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Performance Study of Dynamic Source Routing Protocol with respect to Mobility of Ad hoc network

Samiksha Nikam[1*], B.T. Jadhav[2]

[1]College of Computer Application for Women, Satara, Affiliated to S.N.D.T. University, Mumbai, India
[2]Department of Electronics and Computer Sciences, Y.C. Institute of Sciences, Satara, Affiliated to Shivaji University, Kolhapur, India

**Corresponding Author: svnikam1975@gmail.com*

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Abstract— Ad hoc network is a collection of mobile nodes that dynamically form a temporary network. This network is self-organized and does not have any centralized control. Each node acts as a router. In ad hoc network, nodes are independent of each other and free to move anywhere which changes topology dynamically. Therefore, routing is one of the centralized requirements in such type of network. In this paper DSR routing protocol is studied. The performance of routing protocol is affected by the network scenario parameters like Pause time, number of nodes, Speed of nodes and number of connectors between the nodes. The performance analysis of the protocols is the most important step prior to selecting a particular protocol. In real world scenario pause time and speed of nodes frequently changes. This paper analyses performance of DSR protocol using network simulator ns2.34 in high and low pause time scenario. The performance of DSR protocols has been evaluated on the basis of average throughput, delay, Packet delivery fraction (PDF), and Normalized Routing Load (NRL) metrics. The simulation results show that DSR protocol work efficiently in low mobility scenario. When node mobility increases performance degrades. We believe that this study will give comprehensive analysis of DSR protocol under low and high mobility scenario, which will help researchers further to investigate any metric for particular protocol.

Keywords— Adhoc Network, DSR protocol, NRL, PDF, Throughput

I. INTRODUCTION

A mobile ad hoc network is an autonomous collection of mobile users communicating over relatively constrained bandwidth. The network topology may change unpredictably and rapidly over time. An Ad hoc network does not require any pre-established infrastructure. The network can be formed anytime and anywhere. Hence the current scenario in which the network is formed highly affects the performance of the network. The performance of the network depends upon the routing protocol used in the network. The main goal of an ad hoc network routing protocol is to establish an optimal route between the source and the destination node. The route should be discovered and maintained with minimum overhead and bandwidth consumption. Routing is a key factor in the transfer of packets from source to destination [3]. Node mobility is an important parameter in an ad hoc network that decides the efficiency of the network. The efficiency of the network highly depends on the performance of the protocol. Due to mobile nodes topology of the network changes frequently hence the protocol has to update their routing tables. This might lead to an increase in routing load in the network. Thus, dynamic topology is one of the greatest challenges in an ad hoc network.

In this paper, researchers studied the DSR routing protocol. This protocol is an on-demand routing protocol designed to use in multi-hop wireless ad hoc networks. This protocol is designed to restrict the bandwidth consumed by control packets in an ad hoc network by eliminating periodic updates of a routing table. The major difference between DSR and other on-demand protocols is that it is beaconless and hence doesn't require periodic hello packets. The protocol is comprised of two phases i.e. route discovery and route maintenance.

Many researchers have analysed the performance of the DSR protocol by using different performance parameters under different circumstances. The main objective of this paper is to evaluate DSR protocol performance in a low and high-mobility scenario. Low pause time means high mobility and high pause time means low mobility. Under predefined scenario and constrained like 50 mobile nodes, simulation area 500*500, maximum connections 10,512 bytes packet size, having fix mobility of 10m/s with varying pause time at P.T.=0 and P.T. =100ms. Throughput, delay, routing load, and packet delivery fraction are the network performance parameters selected to investigate the performance of the DSR protocol. A simulation study is carried out using network simulators ns2.34 [9].

This paper is organized as follows. The second section explains the working of the DSR protocol and performance parameters selected for the evaluation; the third section describes the simulation environment and experimental performance data under high and low mobility conditions. The fourth section evaluates the performance of the DSR protocol by varying network scenario parameters (one at a time) then we conclude at the end.

Dynamic Source Routing (DSR) Protocol

When the source node has a data packet to transfer and if a route is not available then it starts route discovery by flooding the Route Request Packet across the network. Each node upon receiving the route Request packet rebroadcast the packet to its neighbor if it has not been forwarded already or it is not the destination node. A node upon receiving a Route Request packet checks the sequence number on the packet before forwarding it. The packet is forwarded only if it's not a duplicate Route Request. The sequence number on the packet is used to prevent loop formation and to avoid multiple transmissions of the same Route request by an intermediate node that receives it through multiple paths. Thus all nodes except the destination node forward a Route Request packet during the route construction phase. A destination node, after receiving the first Route Request packet, replies to the source node through the reverse path, and the Route Request packet is traversed.

II. SIMULATION METHOD AND PERFORMANCE METRIC

A. Performance Metrics

This section presents the performance parameters used to analyse the performance of DSR routing protocol.

1. **Throughput**: A throughput is a measure of the network's successful transmission rate. It is defined as the number of data packets successfully delivered to their final destination per unit time. However, to convert this metric to a measure of data throughput or to compare it with other networks, the network's packet size and the network's number of nodes must be known [1][7].
2. **Delay**: A network's delay is defined as the average time interval between the generation and successful delivery of data packets, for all nodes in the network, during a given period of time. Packets that are discarded or lost are not included in the calculation of this metric [1][7].
3. **Normalized Routing Load (NRL**): It is the ratio between the number of routing packets and the number of received packets. The Normalized Routing load must be low [5] The routing load metric evaluate the efficiency of routing protocol.
4. **Packet Delivery Fraction [PDF]:** This is the ratio of the data packets delivered to the destination to those generated by the traffic source. [5]

B. Simulation Process

The simulations were performed using Network Simulators NS2.34. Initially scenario and traffic files are generated. These files are used as input for TCL script. After execution of TCL script two files are created i.e. NAM file and trace file. Trace files are used to analyze the behavior of network. Trace files are analyzed using AWK scripts. Ad hoc networks are highly dynamic hence simulation technique is an option to measure the performance. Table 1 shows list of simulation parameters and their values to run the simulation.

Following steps are performed to run the simulation.

- Select the performance parameters. (Throughput, delay, routing load and packet delivery fraction).
- Generate scenario and topology files using cbrgen and setdest commands.
- Write TCL script (.tcl Extension file)
- Execute TCL script (Use ns Command)
- Generate Trace and NAM file.
- Execute AWK script to measure performance.

Table 1. Simulation Parameters

Parameter	Value
Ad-hoc Routing Protocol	DSR
Antenna Type	Omni-directional
Simulation Time	100 sec
Simulation Area	500 X 500
Traffic Type	CBR
Node Speed	10 m/s
Data Packets	512bytes
Pause Time	0 and 100 ms
Number of Nodes	50
Mobility Model	Random Waypoint
Propagation Model	Two-ray Ground reflection
Interface Queue Type	Drop Tail/ Priority Queue
Interface Queue Length	50 Packets
Max. Number of Connections	10

III. EXPERIMENT DESIGN AND SIMULATION

A. Experiment No 1

The aim of this simulation study is to analyze the performance of DSR wireless ad hoc routing protocol. The experiment is performed in low and high mobility scenario. When pause time is zero it means mobility is high and when pause time is equal to 100 means mobility is low. The simulations have been performed using network simulator ns2.34. The simulation has been carried out in terrine dimensions 500X500 with 50 nodes placed randomly, max connections between the nodes is 10 and duration fixed 100 sec for each of simulation. Following table1 shows experimental performance data for DSR protocol.

Table 2: Experimental Performance Data

Node speed	Pause Time = 0				Pause Time = 100			
	Th.	Delay	PDF	NRL	Th.	Delay	PDF	NRL
10	46.73	24.86	99	0.747	47.08	14.21	99.97	0.246
15	46.18	30.93	97.9	0.528	47.02	12.49	99.97	0.195
20	45.71	27.76	97.1	0.636	46.89	10.96	99.92	0.2
25	45.61	46.39	97.13	0.597	47.12	13.4	99.95	0.221

30	45.56	68.12	96.77	0.661	47.15	12.73	99.96	0.218
35	45.4	46.36	96.9	0.813	47	12.98	99.97	0.232
40	45.61	73.75	97.3	1.011	46.99	13.29	99.98	0.216
45	45.35	84.33	96.53	1.052	47.23	13.22	100	0.253
50	45.62	52.84	96.91	1.144	46.94	14.4	99.93	0.232
55	44.88	93.4	95.62	1.068	47.22	11.69	99.98	0.209
60	44.62	98.12	95.22	1.152	46.97	13.21	99.98	0.241

Performance Analysis:
Performance of DSR protocol is analysed in high and low mobility scenarios by varying only one network parameter (No. of Nodes, Max. Speed, Max. Connections) at a time.
Node Speed vs. Throughput: Figure 1 shows a graphical representation of node speed vs. throughput under high and low mobility scenarios. It is observed that as compared to a low mobility scenario, in high mobility scenario throughput decreases as node speed increases. However, there is no major change in throughput value i.e. it maintains between 45 to 50 kbps. We conclude that throughput is moderately affected by an increase in node speed in both low and high mobility scenarios. Throughput slightly decreases because when node speed increases, the possibility of route failure is more which can affect the throughput.

Node Speed vs. Delay: it is observed from figure 2 that delay of the network remains at a constant level in the low mobility scenario. In the high mobility scenario delay increases as node speed increases. This is because in high mobility scenario probability of route failure is more which results in increased route setup time.

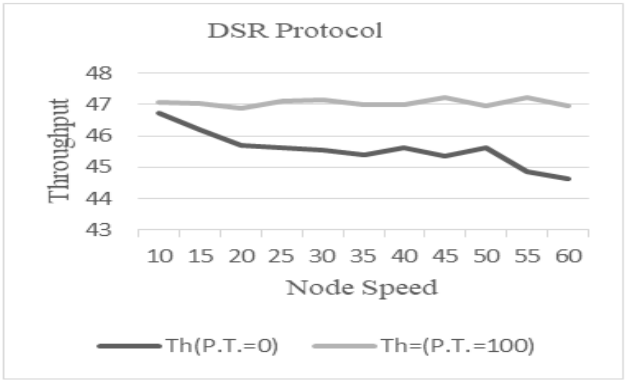

Figure 1. Nodes speed vs. Throughput

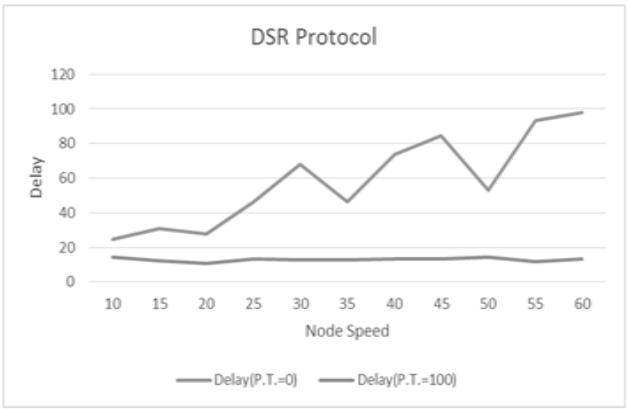

Figure 2. Nodes speed vs. Delay

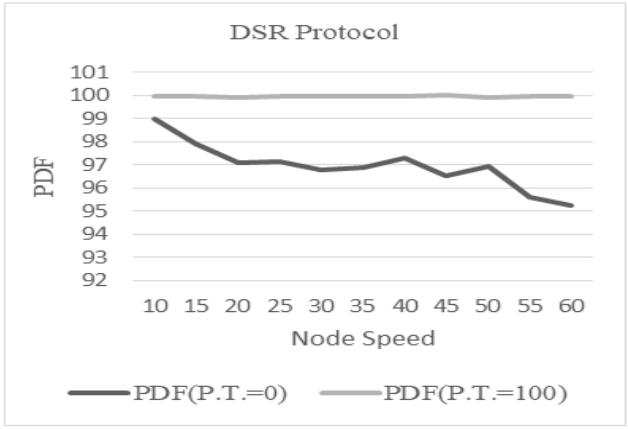

Figure 3. Nodes Speed vs. PDF

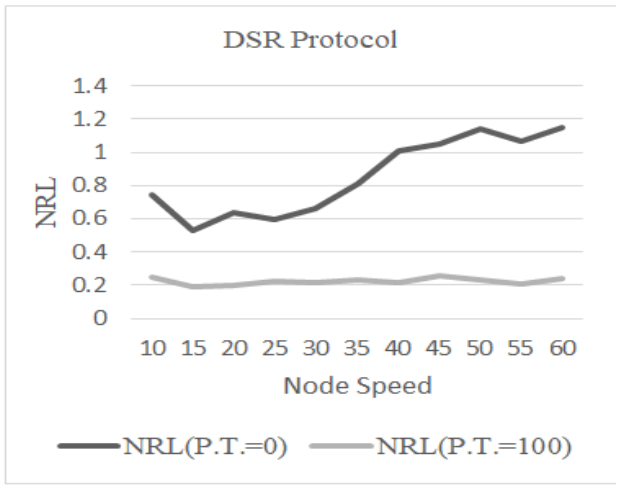

Figure 4. Nodes Speed vs. NRL

Node Speed vs. PDF: Graphical representation of node speed vs. PDF is demonstrated in figure 3 it is observed that Packet Delivery Ratio is approximately 100% in a low mobility scenario. In the case of high mobility scenario as node speed increases PDF decreases. In high mobility scenario when node speed increases chances of route failure are more this increases packet drop which results in degradation of PDF

Node Speed vs. NRL: figure 4 describes DSR protocol analysis for node speed vs. NRL In a low mobility scenario as node speed is increasing routing load is decreasing. In high mobility scenario as node speed is increasing routing load is increasing.

Experiment No 2
This experiment aims to analyse DSR protocol performance by varying the number of connections between the nodes and the rest of the parameters are kept at constant values i.e. Number of Nodes =50, Max Speed of nods = 10m/s, Pause time = 0 and 100ms. Simulations perform using ns2.34 and the result is stored in table 2

Table2. Experimental Data

	Pause Time (P.T.) = 0				Pause Time (P.T.) = 100			
Max. Conn	Th	Delay	PDF	NRL	TH	Delay	PDF	NRL
5	21.35	16.38	98.65	0.626	21.54	11.18	99.96	0.305
7	35.3	26.89	98.15	0.406	36.04	12.01	99.97	0.196
10	46.36	20.39	98.47	0.343	46.91	12.47	99.97	0.236
13	52.35	19.04	98.89	0.396	53.01	12.83	99.96	0.229
15	61.99	25.79	98.91	0.438	62.69	13.35	99.94	0.221
20	70.57	24.35	98.44	0.461	71.98	13.65	99.97	0.206
25	83.62	25.35	98.81	0.475	84.33	14.63	99.96	0.204
30	96.05	26.76	98.91	0.461	97.26	15.71	99.89	0.183
35	97.28	28.81	98.53	0.454	98.5	16.06	99.92	0.204
40	100.58	22.7	98.8	0.412	101.51	16.05	99.9	0.204
45	103.34	26.03	98.8	0.401	104.11	16.13	99.9	0.198

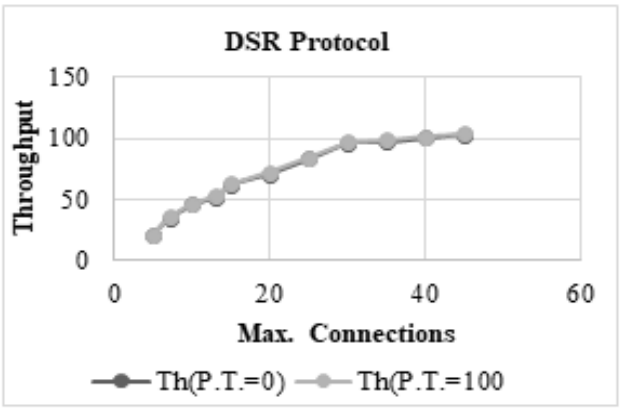

Figure 5. Max. Connection vs. Throughput

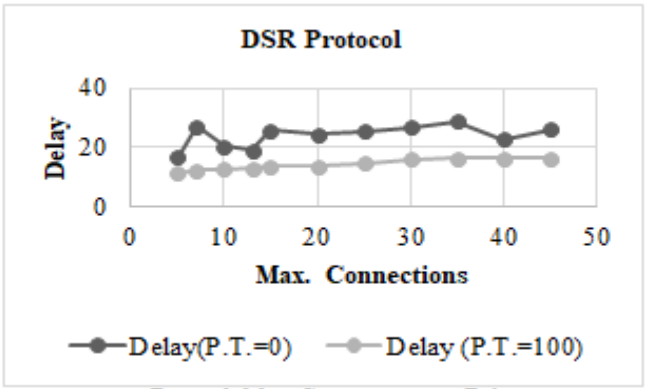

Figure 6. Max. Connections vs. Delay

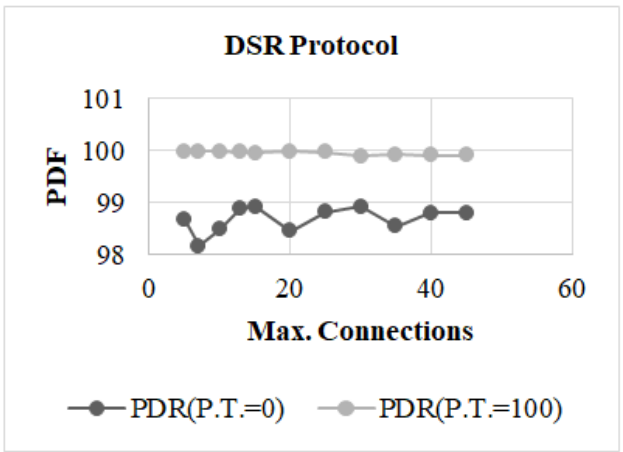

Figure 7. Max. Connection vs. PDF

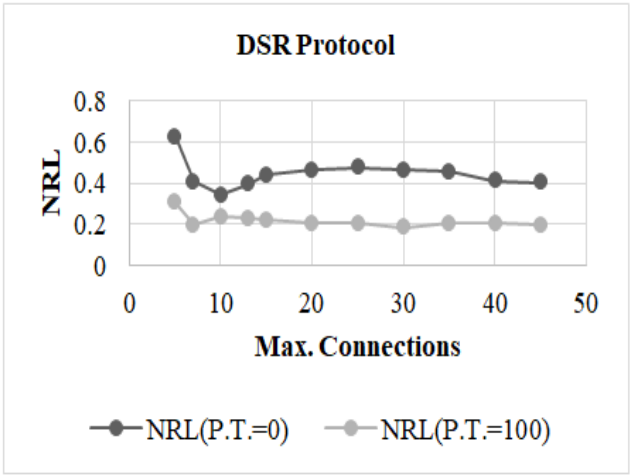

Figure 8. Max. Connection vs. NRL

Performance Analysis: Performance analysis for DSR protocol against variable connections between the nodes is shown with graphical representation**.**

Max. Connections vs. Throughput: Throughput decides number of packets transmitted per unit time. Higher throughput is always desirable in networking. Throughput for DSR protocol is studied in low and high mobility scenario. It is observed from graphical representation in figure 5, in both the situations throughput increases when increases number of nodes.

Max. Connections vs. Delay: when number of connections increases possibility of alternate available route increases which reduces route set up delay. Hence it is observed from figure 6 that, the delay is approximately constant in both low and high mobility scenario.

Max. Connections vs. PDF: DSR protocol provides approximately 100% PDF when number of connections increases under low mobility scenario is shown in figure 7. In high mobility scenario PDF decreases slightly up to 98%. We can conclude that PDF is not much affected by increasing the number of connections in both high and low mobility scenario.

Max. Connections vs. NRL: in both low and high mobility situation routing load is constant when number of connections increases. This is depicted by graphical representation in figure 8.

A. Experiment No 3

The aim of this experiment is to analyze the DSR protocol performance by varying number of nodes. Rest of the parameters are kept at constant value i.e. Number of Connection =50, Max Speed of nods = 10m/s, Pause time = 0 and 100ms. Simulations perform using ns2.34 and the result is stored in table 3

Table 3. Experimental Data

	Pause Time (P.T.=0)				Pause Time (P.T.=100)			
No .of Nodes	TH	Delay	PDF	NRL	TH	Delay	PDF	NRL
15	46.88	57.78	99.76	0.106	45.25	14.05	96.1	0.0927
20	46.13	24.96	98.37	0.292	46.73	14.38	100	0.103
25	46.75	18.99	98.97	0.249	47.03	14.65	99.97	0.12
30	46.67	27.96	98.9	0.308	47.07	13.69	100	0.152
35	46.61	12.54	99.38	0.241	47.34	14.11	99.78	0.148
40	46.15	21.7	98.45	0.398	46.75	12.25	99.98	0.185
45	46.85	17.57	99.24	0.427	46.89	15.08	99.98	0.251
50	46.36	20.39	98.47	0.344	46.58	12.48	99.97	0.236
55	45.99	31.27	97.94	0.435	47.16	12.58	99.95	0.197
60	46.6	21.85	99.03	0.368	47.08	14.29	99.98	0.243
65	46.48	16.88	98.74	0.468	46.82	12.8	99.8	0.269

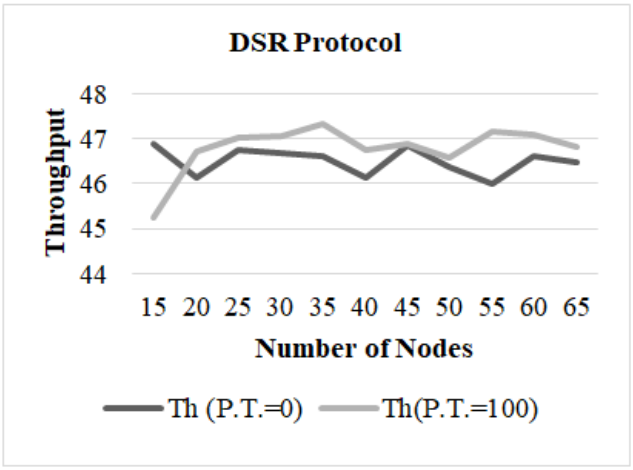

Figure 9. Number of Nodes vs. Throughput

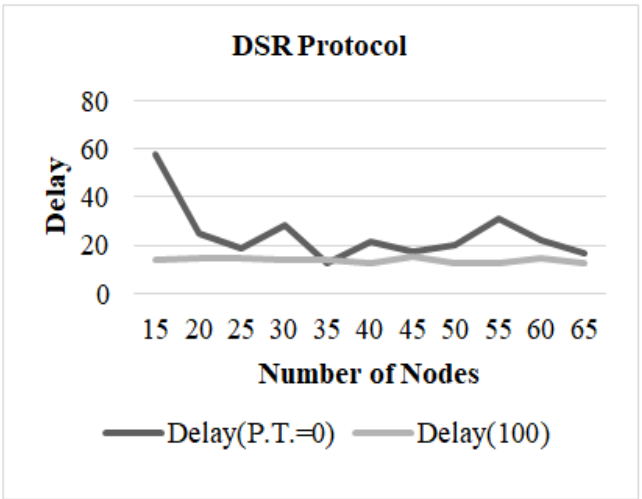

Figure 10. Number of Nodes vs. Delay

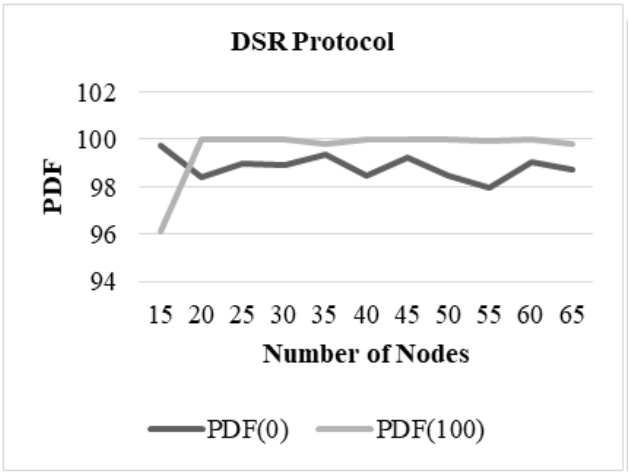

Figure 11. Number of Nodes vs.PDF

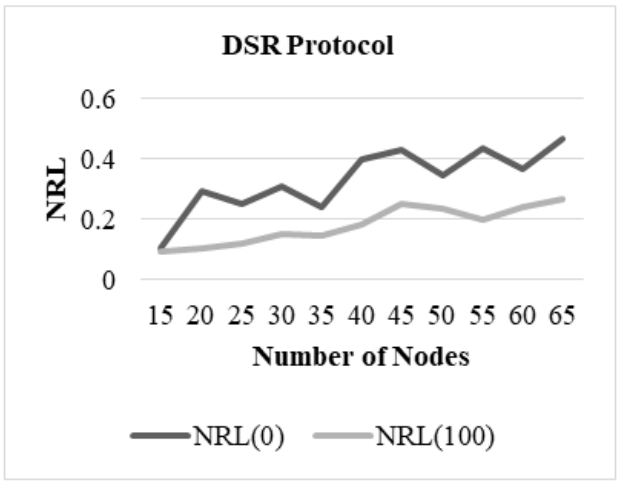

Figure 12. Number of Nodes vs. NRL

Number of Nodes vs. Throughput: graphical representation for nodes vs. throughput is shown in figure 9. When number of nodes in the network increases throughput is not much affected and remains in the range 45- 48 kbps. The packet generated from the source node does not depend upon number of nodes in the network. Hence increase in the number of nodes does not affect the throughput.

Number of nodes vs. Delay: Graphical representation for nodes vs. delay is shown in figure 10. It is observed that when number of nodes increases delay still remains low in high and low mobility environments.

Number of Nodes vs. PDF: Graphical representation for nodes vs. PDF is shown in figure 11. It is observed that in low as well as high mobility scenarios PDF is maintained above 95%. Thus even if number of nodes is increased PDF remains unaffected in high and low mobility situation. **Number of Nodes vs. NRL**: figure 12 shows graphical analysis of node vs. NRL. It is observed that as number of nodes increases control packets increases which results in

increasing routing load. Researchers also observed that routing load is more in high mobility scenario as compared to low mobility scenario.

Collective Performance Analysis: in this paper, we design three experiments to evaluate the performance of DSR protocol. The collective performance analysis is done by observing performance data of three experiments. It is mentioned in table 4

Table 4: Collective Performance Analysis

Sr. no.	Variable Scenario Parameter	Throughput (P.T. =0)	Delay (P.T.=0)	PDF (P.T.=0)	NRL (P.T.=0)
1	Nodes Speed increases	Decreasing	Variable and increasing	Decreasing	Increasing
2	Max. Connections between the nodes Increases	Increasing	Increasing	Variable in the range 96 to 100%	Decreasing
3	Number of Nodes increases	Slightly increasing	Variable and decreasing	Slightly decreasing	Variable and increasing

The following observations are mentioned from the collective performance analysis table. The Performance of the protocol gets highly affected by network scenario parameters**.**

Throughput is not much affected due to fluctuating scenario parameters of an ad hoc network in high mobility situation. However in high mobility scenario throughput increases when the number of connections between the nodes increases.

Delay is adversely affected by varying scenario parameters of an ad hoc network in high mobility scenario. When number of nodes increase in the network delay decreases. This is because more number of alternate routes are available to transfer the data.

PDF is not much affected by scenario parameters in both low and high mobility scenario. It is maintained above 95 % .

When number of nodes and connections between the nodes increases **NRL** decreases. However when speed of the node is increasing and mobility is high, NRL is increasing

IV. CONCLUSION

In this paper researchers analyze the performance of DSR routing protocol by varying network scenario parameters in high and low mobility scenarios. Mobility is fundamental factor of an ad hoc network. Hence performance is measured in high (P.T. =0) and low (P.T. =100) mobility environment. To measure the performance four performance metrics are selected i.e. Throughput, Delay, PDF and NRL. We observed that the DSR protocol performs better in low mobility scenarios. In high mobility environment Throughput and PDF is moderately affected by scenario parameters. However, when speed and mobility are increasing, throughput and PDF are slightly decreasing. Delay is increasing when speed and connections between the nodes is increasing in high mobility situation. However increase in delay can be controlled by increasing number of nodes. In high mobility environment when node speed and connection between node increases routing load is increases.

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