PERFORMANCE EVALUATION OF DSR PROTOCOL USING NS2 SIMULATOR

Dr. L V Raja

Assistant Professor, Dept. of Computer Science & Applications,
Faculty of Science and Humanities, SRM Institute of Science & Technology, Vadapalani,
Chennai - 26 – India

---***---

ABSTRACT - A Mobile ad hoc network is a type of that can change locations and configure itself on the fly. They use wireless connections to connect to various networks which can be a standard Wi-Fi connection, or another medium, such as a cellular or satellite transmission. Mobile ad hoc networks (MANET) represent complex distributed systems that comprise wireless mobile nodes which can dynamically self-organize into arbitrary and temporary, "ad-hoc" network topologies. This allows people and devices to seamlessly internetwork in areas with no pre-existing communication infrastructure. MANET may operate as standalone fashion or they can be the part of larger internet. They form highly dynamic autonomous topology with the presence of one or multiple different transceivers between nodes. The main challenge for the MANET is to equip each device to continuously maintain the information required to properly route traffic. Routing has received a tremendous amount of attention from researchers and has led to development of many different routing protocols. Correct and efficient route establishment between a pair of nodes is the primary goal of routing protocol. This paper is a simulation based analysis of Dynamic Source Routing (DSR) protocol. The mobility models used in this work is Random Waypoint using network simulation tool NS2. The results presented in this work illustrate the performance of DSR routing protocols in an ad hoc environment.

Keywords: *MANET, Reactive protocols, DSR, AODV, Performance metrics*

1. INTRODUCTION

Computer networks are the basis of communication in Information Technology. They are used in a huge variety of ways and can include many different types of network. Networks can be classified into two categories wire and wireless networks. In recent years, however, wireless technologies have grown and become much more popular. Wi-Fi and other wireless technologies have become the favorite option for building computer networks. One of the reasons for this is that wireless networks can easily support different types of wireless gadgets that have become popular over the years, such as smart phones and tablets. Wireless networks are also named as ad hoc networks. In ad hoc networks all nodes are mobile and can be connected dynamically in an arbitrary manner. All nodes of these networks behave as routers and take part in discovery and maintainers of routes to other nodes in the network. The main advantages of ad hoc networks are flexibility, low cost, and robustness. MANET is a collection of mobile nodes, which forms a temporary network without the aid of centralized administration or standard support services regularly available on conventional networks. The nodes are free to move randomly and organize themselves arbitrarily; thus the network's wireless topology may change rapidly and unpredictably.

The most basic operation in MANET is to successfully transmit data packets from one source to one destination. Routing has been a challenging task ever since the wireless networks came into existence. The major reason for this is the constant change in network topology because of high degree of node mobility. A number of routing protocols have been developed to work with both wired and wireless networks. Routing protocols can be classified into three major categories based on the routing information update mechanism. They are Proactive, Reactive and Hybrid protocols. *Reactive protocols*, also called on-demand routing protocols, start the routing discovery process when data need to be transmitted to a desired destination. These protocols have the benefit of having reduced bandwidth consumption, as the routing process is triggered only by data needed to be transmitted; the delay related to the routing path discovery is then added. One of the protocols is dynamic source routing (DSR).

The primary objective of this paper is to evaluate the performance of DSR protocol and study its effects with respect to performance metrics that may influence network performance. The metrics like Packet Delivery Ratio, End to End Delay, Route Overhead, Throughput, and Energy Consumption are verified using the number of nodes, Simulation Time, Packet Size

and Mobility. The paper is organized as follows: Section 2 presents the overview of DSR. Section 3 provides the Network Simulators (ns2). The simulation parameters and metrics are described in Section 4. Section 5 presents the Simulation Results. Finally Section 6 concludes the paper.

2. OVERVIEW OF DSR

The Dynamic Source Routing (DSR) is a reactive unicast routing protocol based on the concept of source routing algorithm. It forms a route on-demand when a transmitting node desires instead of relying on the routing table at each intermediate device. DSR is an on-demand protocol designed to restrict the bandwidth consumed by control packets in ad-hoc wireless networks by eliminating the periodic table-update messages required in the table-driven approach. The protocol is composed of two main phases Route Discovery and Route Maintenance, which work collectively to allow nodes to determine and maintain routes to arbitrary destinations in the ad-hoc network. These phases are described below.

2.1 Route Discovery Phase

Figure 1shows the initialization process of the DSR implementation in a specific simulation. A simple packet flow within a single node is shown in this simulation. Source node (28th) initiates route request (RREQ). This request is forwarded to each node of the MANET. RREQ packet contains Request ID, Source ID, Destination ID and Sequence Number. Source broadcasts this packet to all its neighbors.
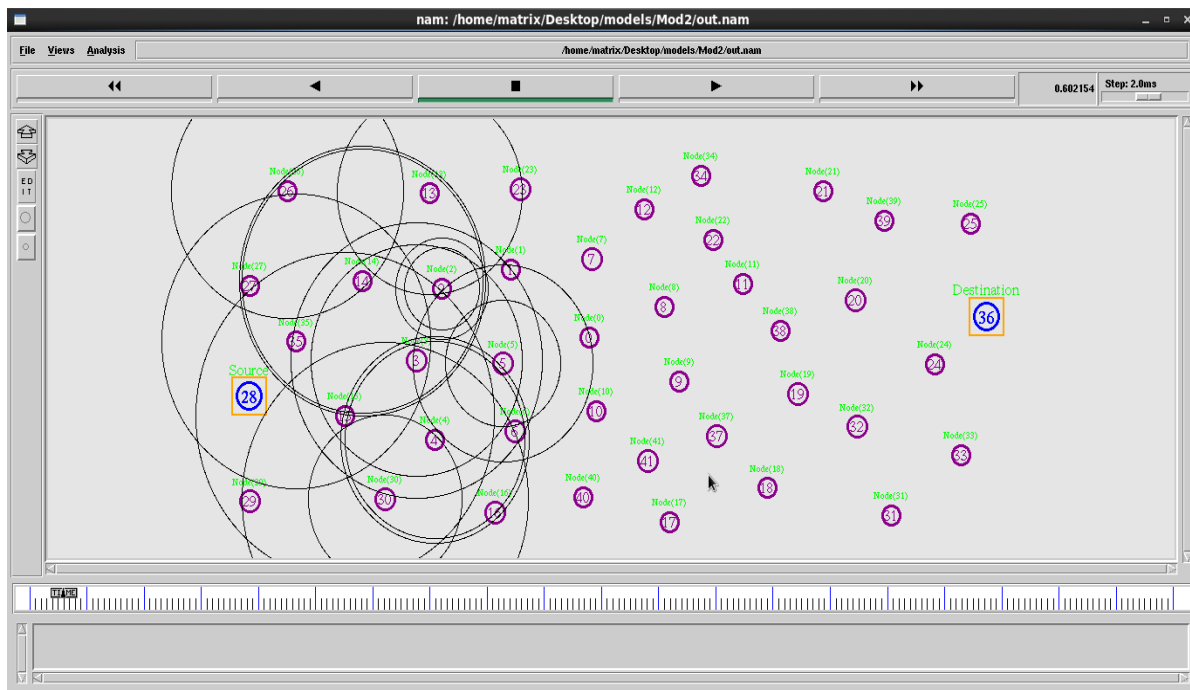

Figure 1: DSR - RREQ – Network Animator with 42 nodes

The sequence number is used for checking the freshness of routes and prevents looping. The neighbors append there ID in the RREQ packet header than rebroadcasts it to its neighbors. Every node carries out this process until RREQ reaches the destination node. The destination node (36th) generates route reply (RREP) packet as shown in below figure 2 and unicasts it to the reverse path as shown in RREQ. When source node receives RREP, it caches RREP and data communication initiated.
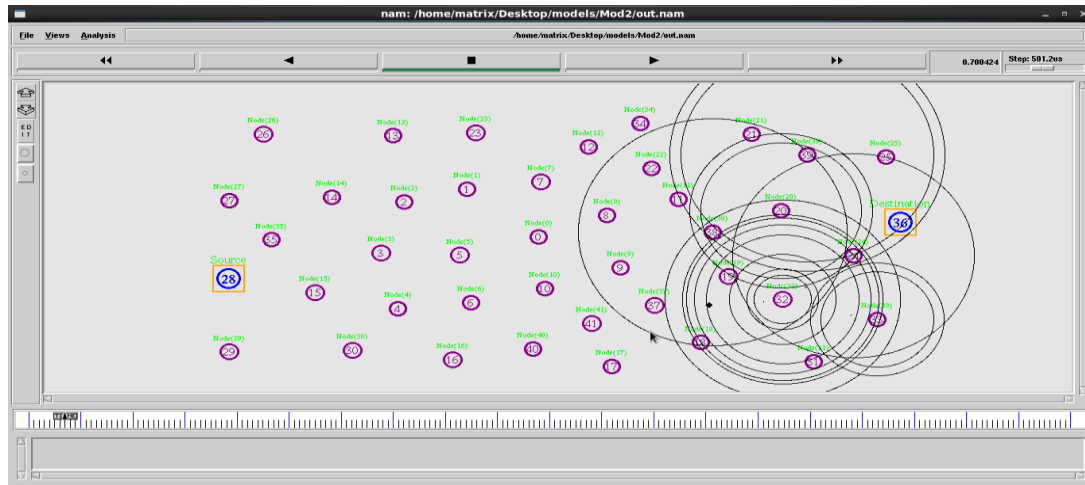
Figure 2: DSR - RREP – Network Animator with 42 nodes

1.2 DSR-Route 1

The routing path will be set based on the nearest nodes which reply first to the source node (28th). This scenario is followed for every node while receiving reply from the destination node. The path is shown in green color in the below figure 3. Now the first route is created with the following nodes: **28-15-3-5-40-9-38-39-36.** Once the route is set, then the source node will initiate the packet transmission to the destination node.
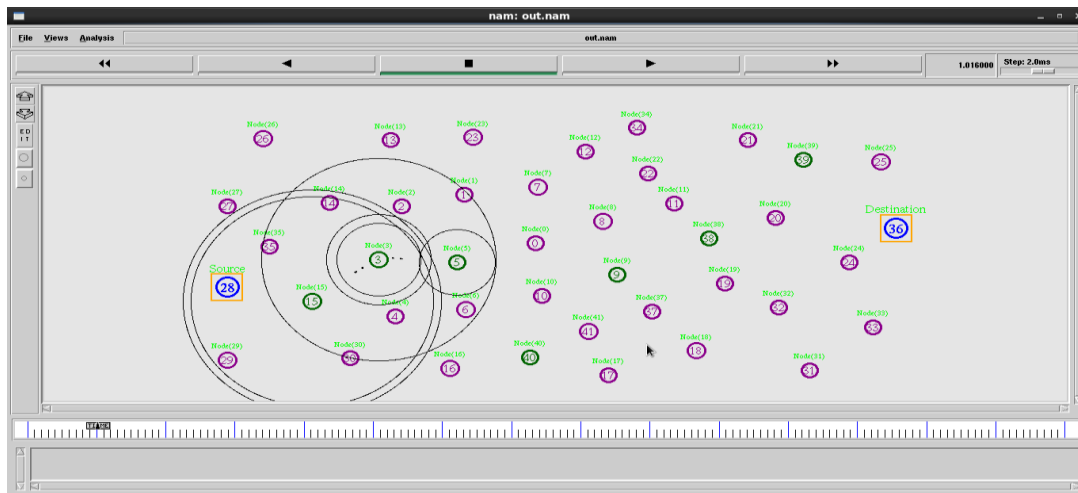

Figure 3: DSR – PATH-1 – Network Animator with 42 nodes

1.3 Route Maintenance Phase

This phase is used to manage the network in case of failure. If a node discovers a link breakdown, it generates RERR packet. Then it sends RERR to source and deletes cache entry for the failed route. All the transitional nodes also discard the entry of that particular route from their route cache. As soon as the first route fails then the source node will automatically start setting the path with the second nearest node from which it receives reply. Route changes are depicted in the figure 4.
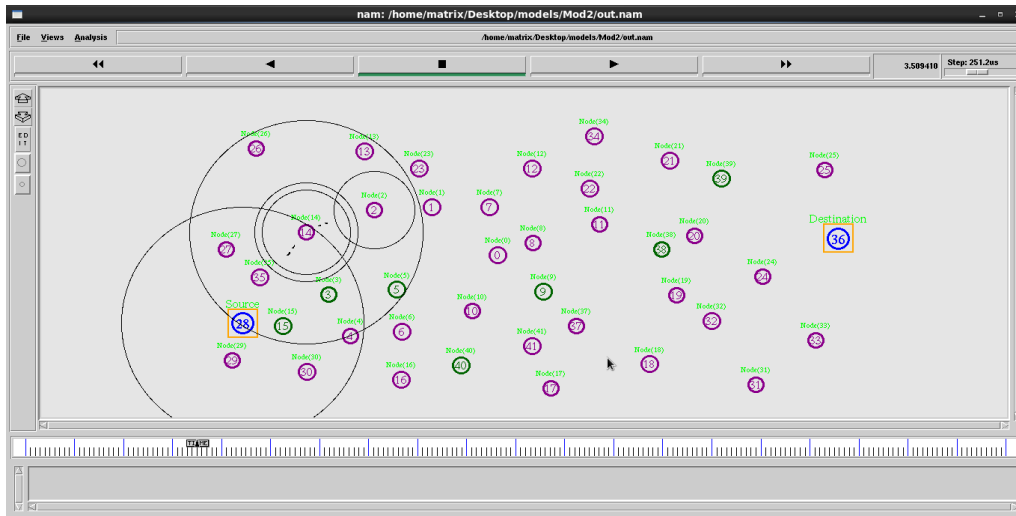
Figure 4: *DSR – PATH-2 – Network Animator with 42 nodes*

In both AODV & DSR, route discovery process is same but differs in the route maintenance process. In AODV once failure occurs the source node will start sending request to each nearest nodes once again but in DSR the source node automatically chooses the next nearest node.

1.4 DSR-End Route

Detected routes are cached within this implementation, so that not every send packets requires a related DSR route request. After the detection of the route, the packet is sent. Then the packet flow during the transmission is relatively simple. While transmission of packets, if there is any energy loss in any one of the nodes, it is represented in yellow color node. Yellow color node finally loses its energy fully and becomes dead represented in red color in the figure 5.

Figure 5: *DSR – ENDPATH – Network Animator with 42 nodes*

3. NETWORK SIMULATORS (NS2)

Ns-2 is a discrete event simulator targeted at networking research. It provides substantial support for simulation of TCP, routing and multicast protocols over wired and wire-less networks. The network simulator (ns) contains all commonly used IP protocols. Ns-2 fully simulates a layered network from the physical radio transmission channel to high-level applications. NS2 (2.34 & 2.35) simulator is used for simulating different reactive routing protocols. The simulator is written in C++ and a script language called OTcl. NS uses an OTcl interpreter towards the user. This means that the user writes an OTcl script that defines the network (number of nodes, links) the traffic in the network (sources destinations, type of traffic) and which protocols it will use. This script is then used by ns during the simulations.

The result of the simulations is an output trace file that can be used to do data processing (calculate delay, throughput etc) and to visualize the simulation a program called Network Animator (NAM) used. NAM is a very good visualization tool that visualizes the packets as they propagate through the network. NAM is a Tcl/AWK based animation tool for viewing network simulation traces and real world packet trace data. The first step to use NAM is to produce the trace file. The trace file contains topology information, e.g., nodes, links, as well as packet traces. During an NS simulation, a user can produce topology configurations, layout information, and packet traces using tracing events in NS. When the trace file is generated, it is ready to be animated by NAM. Upon startup, NAM will read the trace file, create topology, pop up a window, do layout if necessary.

4. SIMULATION PARAMETERS

The goal of our experiments is to examine and quantify the effects of various factors and their interactions on the overall performance of ad-hoc networks. Every run of the simulator accepts a scenario file as input that describes the exact motion of each node using Random Waypoint mobility model.

Table 1: Simulation Parameter

Experiment Parameter	Experiment value	Description
Simulation Time	0 – 10 mps	Simulation Duration
Terrain Dimension	[1050*600]m	X,Y Dimension of motion
No. of mobile nodes	42	No. of nodes in a network
Node Placement	Random Waypoint	Change Direction randomly
Mobility Speed	0 – 10 mps	Mobility of nodes
Packet Size	256,512,625,712,850	Size of packets
Mobility Model	Random	Mobility direction
Routing Protocols	AODV, DSR, TORA	Path-finding
MAC Protocol	802.11	Wireless Protocol
Channel Type	Wireless Channel	Types of Channel
Maximum Packets	50	No. of packets

The exact sequence of packets originated at each node together with exact time during change in packet or motion origination occurs. In all our experiments we considered five sample points of a particular factor and verified for AODV (DSR) protocol. Therefore 15 simulation runs were conducted to analyze the performance. Standard statistics of the packet delivery ratio, packet end to end delay, routing overhead, throughput and energy consumption for the entire MANET is examined. In our simulations, the MAC layer runs on the IEEE 802.11 Distributed Coordination Function (DCF). The bandwidth is set to 2 Mbps and the transmission range is set to 250 m. The evaluations are conducted using 42 nodes that are randomly distributed in an area covering 1050m x 600m.

The traffic sources are CBR (continuous bit –rate). The mobile nodes and the server were spread randomly within the geographic area. In this project, we used TCP traffic to study the effects of the ad hoc protocol. In the Random Waypoint model, each node starts to move from its location to a random location with a randomly chosen speed from a minimum speed equal to 5 m/s and maximum speed equal to 30 m/s. In each test, the simulation lasts for 600 seconds. Once the destination node is reached, the node takes a break for a certain period of time in seconds and another random destination is chosen after that pause time. The model parameters that are used in the experiments are summarized in Table 1. The size of each Constant Bit Rate (CBR) packet is 1000 bytes and packets are generated at a fixed interval rate of 4 packets per second. 15 flows were configured to choose a random source and destination during the simulation.

4.1 Performance metrics

Packet delivery ratio: The ratio between the number of packets originated by the CBR sources and the number of packets received by the CBR sink at the final destination. It describes the loss rate seen by the protocol.

End-to-End Delay: Average amount of time taken by a packet to go from source to destination. This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission on delays at MAC, and propagation and transfer times.

Route overhead: The total number of routing packets transmitted during the simulation. If control and data traffic share the same channel, and the channels capacity is limited, then excessive control traffic often impacts data routing performance. This is the ratio between the total control packets generated to the total data packets during the simulation time.

Throughput: It is defined as total number of packets received by the destination. It is a measure of effectiveness of a routing protocol. There is two representations of throughput one is the amount of data transferred over the period of time expressed in kilobits per second (Kbps). The other is the packet delivery percentage obtained from a ratio of the number of data packets sent and the number of data packets received.

Energy Consumption: Energy consumption of a node is mainly due to the transmission and the reception of data or controlling packets. To measure this amount of energy consumed during the transmission process (noted txEnergy), we should multiply the transmission power (txPower) by the time needed to transmit a packet:

$$txEnergy = txPower \times (packetsize/bandwidth)$$

And for a received packet:

$$rxEnergy = rxPower \times (packetsize/bandwidth)$$

5. SIMULATION RESULTS
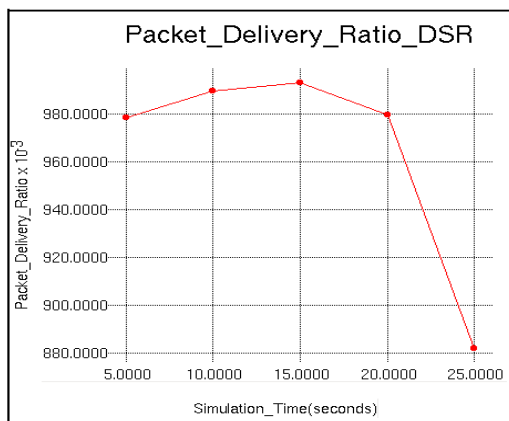
5.1 DSR Performance with respect to Simulation Time

The performance of AODV (DSR) routing protocol is evaluated in same simulation environment with 42nodes. Simulation results are collected from different scenarios of reactive protocols. They are revealed in the subsequent section in the form of X-graph taking simulation time along X-axis and the performance metrics in Y-axis. A study of performance metrics

of AODV (DSR) reactive protocol is done with respect to Simulation time 5, 10, 15, 20 and 25seconds. A table of performance metric values with respect to simulation time was created & shown below Table 2.
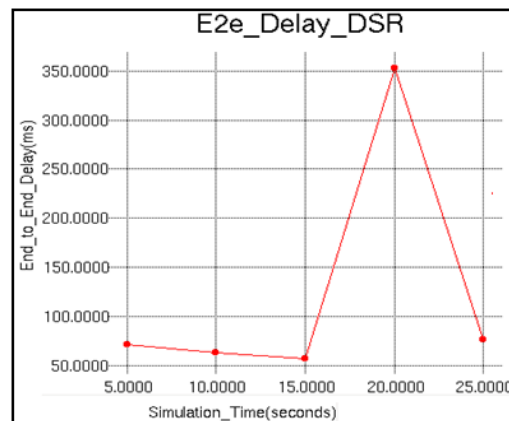
Table 2: DSR – Simulation Time

DSR-Simulation Time					
Values	**PDR**	**E2E**	**Rout-over-head**	**Throughput**	**Egy-consump**
5	0.9783	71.473	0.660	352.38	18.6055
10	0.9896	63.1506	0.313	338.93	38.4499
15	0.9932	56.2411	0.208	308.86	54.7827
20	0.9795	353.319	0.438	382.85	80.6357
25	0.8816	76.2308	1.192	301.68	92.4385

The X-Graphs Shown in figure 6 represents performance metrics of DSR Vs Simulation time. Figure (a) illustrates the results of Packet Delivery Ratio with Simulation time, taking Simulation time along the X-axis and Packet Delivery Ratio along the Y-axis. In this initially there is less packet loss but the number of packet received decreases according to simulation time; it means generated packets are being received at a moderate ratio by the nodes. As the simulation time increases the packet loss increases substantially. Figure (b) shows the results of End to End Delay with Simulation time, taking Simulation time along the X-axis and End to end delay in the Y-axis. This graph indicates End to End Delay in ms.
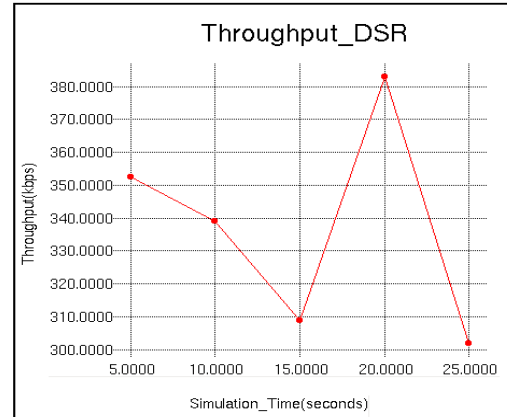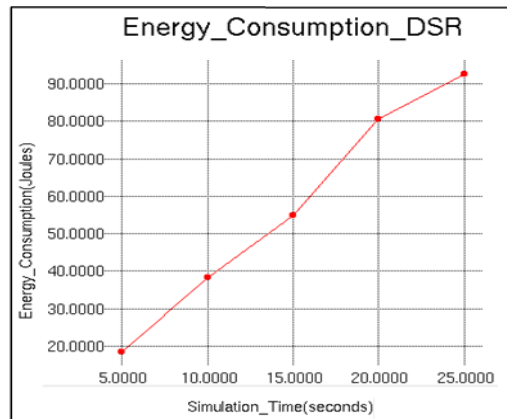

a). Packet Delivery Ratio   *b). End to End Delay*

c). Routing Overhead

d). Throughput

e). Energy Consumption

Figure 6: *Graphical representation of performance metrics in DSR Vs Simulation Time*

In this the delay is more when the simulation time is 20s and the delay reduces as the simulation time increases. Figure (c) illustrates the results of Route Overhead with Simulation time, taking Simulation time along the X-axis and Route Overhead along the Y-axis. In this Route Overhead decreases at 15sec and gradually increases as simulation time is increased. Figure (d) illustrates the outcome of Throughput with Simulation time, taking Simulation time along the X-axis and Throughput in the Y-axis. This graph shows Throughput in kbps. Here the Throughput behaves irregularly less at 15 s and high at 20s and once again reduces at 25s. Figure (e) illustrates the results of Energy Consumption with Simulation time, taking Simulation time along the X-axis and Energy Consumption in Y-axis. The unit is in joules which increase as simulation time increases.
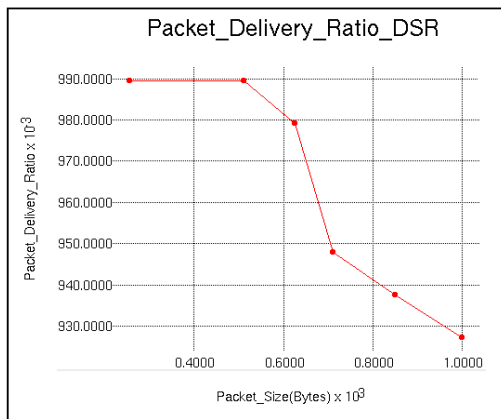
5.2 DSR Performance with respect to Packet Size

The performance of AODV (TORA) routing protocol is evaluated in same simulation environment with 42nodes. Simulation results are collected from different scenarios of reactive protocols. The effects of simulation are exposed in the subsequent section via X-graph. X-axis shows the packet size and y-axis shows the metrics. A study of performance metrics of AODV (TORA) reactive protocol is done with respect to packet size 256, 512, 625, 712, 850 & 1000 bytes. A table of performance metric values with respect to packet size was created & shown in below table 3.
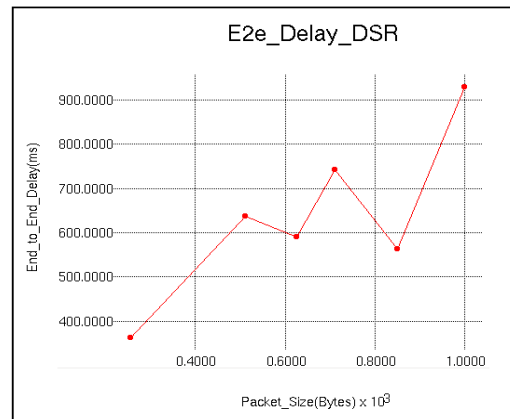
Table 3: *DSR – Packet Size*

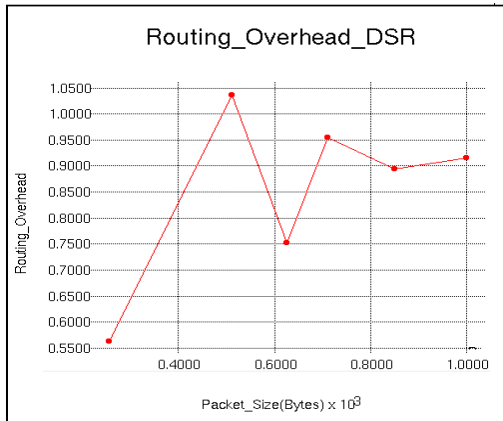| DSR-Packet Size					
Values	**PDR**	**E2E**	**Rout-Over-Head**	**Throughput**	**Egy-Consum**
256	0.9896	363.252	0.564	254.3981	18.6019
512	0.9896	637.287	1.037	395.13	33.4108
625	0.9792	589.462	0.752	436.05	40.7255
712	0.9479	741.51	0.954	452.54	45.2316
850	0.9375	562.865	0.895	377.17	42.3117
1000	0.9271	927.747	0.915	608.54	56.8761

The X-Graphs Shown in figure 7 represents performance metrics of DSR Vs Packet Size. Figure (a) illustrates the results of Packet Delivery Ratio with Packet Size, taking Packet Size along the X-axis and Packet Delivery Ratio along the Y-axis. In this initially there is less packet loss but the number of packet received decreases according to packet size. Figure (b) is the result of End to End Delay with Packet Size, taking Packet Size along the X-axis and End to End delay in the Y-axis. This graph indicates End to End Delay in ms. In this the delay is more when the packet size is 1kb and the delay reduces as the packet size decreases.
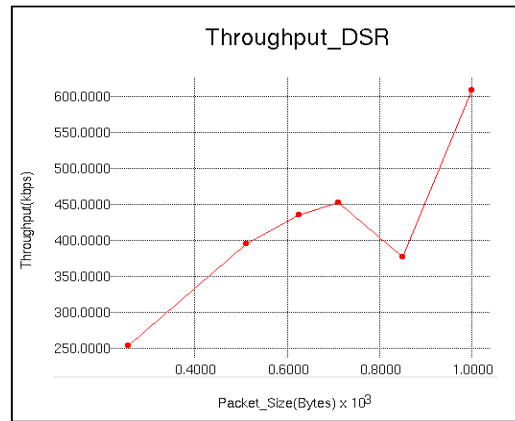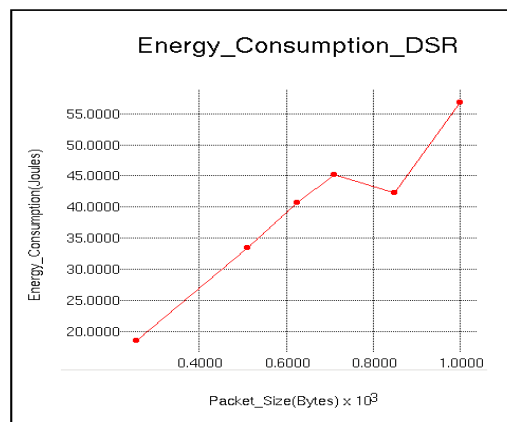

a). Packet Delivery Ratio   *b). End to End Delay*

c). Routing Overhead   d). Throughput

e). Energy Consumption

Figure 7: *Graphical representation of performance metrics in DSR Vs Packet Size*

Figure (c) illustrates the results of Route Overhead with Packet Size, taking Packet Size along the X-axis and Route Overhead along the Y-axis. In this Route Overhead increases at 512bytes and decreases at packet size 625bytes and gradually increase at 712bytes and constant for further packet sizes. Figure (d) illustrates the results of Throughput with Packet Size, taking Packet Size along the X-axis and Throughput in the Y-axis. This graph indicates Throughput in kbps. Here the throughput behaves irregularly high at 712bytes and less at 850bytes and once again high at 1kb. Figure (e) illustrates the results of Energy Consumption with Packet Size, taking Packet Size along the X-axis and Energy Consumption in the Y-axis. This graph shows the Energy Consumption in joules which increases as packet size increases.

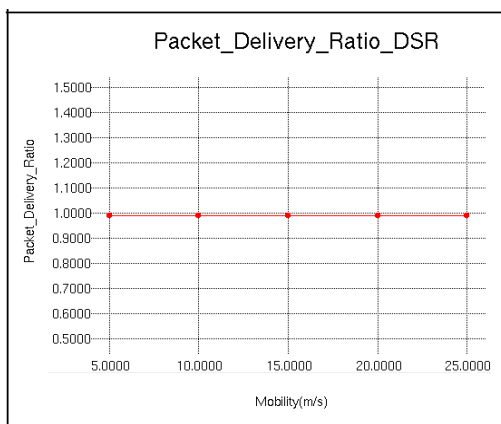## 5.3 DSR Performance with respect to Mobility

The performance of AODV routing protocol is evaluated in same simulation environment with 42nodes. Simulation results are collected from different scenarios of three reactive protocols. The simulation results are revealed in the subsequent section via X-graph taking mobility along X-axis and the performance metrics in Y-axis. A study of performance metrics of

AODV reactive protocol is done with respect to mobility speed 5, 10, 15, 20 & 25m/s. A table of performance metric values with respect to mobility speed was created & shown below Table 4.
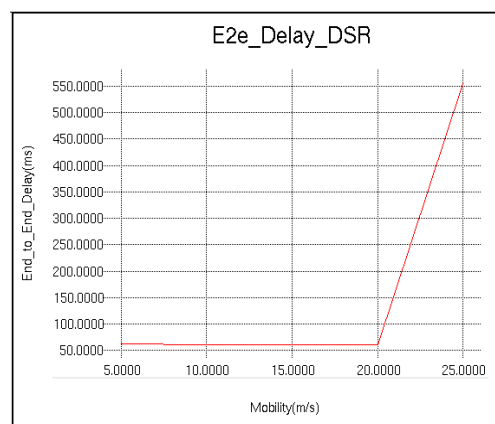
Table 4: DSR – Mobility

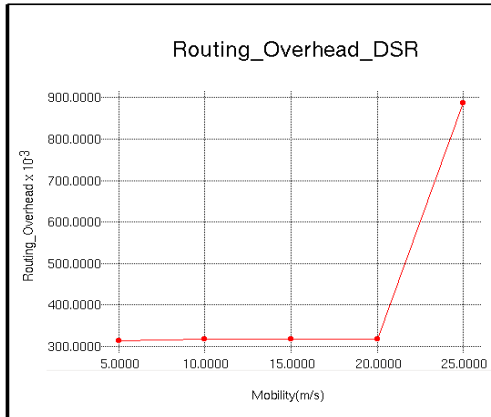| DSR-Mobility					
Values	**PDR**	**E2E**	**Rout-over-head**	**Throughput**	**Egy-consump**
5	0.9896	63.1334	0.313	338.99	38.7279
10	0.9896	60.2488	0.317	320.93	37.209
15	0.9896	60.2794	0.317	320.94	37.9564
20	0.9896	60.2481	0.317	320.93	38.3777
25	0.9896	555.589	0.886	300.15	37.844

The X-Graphs Shown in figure 8 represents performance metrics of DSR Vs Mobility. Figure (a) is the result of Packet Delivery Ratio with Mobility, taking Mobility along the X-axis and Packet Delivery Ratio in Y-axis. This graph shows PDR as constant for low & high mobility speed. Figure (b) shows the results of End to End Delay with Mobility, taking Mobility along the X-axis and End to End delay in Y-axis. The unit is in ms. In this the delay is lesser up to 20m/s and increases substantially for 25 m/s. Figure (c) illustrates the results of Route Overhead with Mobility. X-axis represents mobility with Route Overhead in Y-axis. This graph shows Route Overhead which is constant up to 20m/s and increases substantially for 25 m/s. Figure (d) illustrates the results of Throughput ` in the Y-axis. This graph shows Throughput in kbps. Here the throughput decreases for 10m/s and constant up to 20m/s and still decreases at 25m/s. Figure (e) illustrate the results of Energy Consumption with Mobility, taking Mobility along the X-axis and Energy Consumption in the Y-axis. This graph shows the Energy Consumption in joules. In this Energy Consumption is high at 5m/s (low mobility) and moderate at 25m/s (high mobility).
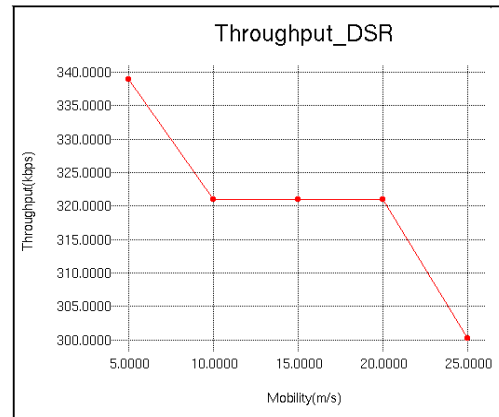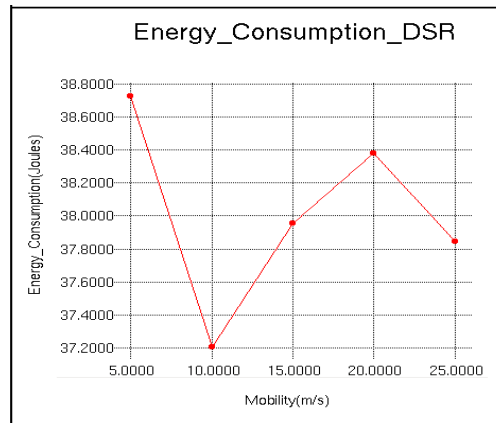

a). Packet Delivery Ratio

b). End to End Delay

c). Routing Overhead

d). Throughput

e). Energy Consumption

Figure 8: *Graphical representation of performance metrics in DSR Vs Mobility*

6. CONCLUSION

This work is an attempt towards a comprehensive performance evaluation of DSR routing protocols using the latest simulation environment NS 2. The simulation characteristics used in this research are unique in nature, and are very important for detailed performance evaluation of any networking protocol. Implementation of DSR reactive routing protocol is done. Basically the five performance metrics packet delivery ratio, end to end delay, routing overhead, throughput and energy consumption are discussed. The trace files are generated and results are shown via X-Graphs. The results are projected by varying the simulation time, packet size and mobility using trace files. DSR has its excellent support for routing in multi-hop wireless ad hoc networks. DSR has very low routing overhead and is able to correctly deliver almost all originated data packets, even with continuous, rapid motion of all nodes in the network.

REFERENCES

[1] Nilesh P. Bobade, Nitiket N. Mhala, "Performance evaluation of AODV and DSR on-demand Routing protocols with varying manet size", International Journal of Wireless & Mobile Networks (IJWMN) Vol. 4, No. 1, February 2012.

[2] David B. Johnson and David A. Maltz, "Dynamic Source Routing in Ad Hoc Wireless Networks", Computer Science Department, Carnegie Mellon University, Avenue Pittsburgh, PA 15213-3891.

[3] Rajesh Deshmukh, Asha Ambhaikar, "Performance Evaluation of AODV and DSR with Reference to Network Size", International Journal of Computer Applications (0975 – 8887) Volume 11– No.8, December 2010.

[4] Shaily Mittal, Prabhjot Kaur, *"Performance Comparison of AODV, DSR and ZRP Routing Protocols in MANET's"*, International Conference on Advances in Computing, Control, and Telecommunication Technologies, 2009.

[5] Davesh Singh Som and Dhananjaya Singh. " Performance Analysis and Simulation of AODV, DSR and TORA Routing Protocols in MANETs." International Journal of Recent Technology and Engineering (IJRTE), Volume-1, Issue-3, August 2012.

[6] Kapang Lego, Pranav Kumar Singh, Dipankar Sutradhar, *"Comparative Study of Adhoc Routing Protocol AODV, DSR and DSDV in Mobile Adhoc NETwork"*, Indian Journal of Computer Science and Engineering Vol. 1 No. 4 364-371, 2011.

[7] Sachin Dnyandeo Ubarhande. " Performance Evolution of AODV and DSR Routing Protocols in MANET Using NS2." International Journal of Scientific & Engineering Research Volume 3, Issue 5, May-2012.

[8] Satveer Kaur "Performance Comparison of DSR and AODV Routing Protocols with Efficient Mobility Model in Mobile Ad-Hoc Network", IJCST Vol. 2, Iss ue 2, June 2011.

[9] Er. Saurabh Mittal,Pinki "Performance Evaluation of AODV, DSR, DSDV and TORP Routing Protocols", International Journal of Multidisciplinary Research Vol.2 Issue 2, February 2012.

[10] Ammar Odeh, Eman AbdelFattah and Muneer Alshowkan "Performance Evaluation of AODV and DSR Routing Protocols in MANET Networks", IJDPS Vol.3, No.4, July 2012.

[11] Humaira Nishat, Sake Pothalaiah and Dr. D.Srinivasa Rao "Performance Evaluation of Routing Protocols in MANETS", IJWMN Vol. 3, No. 2, April 2011.

[12] S. Corson and J. Macker, "RFC 2501 - Mobile Ad Hoc Networking (MANET): Routing Protocol Pe", Network Working Group, Request for Comments: 2501, University of Maryland, Naval Research Laboratory, JAN 1999.