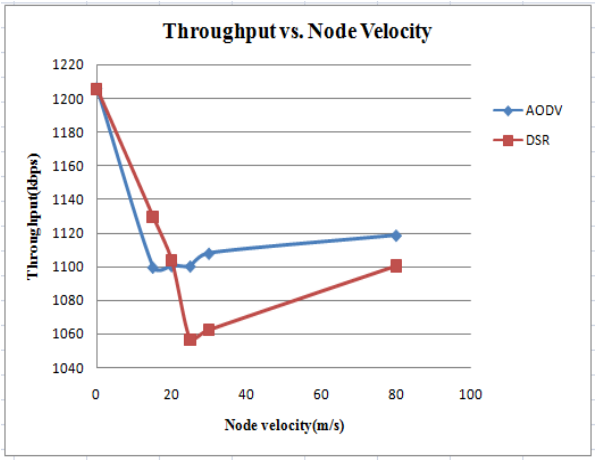

Fig. 4: Plot of throughput vs. node velocity

From fig 4, it is clear that at moderate node speed, throughput of DSR is greater than AODV. But at higher node speeds throughput of AODV goes up. So AODV performs better than DSR at higher node velocity.

VI. Conclusion

This paper compared the two popular ad-hoc routing protocols AODV and DSR. Simulation results show that DSR protocol performs better than AODV with low node speed. So DSR should be used in the networks where nodes mobility is low. But AODV protocol performs better than DSR with high node speed. So AODV should be used in the networks where nodes mobility is high.

VII. Future scope

The studied protocols in this paper can be optimized further to preserve energy of each node in the network. As in the ad-hoc networks nodes have limited initial amount of energy which is consumed at different rates depending upon the power level and target receivers. So to save energy further study can be carried out on these existing protocols.

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