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Simulating and Analyzing the Behavior of Table-Driven and On-Demand Routing Protocol

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Abstract- Routing is a mechanism to find an optimal route from a source node to destination which is the responsibility of routing protocols. Two prominent routing protocols are reactive or on-demand routing protocols and proactive or table-driven routing protocols. Both types of protocols are efficient in themselves. Performance evaluation of protocols by using performance metrics such as PDR, Average End to End delay, Routing Overhead and throughput etc. is an important aspect in estimating the efficiency of protocols. It helps in making choice of protocols according to the network environment and conditions. This paper describes routing behavior of on-demand routing protocols (DSR, AODV) and table-driven routing protocol (DSDV). Simulations of these three protocols have been performed on NS-2 by varying pause time and speed and then results have been analyzed.

Keywords: *AODV, DSDV, DSR, Metrics, PDR, Routing, Simulation.*

I. INTRODUCTION

Ad-hoc networks consist of various temporary interconnected nodes that do not rely on any centralized system. Mobile Ad-hoc network is a more generalized infrastructure-less network of mobile nodes, which keep on changing their positions with time thus forming arbitrary topology. Mobile nodes are dynamic in nature. They are capable of acting as a host as well as a router. As nodes in the network arrange themselves dynamically and spontaneously without having knowledge of existing topology of the network therefore mobile ad-hoc networks are always referred to as self-organizing and self-configuring networks [1]. Any new node that enters inside the range of other neighbor node can configure and establish its connection with it. These two characteristics of mobile ad-hoc network make it extremely efficient as well as deployable.

Routing is the basic functionality of a network, which aims at finding an optimal route to a specified destination. In order to route a packet between the nodes of the network, there is always a need of an efficient routing protocol. Routing protocols [2] can be classified as proactive or table-driven and reactive or on-demand routing protocols. Proactive routing protocols maintain routing table at every node of the network in advance. These protocols are known as table - driven because routing table contains entries regarding every possible existing path. Whenever there is a change in the network topology, update packets are used for sending updates, so that changes could be updated in the routing table of every node of network. On the other hand, Reactive or on-demand routing protocols discover a route only when demand for performing routing arises. As it works only when any request arrives, no routing tables are maintained in advance at nodes of network. Maintenance of routing table and sending update messages to every node of a network consumes lots of energy and bandwidth of the link. On-demand routing protocols thus produce less overhead and are generally more efficient as compared to table-driven one.

There are various issues in networks, which affect the performance of a routing protocol such as energy constraints, node movement, node speed, protocol convergence rate, loop freeness, pause time and stale routes etc. Measuring routing protocol performance is thus a critical area that needs to be considered. In order to measure the performance of routing protocols [3], various performance metrics exist such as network overload, average End to End delay, packet delivery ratio, throughput and packet drop ratio etc.

The rest of the paper has been organized as follows: Section II describes three main followed routing protocols under table-driven and on-demand routing category. Section III discusses various performance metrics used to measure the performance of a routing protocols. Section IV performs simulation of key protocols on NS-2 and analyses the results of simulations. Section V concludes the study done in the paper.

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II. ROUTING PROTOCOLS

Successfully delivering of data packet with minimal delay and overhead is main aim of routing protocols in networks. In this section, how routing is carried out in three mainly used routing protocols (i.e. DSR, AODV and DSDV), has been described.

A) Dynamic Source Routing (DSR)

DSR [4] uses source routing algorithm for finding route to a destination. Source routing means routing decision are taken at the source node and route request (RREQ) packets thus initiated by the source node (S) is broadcast to the neighbors which further broadcast it until RREQ does not reach at the destination node (F) as shown in fig. 1. In fig. 2, node F being a destination node will generate Route Reply packet (RREP) and unicast it towards sender node (S).

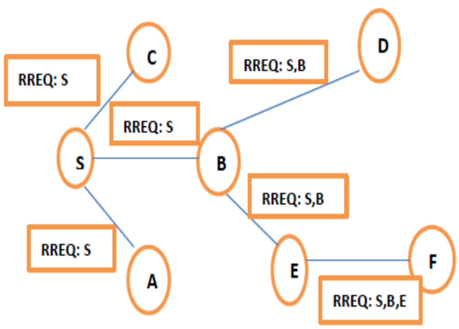

Fig.1. Flooding DSR RREQ Packets

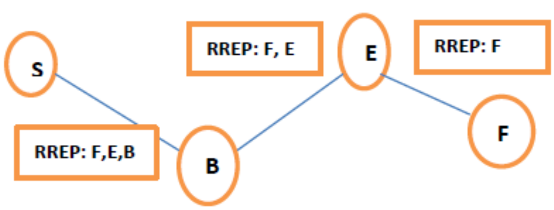

Fig.2. Unicasting DSR RREP Packet

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

AODV [5] is an on-demand reactive routing protocol. It utilizes both source routing behavior of DSR and maintains Sequence Number field in control packets from DSDV for achieving loop freedom. Fig. 3 shows how route request is flooded in network. When RREQ reaches at node E, it will create forward route entry and generate unicast route reply back to the source node (S) (Fig. 4), as it contains entry for node F (destination node).

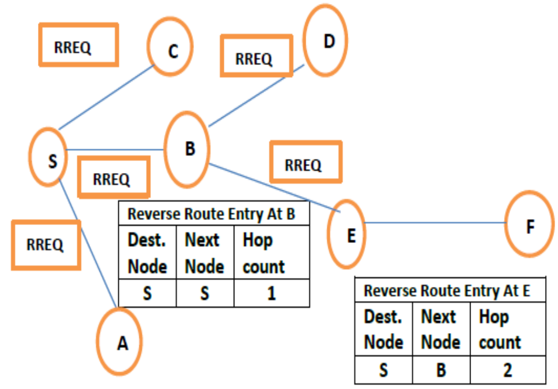

Fig.3. Flooding AODV RREQ Packets

TABLE I. RREQ PACKET FIELD

Route Request Packet (RREQ)				
Dest. Address	Dest. Seq. no.	Source address	Source Seq.No.	Hop Count

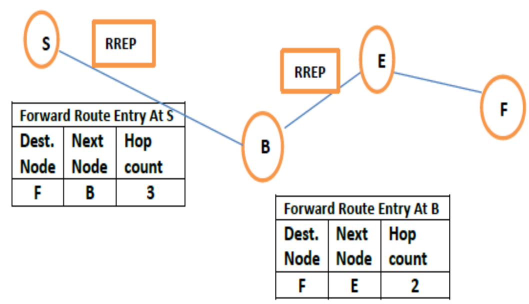

Fig.4. Unicasting AODV RREP Packet

TABLE II. RREP PACKET FIELD

Route Reply Packet (RREP)				
Dest. Address	Dest. Seq. no.	Source address	Source Seq.No.	Hop Count

C) Destination Sequenced Distance Vector Routing (DSDV)

DSDV [6] is a proactive or table-driven routing protocol. Routes are determined in advance by maintaining routing tables at every node in the network. These routing tables need to be updated which are usually done through exchange of routing control messages from time to time or whenever there is a change in topology. Fig. 5 shows how routing table are maintained in DSDV routing and are used to find route from source node (S) to destination node (F). Each node in the network maintains entry for the every other

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node in network and the next immediate node required to reach at that node. Fig.5 shows how the routing tables are maintained at the nodes of the network.

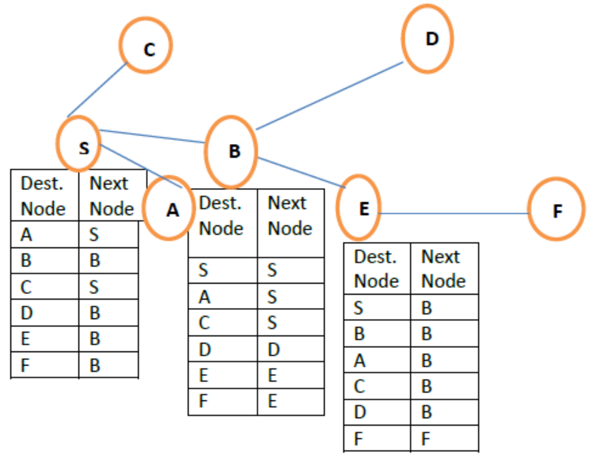

Fig.5. Routing Tables Maintained At Every Intermediate Node Between S And F

III. PERFORMANCE METRICS

Performance metrics are the parameters that are used to measure the performance of ad-hoc routing protocols [7]. Each protocol behaves differently with respect to the performance metrics according to the type of simulation environment provided, so these metrics play significant role in evaluating the efficiency of protocols. Following are some of the performance metrics, which can be used for evaluating performance of a routing protocol:

A) *Packet Delivery Ratio (PDR):* PDR calculates the ratio of the total number of successfully delivered packets to the total number of sent packets.

B) *Average End to End Delay:* This metric gives the average value of the total delay that a packet faces while travelling from source node to destination node. It includes queuing delay, propagation delay and transmission delay etc.

C) *Throughput:* Throughput measures the rate at which data packets are sent over the channel before congestion occurs at either side.

D) *Routing Overhead:* Routing overhead occurs due to the exchange of control packets. Routing overhead increases whenever network is flooded with control packets rather than sending data packets.

IV. SIMULATION AND ANALYSIS

Network simulator (NS 2.34) is used as a simulation tool for simulating Ad-hoc On-Demand Distance Vector routing (AODV), Dynamic Source Routing (DSR) and Destination Sequenced Distance Vector routing (DSDV) protocols. There are various scenarios [8] which can be used for evaluating the value of performance metrics for a particular protocol such as:

A) By varying speed of nodes and keeping pause time & number of nodes in network constant.

B) By varying pause time (sec) and keeping speed of nodes & number of nodes in network constant.

C) By varying number of nodes and keeping pause time & speed of nodes constant.

The first two scenarios are being discussed as under:

TABLE III. SIMULATION SCENARIO 1

Routing Protocol	AODV, DSR, DSDV
Network topology	670 * 670
Antenna Type	Antenna/ OmniAntinna
MAC Type	802.11
Radio Propagation Model	Two Ray Ground
Number of Nodes	11
Max. Packet in IFQ	50
Pause Time	100 s
Nodes Speed	2,5,10,15,20,25,30
Traffic source	TCP
Max. Simulation time	600 s

TABLE IV. EFFECT ON PDR BY VARYING SPEED

SPEED	AODV	DSR	DSDV
2	98.15	99.78	99.17
5	98.40	99.80	99.20
10	98.16	99.84	99.33
15	98.15	99.84	99.23
20	97.95	99.87	99.34
25	98.82	99.75	99.21
30	98.40	99.31	99.31

TABLE V. EFFECT ON DELAY BY VARYING SPEED

SPEED	AODV	DSR	DSDV
2	0.49974	0.76957	0.5345
5	0.48534	0.61896	0.42088
10	0.45187	0.65324	0.38790
15	0.43753	0.73653	0.34906
20	0.45022	0.58450	0.27171
25	0.47969	0.55374	0.31979
30	0.46200	0.27987	0.27987

TABLE VI. EFFECT ON THROUGHPUT BY VARYING SPEED

SPEED	AODV	DSR	DSDV
2	550615.10	603752.72	654844.74
5	533088.74	611343.54	666379.06
10	538017.30	616825.98	666530.35
15	530505.23	617697.71	667569.01
20	525237.31	622203.77	669428.39
25	530207.06	627062.93	667047.53
30	533543.07	669275.08	669275.08

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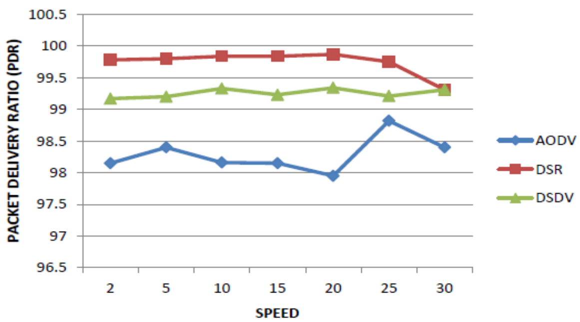

Fig. 6. Variation of PDR With Speed

Packet delivery ratio is highest (99.87) for DSR and lowest (97.95) for AODV by varying speed of nodes and keeping number of nodes & Pause time constant. DSDV performs in between both of them. DSR is best among three due to its source routing behavior. Furthermore its caching mechanism is still able to send data packets successfully, even when the nodes move with high speed in the network.

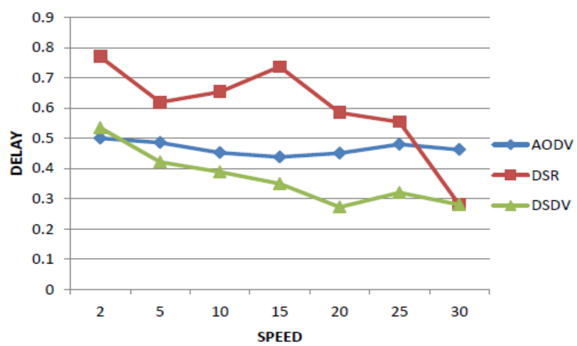

Fig. 7. Variation of Delay with Speed

Delay is a minimization metric. It is always desirable to introduce minimum delay, while routing packets in the network. As seen from fig. 7, DSR introduces maximum delay (0.769) initially, but as the speed of nodes increase, value of delay decreases and when nodes attain speed of 30, DSR produces least value of delay (0.279) same as that of DSDV. DSDV obviously has least value delay, due to the routes already present in the routing table of every node.

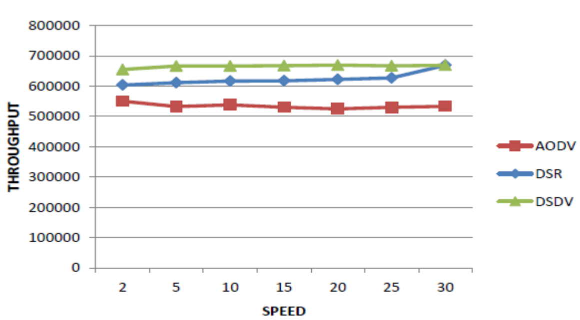

Fig. 8. Variation of Throughput with Speed

As seen from Fig. 8, DSDV consistently maintains highest value of throughput followed by DSR and AODV. DSDV is a table-driven protocol. It maintains routing table by sending update messages from time to time. So, in higher mobility environment, it is able to maintain highest throughput in the network.

TABLE VII. SIMULATION SCENARIO 2

Routing Protocol	**AODV, DSR, DSDV**
Network topology	670 * 670
Antenna Type	Antenna/ OmniAntinna
MAC Type	802.11
Radio Propagation Model	Two Ray Ground
Number of Nodes	11
Max. Packet in IFQ	50
Pause Time	0,100,200,300,400,500,600
Nodes Speed	2
Traffic source	TCP
Max. Simulation time	600 s

TABLE VIII. EFFECT ON PDR BY VARYING PAUSE TIME

PAUSE TIME	AODV	DSR	DSDV
0	98.26	99.82	99.38
100	98.15	99.78	99.17
200	97.87	99.87	99.46
300	98.00	99.83	99.56
400	98.24	99.88	99.61
500	98.29	99.79	99.53
600	98.29	99.80	99.64

TABLE IX. EFFECT ON DELAY BY VARYING PAUSE TIME

PAUSE TIME	AODV	DSR	DSDV
0	0.51524	0.59898	0.34177
100	0.49974	0.76957	0.53450
200	0.60653	0.89119	0.59531
300	0.69845	1.02626	0.61669
400	0.81675	1.13279	0.80422
500	0.81970	1.22190	0.87893
600	0.82797	0.99288	0.92860

TABLE X. EFFECT ON THROUGHPUT BY VARYING PAUSE TIME

PAUSE TIME	AODV	DSR	DSDV
0	532511.84	638667.05	677866.41
100	550615.10	603752.72	654844.74
200	547621.01	586343.45	646617.45
300	555841.36	582902.51	637121.55
400	554539.54	569953.97	623123.26
500	566741.22	585852.58	603818.95
600	565552.03	596730.6	603818.95

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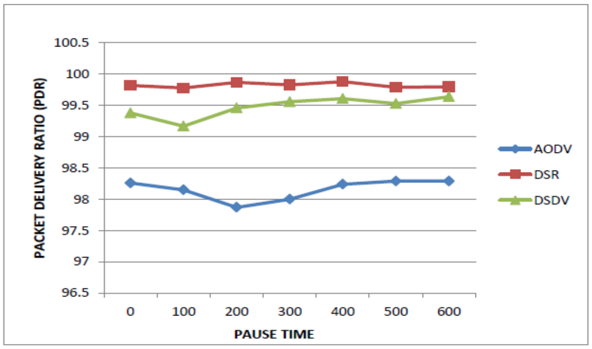

Fig. 9. Variation of PDR with Pause Time

DSR performs best with highest (99.80) Packet delivery ratio as compared to other two routing protocols with variation in pause time. It can be seen from fig. 9 that after 500 s, AODV protocol gives constant output value of PDR and has no effect on PDR of further increasing pause time

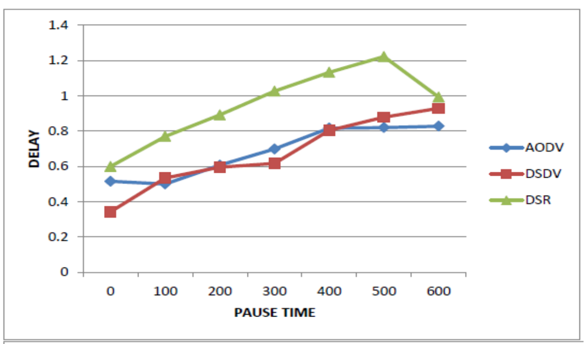

Fig. 10: Variation of Delay with Pause Time

From fig. 10, it is clear that delay increases for every routing protocol with increase in pause time. Delay is less in AODV as compared to DSDV and DSR, because it uses source routing on-demand behavior of DSR and Sequence number field in RREQ packet to ensure latest path information as well as for performing loop free routing.

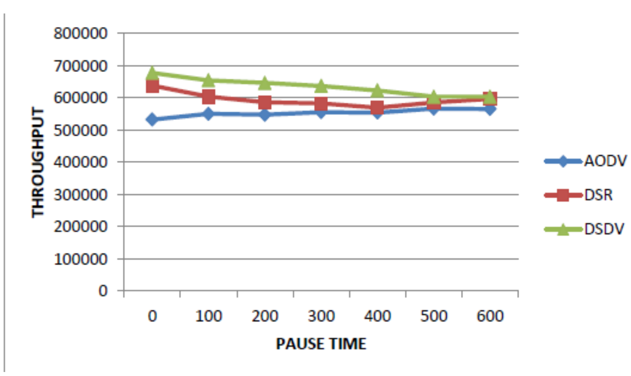

Fig.11. Variation of Throughput with Pause Time

DSDV performs best in terms of throughput initially as seen from fig. 11 but when pause time is varied its throughput decreases with increase in pause time, but it is still higher than other two routing protocol (AODV and DSR) due to its table-driven behavior. After 500 s, DSDV produces constant amount of throughput.

V. CONCLUSION

Performance evaluation of routing protocols critically examines their behavior. In this paper, how routing is carried out in two popular On-demand routing protocol i.e. DSR, AODV and table-driven protocol i.e. DSDV has been discussed with the help of examples. Simulating DSR, AODV and DSDV on NS 2.34 with variation in pause time and speed analyzed that DSR is best among the three protocols in terms of packet delivery ratio while DSDV is a good choice for producing highest throughput. Results show that DSDV throughput consistently decreases as the pause time of the nodes increases. Average End to End delay is least in DSDV as it maintains routing table in advance, which finds route to a destination quickly and sends data packet along the path. It can be concluded that DSR is a best routing choice in the high mobility environment followed by AODV and DSDV. DSDV does not suit well in high mobility environment because routing overhead increases due to more exchange of control packets which causes unnecessary delay in sending data packets.

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