International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-1 Issue-2, July 2012

Performance of Ad-Hoc Network Routing Protocols in Different Network Sizes

Ginni Tonk, S.S. Tyagi

Abstract-A Mobile Ad-Hoc Network (MANET) is a temporary network that is composed of the mobile devices which communicates through wireless links without any pre-existing infrastructure. Routing is one of the major concerns in the MANET due to its frequent changing topology and the absence of centralized administrator. In this paper, we evaluate the performance of Mobile Ad-Hoc Network Routing Protocols Dynamic Source Routing (DSR), Ad-Hoc On Demand Distance Vector (AODV) and Destination-Sequenced Distance Vector (DSDV) under different performance metrics like PDF, Average End-to-End delay, NRL, Throughput, Routing Overhead and Packet Loss. The performance evaluation is done in different network sizes using network simulator NS-2. The comparison result shows that AODV gives highest PDF and Throughput, DSR gives lowest packet loss and DSDV gives the lowest NRL, End-to-End Delay and Routing Overhead.

Keywords: AODV, DSDV, DSR, MANET

I. INTRODUCTION

A Mobile Ad-hoc Network (MANET) is an autonomous system of mobile routers (and associated hosts) communicating with each other without the use of a fixed infrastructure or any centralized administration. One of the distinguishing features in this network is that each mobile node must be able to act as a router to find out the optimal path for forwarding packets. Thus, nodes must discover and maintain routes to other nodes. Therefore, Routing in Ad-Networks is one of the major challenging task. A number of routing protocols have been developed so far for accomplishing this task. There are many ways to classify the MANET routing protocols, depending on how the protocols handle the packet to deliver from source to destination. Routing protocols in MANETs are broadly classified into two types: Proactive and Reactive protocols.

Table Driven or Proactive Protocols: These protocols maintain consistent, upto-date routing information from each node to every other node in the network. These protocols require each node to maintain one or more tables to store routing information.

Revised Manuscript Received on 30 July 2012
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On Demand or Reactive Protocols: These protocols create routes only when desired by the source node.

II. DESCRIPTION OF THE PROTOCOLS

This section briefly explains the AODV, DSR and DSDV routing protocol that are being studied in this paper.

➢ *Destination-Sequenced Distance Vector (DSDV) routing protocol*

DSDV is a Table driven routing protocol based on the classical Bellman-Ford routing algorithm. It was developed by C. Perkins and P. Bhagwat in 1994. It eliminates route looping, increases convergence speed, and reduces control message overhead. In this routing protocol, each mobile node in the network maintains a next-hop table, which it exchanges with its neighbours. There are two types of next-hop table exchanges: periodic full-table broadcast and event-driven incremental updating. The table has all the possible destinations and the number of hops to them in the network is recorded. A sequence number is also associated with each route to the destination. The route labelled with the highest sequence number is always used. The data broadcast by each mobile node will contain the new sequence number, the destination's address, the number of hops to reach the destination and the sequence number of the information received regarding that destination.

➢ *Dynamic Source Routing (DSR) Protocol*

The Dynamic Source Routing protocol (DSR) is an on demand routing protocol. DSR is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. The DSR protocol is composed of two main mechanisms that work together to allow the discovery and maintenance of source routes in the ad hoc network:

- Route Discovery is the mechanism by which a node S wishing to send a packet to a destination node D obtains a source route to D using ROUTE REQUEST and ROUTE REPLY messages. It is used only when S attempts to send a packet to D and does not already know a route to D.
- Route Maintenance is the mechanism by which a node S is able to detect if the network topology has changed because a link along the route no longer works. On detecting link break, DSR sends ROUTE ERROR message to source node for finding a new route. In that case, S can attempt to use any other route it happens to know to D, or it can invoke Route Discovery again to find a new route for subsequent packets to D.

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➢ ***Ad-Hoc On Demand Distance Vector (AODV) Routing Protocol***

The Ad hoc On-Demand Distance Vector (AODV) is an on-demand routing protocol that enables dynamic, self-starting, multihop routing between participating mobile nodes wishing to establish and maintain an ad hoc network. AODV allows mobile nodes to obtain routes quickly for new destinations, and does not require nodes to maintain routes to destinations that are not in active communication. This protocol performs Route Discovery using control messages route request (RREQ) and route reply (RREP), whenever node wishes to send packet to destination. To control network wide broadcast of RREQs, the source node uses an expanding ring search technique. The forward path sets up in intermediate nodes in its route table with a lifetime association using RREP. AODV allows mobile nodes to respond to link breakages and changes in network topology in a timely manner. When either destination or intermediate node moves, a route error (RERR) is sent to the affected source nodes. When a source node receives the (RERR), it can reinitiate the route discovery if the route is still needed. Neighbourhood information is obtained from broadcast Hello packet.

III. RELATED WORK

Several researchers have done the qualitative and quantitative analysis of Ad-Hoc Network Routing Protocols. For this purpose, they have used different simulators and evaluated them by means of different performance metrics under different network conditions.

♦ Sapna S. Kaushik & P.R. Deshmukh in [12] studied & compared the performance of DSDV, AODV and DSR routing protocols for ad hoc networks. They have compared the three routing protocols in Ad hoc network with respect to packet delivery fraction, packet loss and end-to-end time delay by varying number of nodes. The authors have observed that for packet delivery and packet loss ratio, DSR/AODV performs better than DSDV with large number of nodes. Hence for real time traffic AODV is preferred over DSR and DSDV. For less number of nodes and less mobility, DSDV's performance is superior.

♦ P. Manickam1, T. Guru Baskar in [9] studied & analyzed three protocols AODV, DSDV and DSR & were simulated using NS-2 simulator and were compared in terms of throughput, packet delivery ratio and average end-to-end delay in different environment; varying number of nodes and pause time. Simulation results show that DSR shows better performance with respect to throughput among these three protocols. in view of packet delivery ratio, reliability of AODV and DSR protocols is greater than DSDV protocol. For End-to-End delay, DSDV has high reliability than AODV and DSR.

♦ Santosh Kumar, S C Sharma in [11] have evaluated the three routing protocols (AODV, DSR and DSDV) with respect to packet delivery fraction and end-to-end time delay and NRL using NS-2. For the simulation the number of traffic sources was fixed at 10, 30 and 50 and the pause time was varied as 0, 10, 20, 30 40, 50, 60, 70, 100s. They have observed that The average end-to-end delay of packet delivery was higher in both DSR and AODV as compared to DSDV. In low network size, DSR has the highest PDF among the three protocols. In high network size, AODV gives the highest PDF. DSDV perform well with respect to all included performance matrices as compared to AODV and DSR.

♦ Mohamad Usop, Azizol Abdullah in [7] have compared DSDV, AODV and DSR Routing Protocols in Grid Environment. The results were obtained for the metrics: PDF, End to End Delay and Packet Loss for 50 nodes at pause time of 0, 100, 200, 300, 400, 500, 600, 700, 800, 900s. DSDV gives the lowest End-to-End delay. When the pause time is low, AODV gives the highest PDF and when the pause time is high, DSDV gives the highest PDF. AODV has the lowest packet loss.

♦ Akshai Aggarwal, Savita Gandhi in [1] have compared DSDV, DSR and AODV Protocols using NS-2. The simulation was done by varying number of nodes and taking different number of connection. The results were obtained for PDF, NRL, average end-to-end delay and Throughput. It is observed that DSDV gives the lowest end-to-end delay. DSR gives the lowest NRL. AODV gives the highest PDF and Throughput.

IV. SIMULATION SETUP

We carried out simulation using NS2 simulator in order to simulate the performances of Ad-Hoc network routing protocols. The traffic sources are Constant Bit Rate (CBR). The mobility model uses 'random waypoint model' in a rectangular field of 800m x 800m with 20 nodes to 125 nodes. The experiments use a fixed number of packet sizes (512-bytes) and a packet rate of 4 packets per seconds.
The parameters which have been considered for the performance evaluation of the Ad-Hoc Network routing protocols is given below in Table I.

Table I: Parameters for simulation evaluation

Parameter	Value
Protocols	AODV, DSR and DSDV
Traffic Type	CBR
Simulation Duration	100 seconds
Packet Size	512 bytes
Simulation Area	800 m x 800 m
Number of mobile nodes	20,50,75,100,125
Pause Time	20 sec
Maximum speed	30 m/s
Sending Rate	4 packets/sec
Mobility model	Random way point

V. PERFORMANCE METRICS AND RESULT

In order to evaluate the performance of ad hoc network routing protocols, the following metrics were considered**:**

A. Packet delivery fraction (PDF)

PDF is the ratio of the number of data packets successfully delivered to the destinations to those generated by CBR sources.

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From figure 1, we find that when the number of nodes are minimum i.e. 20, DSR has highest PDF; while DSDV has lowest PDF among the three routing protocols. When the number of nodes are between 20 and 75; the PDF for DSDV increases, for DSR it decreases while it almost remains constant for AODV. Now as the numbers of nodes are increased further upto 125, the PDF for the three of them decreases.
In case of low network size, DSR gives the highest PDF and DSDV gives the lowest PDF.
In case of high network size, DSDV gives the highest PDF. Overall, AODV performs better than DSDV and DSR in terms of PDF.

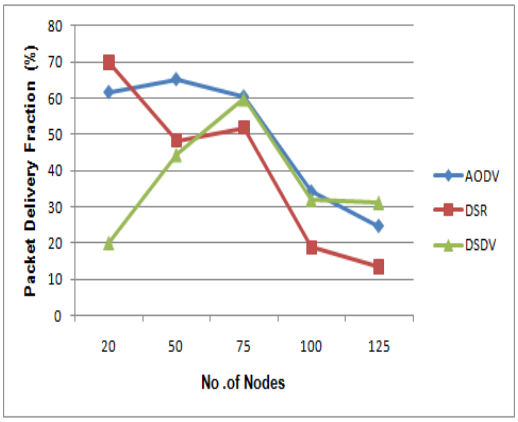

Figure 1: Packet Delivery Fraction vs. Number of Nodes

B. Normalized Routing Load (NRL)

It is the number of routing packets transmitted per data packet delivered at the destination.
It is observed from the figure 2, when the network size is low, DSDV gives the lowest NRL; while AODV gives the highest NRL.
When the network size is high, DSR gives highest NRL; while it is minimum for DSDV.
Overall, DSDV gives the lowest NRL. Reason being that it is proactive routing protocol.

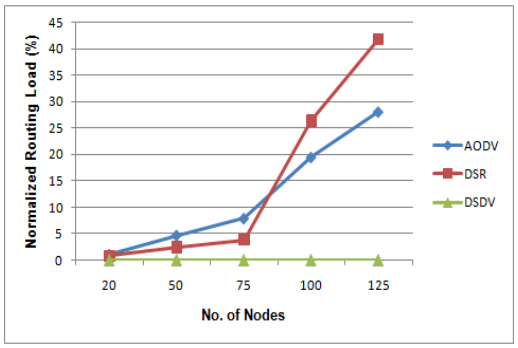

Figure 2: Normalized Routing Load vs. Number of Nodes

C. Average End-to-End delay

It is the average time from the beginning of a packet transmission at a source node until packet delivery to a destination. This includes delays caused by buffering of data packets during route discovery, queuing at the interface queue, retransmission delays at the MAC, and propagation and transfer times.
We observe from the figure 3 that DSDV has the shortest End-to-End delay than AODV and DSR, because DSDV is a proactive protocol i.e. all routing information are already stored in table. Hence, it consumes lesser time than others. However, DSR has highest End-to-End delay than AODV and DSDV.

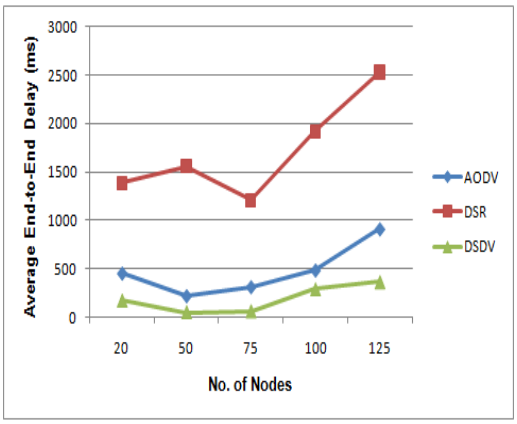

Figure 3: Average End-to-End Delay vs. Number of Nodes

D. Throughput

This represents the number of packets received by the destination within a given Time Interval. It is a measure of effectiveness of a routing protocol.
From figure 4 it is observed that in low network size, DSR gives highest throughput; while throughput for DSDV is minimum. As the network size increases, throughput for AODV becomes highest among the three protocols; while the performance of DSR decreases and becomes lowest. DSDV gives poor performance in low network size and gives best performance in high network size.
Overall when comparing the routing throughput for each of the protocols, AODV has the highest throughput and DSR has the lowest throughput.
Hence, AODV shows better performance with respect to throughput among these three protocols.

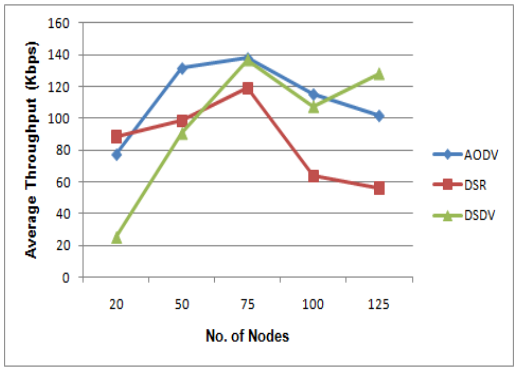

Figure 4: Average Throughput vs. Number of Nodes

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E. Routing overhead

It is the ratio of the total number of routing packets sent and the total number of packets sent.
It is clear from the figure 5 that routing overhead for AODV is highest among the three protocols in case of low and high network size; while for DSDV it is zero throughout. Overall, DSDV has the least overhead throughout.

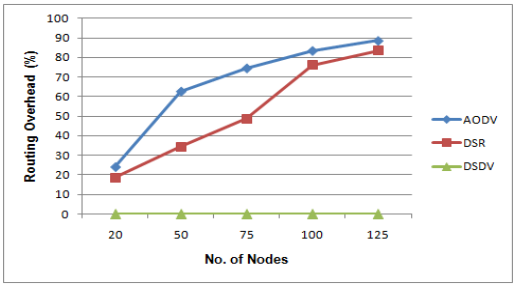

Figure 5: Routing Overhead vs. Number of Nodes

F. Packet loss

It is the difference between the total number of packets send by source and received by sink.
It is observed from the figure 6 when the number of nodes is varied from 20 to 100, Packet Loss for DSDV is highest; while it is lowest for DSR. And when the nodes are increased further upto 125, the packet loss for DSDV first increases and then decreases; and for DSR it will decrease; while packet loss for AODV will increase as the network size increases.
Overall, DSR performs better in terms of packet loss as it has least packet loss throughout.

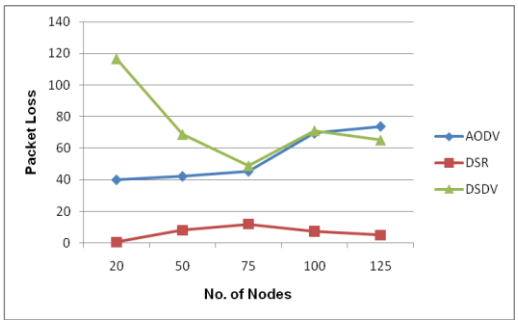

Figure 6: Packet Loss vs. Number of Nodes

V. CONCLUSION

Here, we have evaluated the performance comparison of the routing protocols DSDV, AODV and DSR with increasing number of nodes using NS-2 Simulator. The performance metrics taken are Average End-to-End delay, Normalized Routing Load, Packet Delivery Fraction, Routing overhead, Packet Loss and Average Throughput.
From the performance evaluation and results obtained, we conclude that in low network size; DSDV gives the lowest NRL and Routing Overhead and has the shortest End-to-End delay while DSR gives highest throughput, PDF and gives lowest packet loss.
In case of high network size; DSDV gives the highest PDF, lowest NRL and Routing Overhead, shortest End-to-End delay and gives highest throughput, DSR gives lowest packet loss.
Overall, AODV performs better than DSDV and DSR in terms of PDF and Throughput. DSDV gives the lowest NRL, gives shortest End-to-End delay than AODV and DSR and has the least routing overhead throughout. DSR performs better in terms of packet loss as it has least packet loss throughout.

VI. FUTURE SCOPE

We have analyzed the performance evaluation of the three routing protocols (AODV, DSDV and DSR) in this paper. For the future work, we will try to cover up other routing protocols and compare them by taking different simulation scenarios. And we will try to simulate these protocols using different simulation setups. Also in order to judge their performance, we will try to implement these protocols in real life as well.

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