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Performance Comparison of Ad-Hoc Network Routing Protocols using NS-2

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Abstract: ***Mobile Ad-hoc Network (MANET) is an infrastructure less and decentralized network which need a robust dynamic routing protocol. Many routing protocols for such networks have been proposed so far. The most popular ones are Dynamic Source Routing (DSR), Ad-hoc On Demand Distance Vector (AODV), and Destination-Sequenced Distance Vector (DSDV) routing protocol. In this paper, we are going to compare Mobile Ad-Hoc network routing protocols DSDV, AODV and DSR using network simulator NS-2. The performance matrix includes PDF (Packet delivery fraction), Average end-to-end delay, and Normalized Routing Load. We have compared the performance of routing protocols by varying pause time, number of nodes and maximum speed. The comparison result shows that AODV has the highest PDF and NRL while DSR gives the highest Average End-to-End delay.***

Keywords: AODV, DSDV, DSR, MANET

I. INTRODUCTION

A Mobile Ad-Hoc network consists of a number of wireless mobile nodes that are capable of communicating with each other without the use of a network infrastructure or any centralized administration. In such a network, each mobile node operates not only as a host but also as a router, forwarding packets for other nodes that may not be within direct wireless transmission range of each other. Thus, nodes must discover and maintain routes to other nodes. Therefore, the design of routing protocols for such networks is more challenging than that for wired networks.

II. CLASSIFICATION OF ROUTING PROTOCOLS

A routing protocol has to find a route for packet delivery and deliver the packet to the correct destination. Routing Protocols in Ad-Hoc Networks are classified into two types:

A. Table Driven or Proactive Protocols

Table driven routing 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. These routing protocols respond to changes in network topology by propagating updates information throughout network. This type of routing is called as source routing. DSDV is one of the main proactive routing protocols.

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

DSDV is a Table driven routing protocol based on the classical Bellman-Ford routing algorithm. In this routing protocol, each mobile node in the system maintains a routing table in which all the possible destinations and the number of hops to them in the network are recorded. A sequence number is also associated with each route/path 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.

B. On Demand or Reactive Protocols

These protocols create routes only when desired by the source node. When a node requires a route to a destination, it initiates a route discovery process within the network. Once a route has been established, it is maintained by a route maintenance procedure until either the destination becomes inaccessible along every path from the source or until the route is no longer desired. Some famous on demand routing protocols are: DSR and AODV.

➢ ***Dynamic Source Routing (DSR) Protocol***

This protocol has two mechanisms- Route Discovery and Route Maintenance. The source route is needed when some node originates a new packet destined for some node by searching its route cache or initiate roué discovery using ROUTE REQUEST and ROUTE REPLY messages. On detecting link break, DSR sends ROUTE ERROR message to source node for new route.

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

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. 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.

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C. Performance comparison of the above three routing protocols

Table I : Protocol comparisons

PROTOCOL PROPERTY	DSDV	DSR	AODV
Loop Free	Yes	Yes	Yes
Multicast	No	No	Yes
Periodic Broadcast	Yes	No	Yes
Routes Maintained	Routing Table	Route Cache	Routing Table
Reactive	No	Yes	Yes

III. RELATED WORK

Several researchers have done various performance comparisons of Ad-Hoc Routing Protocols by means of different performance metrics.

♦ Runcai Huang *et al.* [10], have compared the DSDV, DSR and AODV Protocols using ns-2 simulator. They have compared the three routing protocols in Ad hoc network with respect to packet delivery fraction and end-to-end time delay. In simulation environment, they have constructed a random node moving scene, the scope of the scene was 1000m×1000m, the scene includes 50 nodes and the traffic type was CBR (constant Bit Rate). The authors have concluded that AODV protocol is more reliable, as its packet delivery fraction is higher than DSDV and DSR and has lower end-to-end time delay than DSDV and DSR. While DSR has highest end-to-end time delay among the three routing protocols.

♦ Mohammed Bouhorma *et al.* [1], have compared DSR and AODV Protocols. Both protocols were simulated using the tool ns-2 and were compared in terms of packet loss ratio, end to end delay, by varying number of nodes and speed. They have concluded that both protocols deliver higher packet delivery ratio when there is little node motion, but as the maximum speed increases, AODV delivers higher packet delivery ratio than DSR. On the other hand, DSR has the lower End-To-End delay than AODV when pause time is varied.

♦ Shaily Mittal *et al.* [8], have compared the routing protocols (AODV, DSR and ZRP). They have used QualNet Simulator for the simulations. The simulation was done with 50 nodes by varying pause times. They have evaluated AODV, DSR on the basis of Average end to end delay, TTL based hop count and Packet delivery ratio. They have shown that best performance is shown by AODV having lowest end to end delay than DSR and ZRP when pause time is varied. It is analyzed that the hop count increases continuously for AODV as compared to DSR and ZRP. At the same time, AODV and DSR delivers almost 90 percent of packets when compared with ZRP.

♦ Asma Tuteja *et al.* [13], have compared the routing protocols DSDV, AODV and DSR using network simulator NS2. They have compared the performance of three protocols. The results were obtained for the metrics: PDR (Packet Delivery Ratio), Throughput, End to End Delay, Routing overhead by varying packet size, time interval between packet sending, mobility of nodes. They have analyzed that performance of DSDV protocol is not good as throughput is very low and routing load is very high as compared to AODV and DSR protocols. AODV delivers higher packet delivery ratio than DSR and DSDV. DSR is performing better than AODV protocol if we compare average end to end delay.

IV. PERFORMANCE EVALUATION

NS2 simulator is used to simulate the performances of Ad hoc network routing protocols in wireless network transmission. The paper analyzes and compares the simulation results of DSDV, AODV and DSR in Ad hoc network.

In this paper, we use traffic and mobility model based on Continuous bit rate (CBR) traffic sources. Only 512-byte data packets are used. The field configurations used is: 800 m x 800 m field. The simulation parameters which have been considered for the performance comparison of two on-demand routing protocols is given below in Table-2.

Table II : Parameters used in experiment scenario

Parameter	Value
Protocols	AODV, DSR and DSDV
Traffic Source	Constant bit rate CBR
Simulation time	200 seconds
Packet Size	512 bytes
Area	800 m x 800 m
Number of nodes	10,20,30,40,50
Pause Time	0,20,40,60,80
Maximum speed	10,20,30,40,50
Mobility model	Random way point

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

A. Packet delivery fraction

From the figures 1, 2 and 3, it is observed that when no. of nodes is between 10 and 20, DSR protocol has highest PDF. When no. of nodes is between 20 and 30, the results of PDF for AODV, DSDV and DSR are decreasing. When no. of nodes is increased upto 50, AODV shows the highest PDF. In overall, AODV delivers the highest PDF.

When pause time is varied from 0 to 20, the PDF values for AODV, DSR and DSDV increases. In overall, AODV delivers the highest PDF and DSDV shows the lowest PDF. When maximum speed is varied, AODV delivers the highest PDF and DSDV gives the lowest PDF and DSR has PDF somewhat lower than AODV.

B. Normalized Routing Load

From the figures 4, 5 and 6, it is observed that when no. of nodes are 10, DSR and AODV have approximately the same NRL. But when it is increased upto 30, AODV has the highest NRL. When no. of nodes is between 30 and 40, NRL remains constant for AODV and decreases for DSR. When no. of nodes are increased further, the graph for AODV increases gradually and for DSR, the value for NRL will decrease slowly. The value of NRL for DSDV will remain constant throughout. In overall, AODV has the highest NRL.

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When pause time is varied from 0 to 20, the NRL for AODV and DSR decreases, but AODV has the highest NRL. When pause time is increased upto 60, the NRL for AODV and DSR increases. When pause time is increased upto 80, then also the graph for AODV and DSR decreases. In overall, AODV has the highest NRL.

When maximum speed is between 10 and 20,the graph for three of them remains constant, but AODV has the highest NRL. When maximum speed is between 20 and 50, the curve for AODV and DSR increases. The value of NRL for DSDV remains constant throughout. In overall, AODV shows the highest NRL.

C. Average End-to-End delay

From the figures 7, 8 and 9, it is observed that when no. of nodes are between 10 and 20, DSR has the highest Average End-to-End delay, also, the value of Average End-to-end delay for DSR and AODV decreases and it will remain constant for DSDV. When the no. of nodes is increased further, the value of Average End-to-End delay for DSR will be highest among the three protocols and this value will be lowest for DSDV. In overall, DSR has the highest Average End-to-End delay.

When the pause time is 0, DSR has the highest Average End-to-End delay. When the pause time is increased to 20, the slope for DSR decreases and it will almost remain same for AODV and DSDV. Now when the pause time is increased upto 60, the graph for AODV and DSR increases and for DSDV, it will slightly increase. When the pause time is increased to 80, the value for DSR will fall gradually and for AODV, it will also decrease. In overall, DSR has the highest Average End-to-End delay and DSDV gives the lowest Average End-to-End delay by varying pause time and Average End-to-End delay for AODV is somewhat higher than DSDV.

When the maximum speed is varied, .the curve jumps a lot for three of them throughout but overall DSR shows the highest Average End-to-End delay.

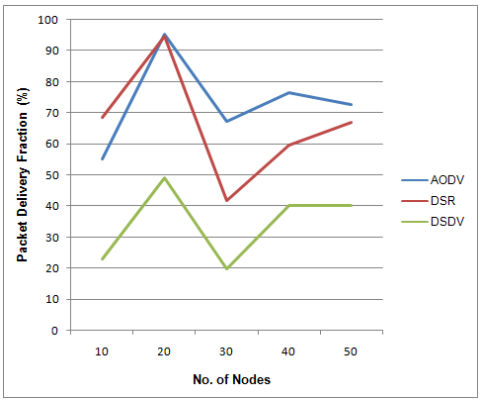

Figure 1 : Packet Delivery Fraction by varying number of nodes

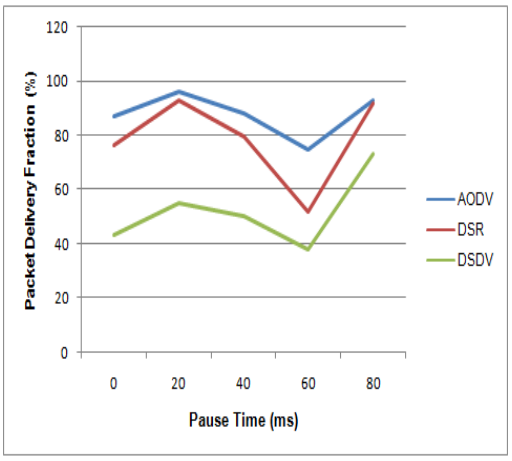

Figure 2 : Packet Delivery Fraction by varying Pause Time

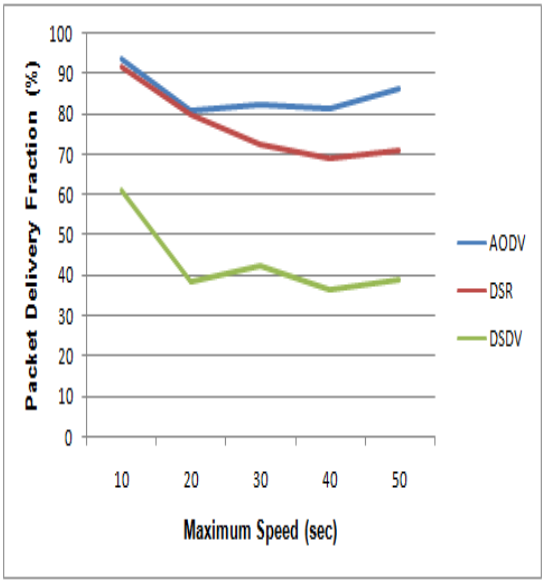

Figure 3 : Packet Delivery Fraction by varying Maximum Speed

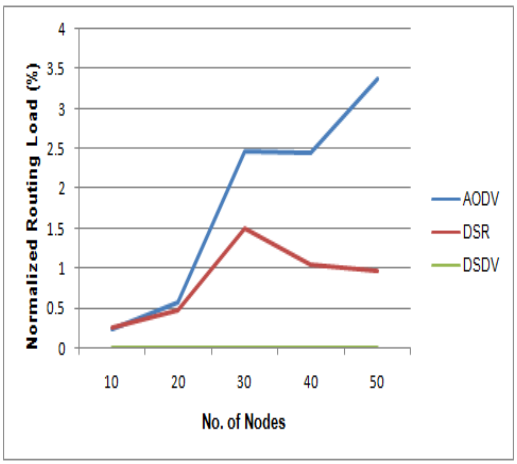

Figure 4 : Normalized Routing Load by varying number of nodes

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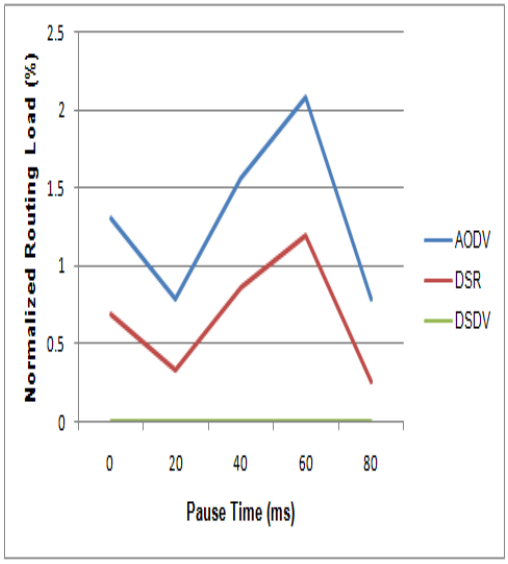

Figure 5 : Normalized Routing Load by varying Pause Time

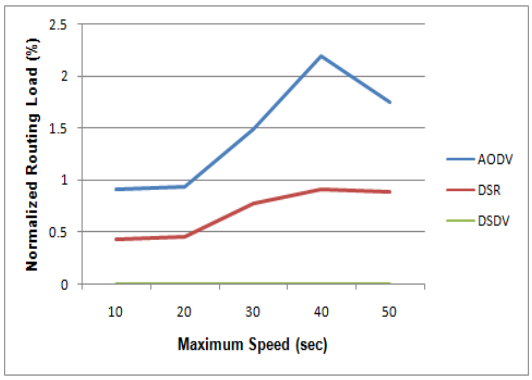

Figure 6 : Normalized Routing Load by varying Maximum Speed

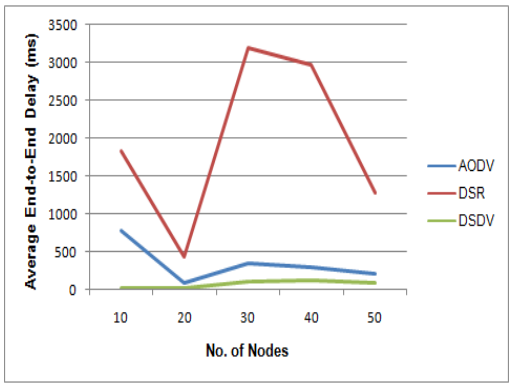

Figure 7 : Average End-to-End Delay by varying number of nodes

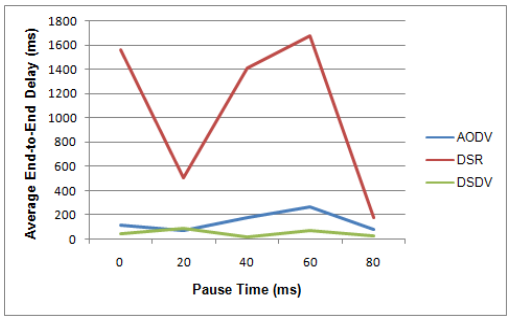

Figure 8 : Average End-to-End Delay by varying Pause Time

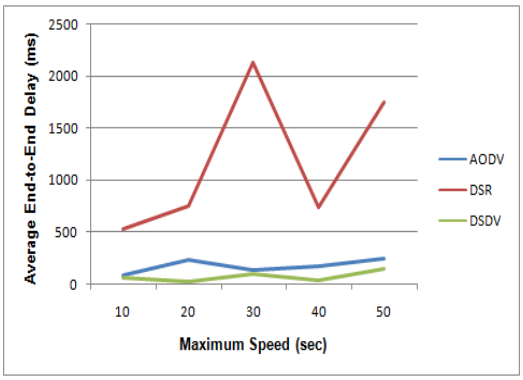

Figure 9 : Average End-to-End Delay by varying Maximum Speeds

V. CONCLUSION

We have analyzed the performance comparison of the routing protocols DSDV, AODV and DSR using NS-2 Simulator. We have compared these routing protocols on the basis of Average End-to-End delay, Normalized Routing Load, and packet delivery fraction by varying number of nodes, pause time and maximum speed.

Through the analysis and comparison of network simulation results, we can conclude that when no. of nodes are varied, AODV delivers the highest PDF and NRL due to on-demand nature of this protocol, while Average End-to-End delay is maximum for DSR due to caching mechanism of DSR.

When pause time is varied, AODV delivers the highest PDF and NRL and Average End-to-End delay is maximum for DSR.

When maximum speed is varied, AODV delivers the highest PDF and NRL and Average End-to-End delay is maximum for DSR.

In all of the 3 cases, AODV has the highest PDF and NRL. And DSR has the highest Average End-to-End delay, while DSDV because of its proactive nature provides the minimum delay.

It is always difficult to draw a conclusion that amongst these protocols which one is the best in all respects. There is always a trade-off between one or the other parameters. Every protocol has its own significance and depending on the type of application they are implemented on it is the user who decides which one would suite best.

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VI. FUTURE SCOPE

In future, we can try different scenarios by varying their Simulation Time, Packet Size, Area and Mobility Models. Behaviour of these protocols can be judged in different scenarios by using different simulation setups. Other than this, we will be trying to implement these protocols in real life scenarios to judge their performance.

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