ISSN:0975-9646

G.L. Saini et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 4 (2) , 2013, 278 - 284

Mobility and Scalability based Performance Analysis of DSDV, AODV and DSR Routing Protocols in MANETs - A Technical Perspective

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Abstract- **Mobile ad hoc network is a self-directed structure of mobile nodes connected by wireless links. All nodes operate not only as an end system, but also as work as a router to forward the packets. Ad hoc wireless networks are characterized by multi-hop wireless connectivity, infrastructure less and habitually changing topology. It may be necessary for one mobile node to schedule other hosts for forwarding a packet from source to destination node due to the constrained transmission range of wireless network interfaces. Therefore a self-motivated routing protocol is required for these networks to work properly. A number of Routing protocols have been created to achieve this task. In this paper, the performance of Mobile Ad-Hoc network routing protocols DSDV, AODV and DSR are evaluated using network simulator NS2. The performance metrics includes PDF (Packet Delivery Fraction), Throughput, End to End Delay, NRL (Normalized Routing Load), routing overhead and Packet Lost. The performances of routing protocols are evaluated by varying mobility and scalability By the simulation it is observed that the performance of reactive routing protocols DSR and AODV performed significantly better than proactive routing protocol DSDV for the CBR based traffic in terms of packet delivery fraction, throughput, packet lost and NRL.**

1. INTRODUCTION

Wireless communication between mobile users is becoming more well-liked than even before. This is due to recent hi-tech advances in laptop computers and wireless data communication devices, such as wireless modems and wireless local area network. This has lead to lesser prices and higher data rates, which are the two main causes why mobile computing continues to enjoy speedy growth. As the significance of computers in our everyday life increases it also sets new anxiety for connectivity. Wired solutions have been around for a long time but there is increasing demand on working wireless solutions for connecting to the Internet, reading and transfer email post, changing information in a conference and so on[1]. Wireless networks provide connection Elasticity between users in dissimilar positions. Moreover, the network can be enlarged to any place. Wireless networks are divided into two categories, infrastructure/fixed networks and infrastructure less/Ad Hoc networks [1, 2].

Infrastructure Wireless mobile based network is a network with prior structured that is made of fixed and wired network nodes and gateways, with normally network services delivered through these pre-configured infrastructures based on the cellular idea and belief on good infrastructure support, in which mobile nodes converse with access points like base stations connected to the fixed network infrastructure.

Infrastructure less/ad-hoc network is created dynamically through the co-operation of a random set of self-directed nodes. There is no fixed arrangement concerning the specific role, each node makes its selection autonomously, based on the network situation. As to infrastructure less approach, the mobile wireless network is known as a mobile ad hoc network (MANET). A MANET is a collection of wireless nodes that can dynamically construct a network to exchange the information without using any fixed network infrastructure. [2].

2. CHALLENGES OF MANET'S

Some challenges in mobile ad-hoc networks are routing, security, mobility, power consumption and Limited wireless transmission range [3, 4]. Since the topology of the network is continually changing, the problem of routing packets between any pair of nodes becomes a challenging task. The routing issue has a focal point of research area in this paper.

3. MOBILE AD HOC NETWORK ROUTING PROTOCOLS

Routing is the act of moving information from a source to destination in a network. At least one middle node within the inter network is encountered during the shift of information. Basically two actions are included in this idea: determining best routing paths and transferring the packets through an internetwork. The transferring of packets through an inter network is called as packet switching which is directly forward, and the path determination could be very difficult.There are many ways to categorize the MANET routing protocols, based on how the protocols operate the packet to deliver from source to destination. But Routing protocols are mainly classified into three types such as Proactive, Reactive and Hybrid protocols [5].

3.1. Overview of Routing Protocols

In this section, a brief overview of the routing operations performed by the familiar protocols DSDV, AODV and DSR is described.

3.1.1 Ad-hoc on demand vector routing (AODV)

AODV is a way of routing messages between mobile nodes. AODV is able of both unicast and multicast routing. It authorizes these mobile nodes, to bypass messages through their neighbors nodes with which cannot directly communicate. AODV does this by find out the routes along which messages can be passed. AODV ensure these routes do not contain loops and tries to find the smallest route possible. It is also able to handle changes in routes and if there is a mistake than it can create new routes.

In AODV, when a source node wants to send packets to the destination but no route is available, it begins a route discovery operation. In the route discovery operation, the source transmits route request (RREQ) packets (Figure 3.1). A RREQ contains addresses of the source and the destination, the broadcast ID, which is used as its identifier, the last seen series number of the destination as well as the source node‘s series number. Series numbers are important to ensure loop-free and up-to-date routes.

To decline the flooding overhead, a node discards RREQs that it has seen before and the enlarging ring search algorithm is used in route detection operation. The RREQ starts with a small Time-To-Live (TTL) value. If the target is not found, the TTL is enlarged in following RREQs. In AODV, each node remains a cache to keep track of RREQs it has received. The cache also stores the path back to every RREQ originator. When the destination or a node that has a route to the destination gets the RREQ, it checks the destination series numbers it at nearby knows and the one particular in the RREQ. To assurance the newness of the routing information, a route reply (RREP) packet is produced and forwarded back to the source only if the destination series number is equal to or larger than the one precise in RREQ. AODV uses only symmetric links and a RREP follows the unwrap path of the particular RREP (Figure 2.2). Upon receiving the RREP packet, each midway node along the route revises its next-hop table entries with respect to the destination node. The extra RREP packets or RREP packets with lesser destination series number will be dropped [5, 15].

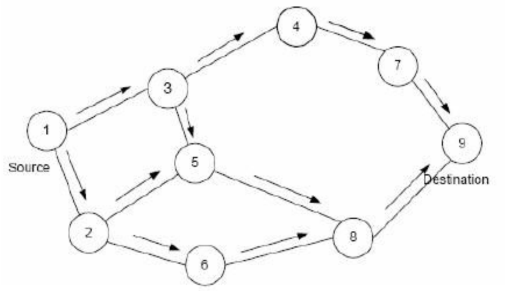


Figure 3.1: The Route Request packets flooding in AODV

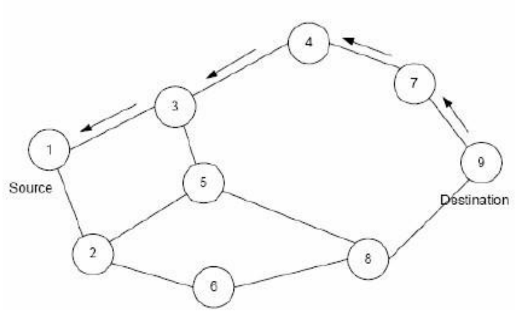


Figure 3.2: The forwarding of Route Reply packet in AODV

3.1.2 Dynamic source routing (DSR)

The Dynamic Source Routing protocol (DSR) [5] is an easy and well-organized routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure. DSR has been implemented by a number of groups, and organized on a number of test beds. Networks using the DSR protocol have been connected to the Internet. DSR can interoperate with Mobile Internet protocol, and nodes using Mobile Internet protocol and DSR have faultlessly moved around between WLANs, cellular data services, and DSR MNETs.

The protocol is created of the two main mechanisms of "Route Discovery" and "Route Maintenance", which work together to sanction nodes to find out and keep routes to random destinations in the ad hoc network. All aspects of the protocol operate completely on-demand, permitting the routing packet overhead of DSR to balance repeatedly to only that needed to react to changes in the routes currently in use. The protocol permits more than one routes to any destination and permits each sender to select and control the routes used in routing its packets, for example for use in load balancing or for increased robustness. Other advantages of the DSR protocol include simply guaranteed loop-free routing, support for use in networks containing unidirectional links, use of only "soft state" in routing, and very fast recovery when routes in the network change. The DSR protocol is designed mainly for mobile ad hoc networks of up to about two hundred nodes, and is designed to work well with very high speeds of mobility.

3.1.3 Destination sequenced distance vector (DSDV)

In DSDV routing messages are exchanged between neighboring mobile nodes Routing alters may be produced. Updates are produced in case routing information from one of the neighbors forces a change in the routing table. A packet for which the route to its purpose is not known is cached while routing queries are sent out. The packets are cached until route-replies are received from the end. There is a maximum buffer size for caching the packets staying for routing information further than which packets are dropped.

The main contribution of the algorithm was to solve the routing loop difficulty. Each entry in the routing table holds a series number, the sequence numbers are usually even if a link is present; else, an odd number is used. The number is produced by the end node. If a router receives new information, then it uses the latest sequence number. If the sequence number is the same as the one previously in the table, the route with the improved metric is used. Old entries are those entries that have not been restructured for a while. Such entries as well as the routes using those nodes as next hops are eliminated [5, 6].

4. LITERATURE REVIEW

A variety of research studies have shown their precious important outcome of MANET routing protocols with different performance metrics. Some of them which influences and stimulated us towards this research study are as follows:

Boukerche [7], focused on on-demand systems, reading and comparing the performance of three routing protocols: AODV (Adhoc On-demad Distance Vector), CBRP (Cluster Based Routing Protocol), and DSR (Dynamic Source Routing). The results show that the two source routing based protocols, DSR and CBRP, have very elevated throughputs while the distance-vector-based protocol, AODV, displays a very small end-to-end delay of data packets. Furthermore, in spite of its upgrading in reducing route request packets, CBRP has an elevated routing overhead than DSR because of its episodic hello messages. DSR has much lesser routing overhead than AODV and CBRP, and AODV has the biggest overhead among the three protocols.

Jayakumar et. al. [8], estimated the performance of two well-known on-demand routing protocols for mobile ad hoc networks: Dynamic Source Routing (DSR), Ad Hoc On demand distance Vector Routing (AODV). A detailed simulation model with MAC and physical layer models was used to study the interlayer communications and their performance suggestions. The paper displayed that even though DSR and AODV split similar on-demand actions, the differences in the protocol mechanisms can guide to substantial performance differentials.

Laxmi Shrivastava et. al. [9] studied and evaluate the performance of MANET routing protocols AODV, DSDV and DSR with dissimilar traffic loads. It is observed that DSR has performed well assess to AODV and DSDV in the situation of strong traffic load.

Rachit Jain et. al. [10] studied and showed the performance contrast of MANET routing protocols based on Packet delivery fraction, Average end-to-end delay of data packets and number of dropped data packets. Their results show that reactive protocols are greatest performer.

5. PROBLEM IDENTIFICATION

MANETs along with its special features has many challenges and problems those need to be considered. Routing in MANETs is a big problem. So keeping this in view, it is considered to assess ad hoc network routing protocols [11, 12]. For set up a wireless or an ad hoc network, it required a routing protocol, able of administration all the environmental changes that take place in an ad hoc network. Till date no protocol has all the capabilities which can handle the difficulties of environment changing with time, moving nodes and regular changing topology. It is projected to study the working of routing protocols in a simulated environment against the dissimilar network parameters [13, 14].

6. IMPLEMENTATION USING NS2.34

The simulation software used in this dissertation is the network simulator version 2.34. This is a discrete event simulator targeted at networking inspect. It is open source software and freely distributed under the General Public License (GPL). The simulation of the tool command language scripts [16] in the NS-2 doesn‘t need large memory and processing speed, thus the simulations are performed on a Pentium IV system with 1.70 GHz CPU and with 1 GB RAM in this dissertation. Simulation of wired as well as wireless network functions and protocols like routing algorithms, TCP and UDP can be done using NS2.

Some of the common existing Ad hoc routing protocols are already in NS-2 [16], such as AODV, DSR, DSDV and TORA. All the simulations those must be completed in the NS simulation environment for the Ad hoc network routing protocols have to be evaluated under practical conditions but limited to a sensible transmission range, limited buffer space for storage of messages, data traffic models, and a sensible mobility replica.

6.1Simulation Parameters

A simulation study is carried out to estimate the performance of MANET routing protocols such as DSDV, AODV and DSR based on the metrics PDF, Throughput, End to End Delay, NRL, routing overhead and Packet Lost.

Parameter	Values
Protocols	DSDV, AODV, DSR
Number of Nodes	20/ 40/ 60/ 80/ 100
Simulation Time	150s
Pause Time	0/20/40/60/80/100
Environment Size	500*500
Traffic type	CBR
Packet Size	512 bytes
Maximum Speed	20 m/s
Simulator	NS-2.34
Mobility Model	Random Waypoint
Packet Rate	2.0 packet/sec

Figure 6.1: The parameters of scenario

7. PERFORMANCE METRICS

Comparing the unlike methods is done by simulating them and investigative their performance. In comparing the three routing protocols, the assessment could be done in the following these metrics:

The end to end delay: is defined as the time a data packet is received by the destination minus the time the data packet is generated by the source.

Packet delivery fraction: The ratio of the data packets delivered to the Destinations to those generated by the constant bit rate sources. Packets delivered and packets missing are taking in to reflection.

Throughput: There are two symbols of throughput; one is the amount of data transferred over the period of time expressed in kilobits per second (Kbps).

Packet Loss: Packet loss happens when one or more packets being transmitted across the network fail to arrive at the target. It may be due to path breaks caused by the mobility of nodes and node failure due to a drained battery. It is defined as the number of packets dropped by the routers through transmission.

Normalized Routing Load: The normalized routing load is defined as the fraction of all routing control packets sent by all nodes over the number of received data packets at the destination nodes. In other words, it is the ratio between the total numbers of routing packets sent over the network to the total number of data packets received.

Dropped packets: Number of packets is dropped at the end of the process.

8. Results And Analysis:

This section discusses the simulation results of the relative study of the performance of routing protocols DSDV, DSR and AODV for wireless ad hoc networks. To widely measure the performance of a protocol, various network parameters are varied in the simulation are varied: The simulation in the performance analysis is done on the basis by varying scalability and mobility.

8.1 Varying Scalability

The simulation results get out some important attribute differences between the routing protocols. The mobility model used is Random waypoint mobility model because it models the random movement of the mobile nodes. In this performance assessment the nodes are varying e.g. 20, 40, 60, 80, and 100 and the left over all parameter are taking fixes e.g. pause time 30, max speed 20, simulation time 150 and the network size is 500m*500m. It is analyze the performance of routing protocol on the basis of a variety of performance matrices.

Figure 8.1 shows that none of the three protocols shows important change on the throughput (Kilobytes/second) with the change in node density. DSDV shows slight variation in the throughput with the change in node density which is insignificant. In proactive protocols, routes to all the nodes in the network are exposed in advance because entire table is broadcasts after a fixed interval of time independent of any route changes or not. This increases the overhead and so decreases the throughput of network using DSDV protocol. In figure 8.2 DSR and AODV shows constant packet delivery fraction above 97% for any node density due to its source routing environment. Where DSDV shows small change in the packet delivery fraction with the change in scalability which is not much important because in rapid change topology it is not as adaptive to route changes in updating its table. By figure 8.3, it is observed that when node size increases from 20 to 100 then AODV shows increasing in delay relevant to nodes. The highest delay of 180.56 seconds in the network of 100 nodes. DSDV gives poor performance continually because the delay is affected by high rate of CBR packets as well. By figure 8.4, it is observe that the routing load is minimum at DSR and also is DSDV produce low results in compare to AODV because the normalized routing load is defined as the fraction of all routing control packets sent by all nodes over the number of received data packets at the destination nodes. DSDV shows substantial packet loss whereas the source routing protocols AODV and DSR shows insignificant packet loss, as shown in Figure 8.5. By the simulation it is observe that DSR have minimum routing packets among DSDV and AODV. So it is better with respect to routing packets. But DSDV give also good result not best in the performance of routing packets in contrast to other protocol as shown in figure 8.6.

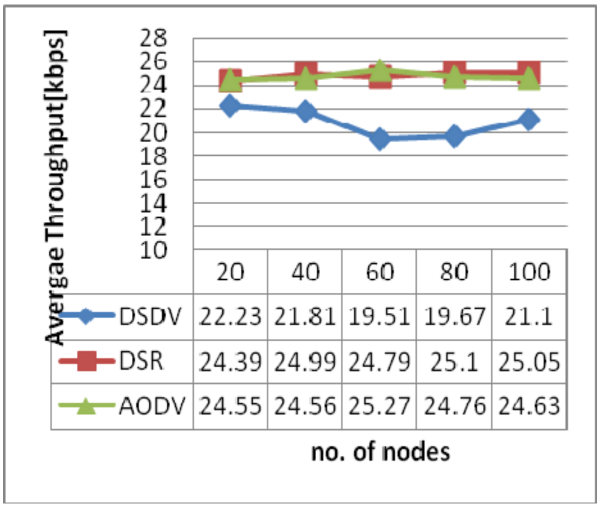


Figure 8.1: Throughput Vs Number of nodes

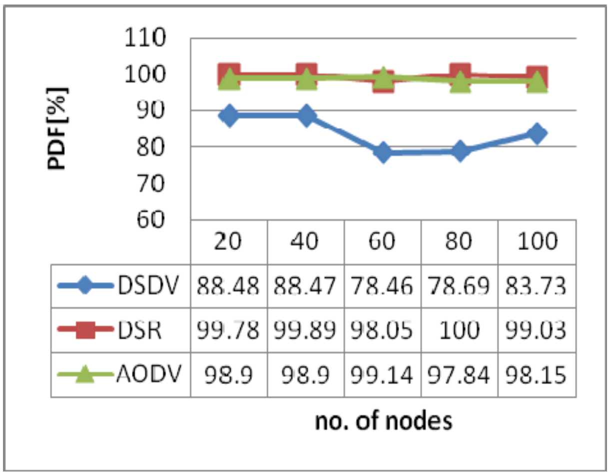
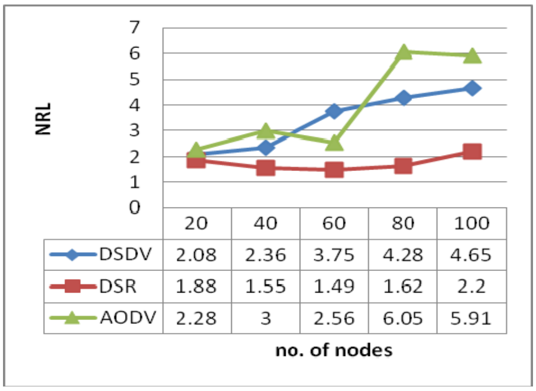
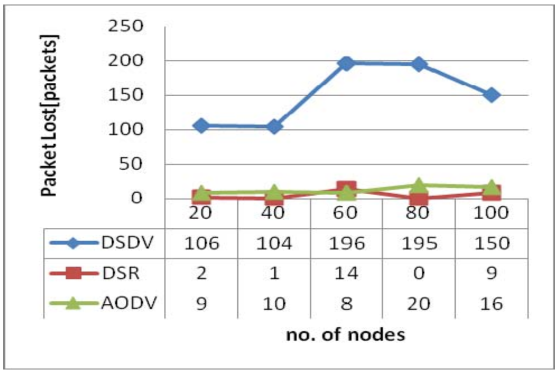


Figure 8.2: Packet delivery fraction Vs Number of nodes



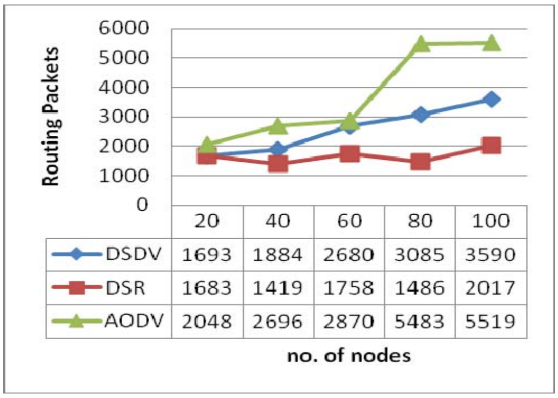
	20	40	60	80	100
DSDV	2.08	2.36	3.75	4.28	4.65
DSR	1.88	1.55	1.49	1.62	2.2
AODV	2.28	3	2.56	6.05	5.91

Figure 8.3: Normalized routing load Vs Number of nodes



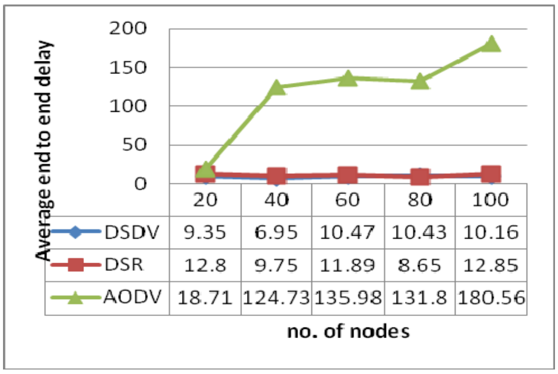
	20	40	60	80	100
DSDV	106	104	196	195	150
DSR	2	1	14	0	9
AODV	9	10	8	20	16

Figure 8.4: Packet lost Vs Number of nodes



	20	40	60	80	100
DSDV	1693	1884	2680	3085	3590
DSR	1683	1419	1758	1486	2017
AODV	2048	2696	2870	5483	5519

Figure 8.5: Routing packets Vs Number of nodes



	20	40	60	80	100
DSDV	9.35	6.95	10.47	10.43	10.16
DSR	12.8	9.75	11.89	8.65	12.85
AODV	18.71	124.73	135.98	131.8	180.56

Figure 8.6

End to end delay ids one of the important parameters in analyzing performance of metrics. It is the time interval between the instant a node initiates a route query and the instant it receives the first response. It is defined as the time a data packet is received by the destination minus the time the data packet is generated by the source.

8.2 Varying Mobility

In this section analyze the performance of three routing Protocols DSDV, DSR and AODV with corresponding to varying mobility. For all the simulations, the same movement models were used, the number of traffic sources was fixed at 20, the maximum speed of the nodes was set to 30m/s, simulation time is 150 and the pause time varied as 0s, 20s, 40s, 60s, 80s and 100s.

It is examined that DSR outperforms other protocols by delivering maximum throughput of 25.7 kb/s as shown in figure 8.7. Source routing protocols AODV and DSR maintain constant throughput regardless of the mobility rate. DSDV on the other hand has problems in discovering routes when mobility increases. DSDV initially shows throughput of 24.96 Kb/s at pause time of 0 second, but decrease increases to 17.76 kb/s as the pause time increased to 100. The reason is that in DSDV routing table update mechanism is not fast enough to update the routing tables when topology changes occur. It is observe by following Figure 8.8 that the packet delivery fraction of DSR is maximum as contrast to DSDV and AODV. AODV has a to some extent lower packet delivery performance than DSR because of higher drop rates. AODV uses route expiry, dropping some packets when a route expires and a new route must be found. The average packet delay increases with mobility for all the three protocols as shown in Figure 8.9. DSDV shows shortest end-to-end delay of the order of 7.42 seconds when the nodes are in movement because only packets belonging to suitable routes at the sending immediate get through.

The source routing protocols have a longer delay because their route detection takes more time as every midway node tries to take out information before forwarding the reply. It is monitored by figure 8.10 that the load in routing is minimum at DSR and AODV because the normalized routing load is defined as the fraction of all routing control packets sent by all nodes over the number of received data packets at the destination nodes. The minimum routing overhead is 1.52 at 60 pause time. Routing load of DSDV is maximum so it is not fine. The number of packets missing is quite high initially for DSDV, dropping 317 packets at pause time of 0 second (Figure 8.11) because of high movement of nodes. As pause time of nodes increases, the number of packets loss fall severely, drops 130 packets at pause time of 100 seconds and it directly affects the number of packets that reach destination. It is clear from here that the performance of DSDV mainly depends upon pause time. For source routing protocols, DSR and AODV, packets lost are relatively low and shows zero packet loss at lowly mobility. DSDV, AODV and DSR all gives average result in the performance of routing packets with corresponding to increasing the pause time as shown in figure 8.12.

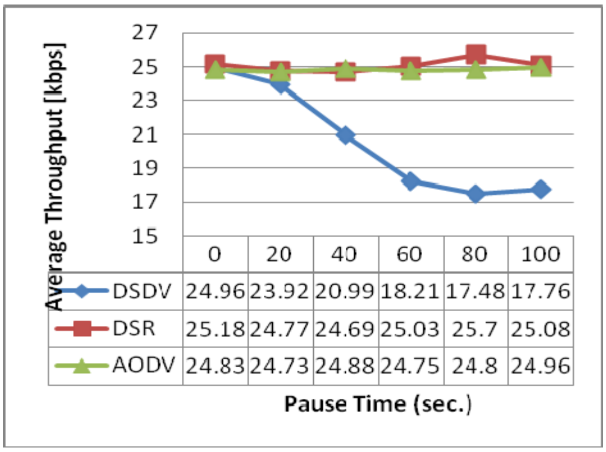


Figure 8.7: Throughput Vs Pause time

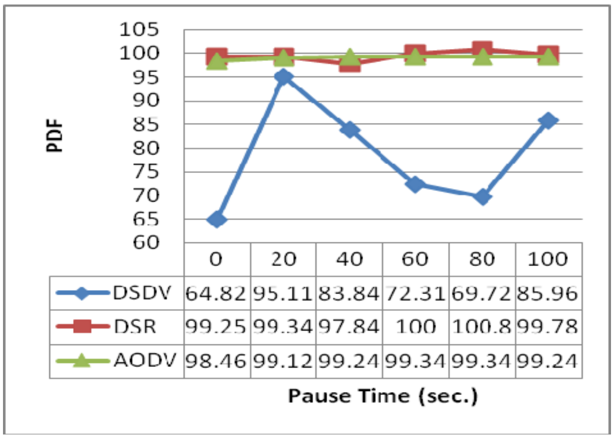


Figure 8.8: Packet delivery fraction Vs Pause time

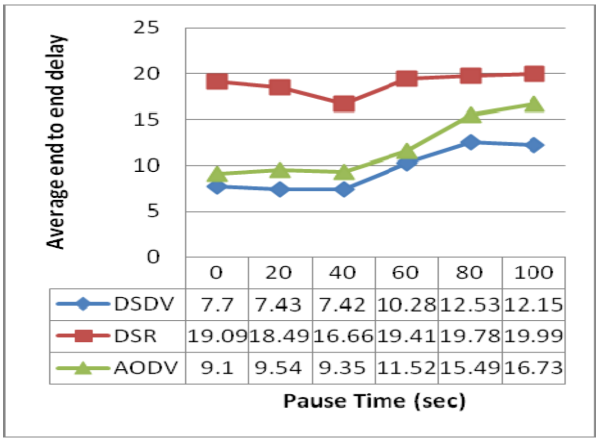


Figure 8.9: Average end-to-end delay Vs Pause time

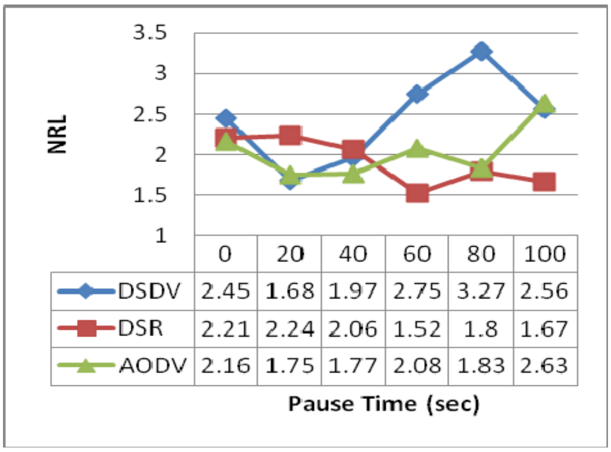


Figure 8.10: Normalized routing load Vs Pause time

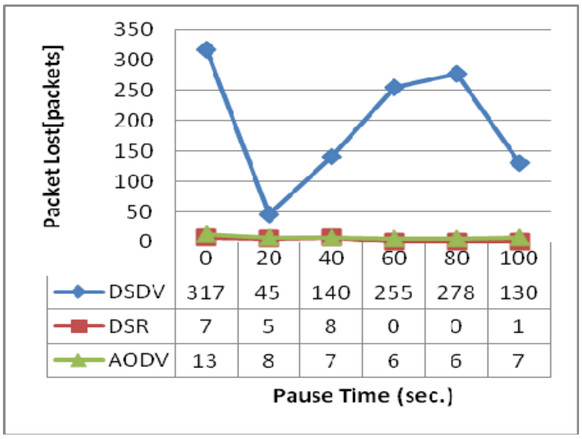


Figure 8.11: Packet lost Vs Pause time

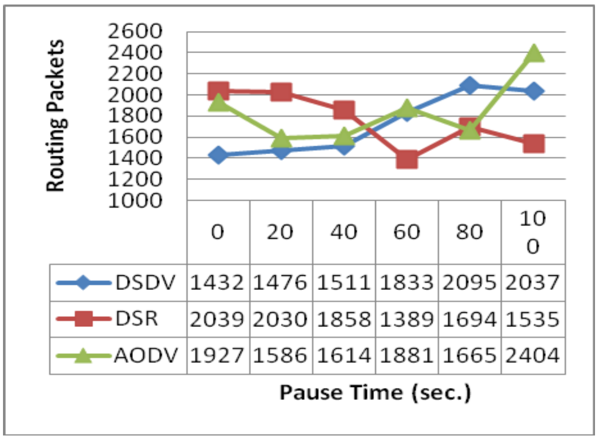


Figure 8.12: Routing packets Vs Pause time

9. CONCLUSION AND FUTURE SCOPE

In this paper, the performance of the three MANET Routing protocols such as DSDV, AODV and DSR was analyzed using NS-2.3 Simulator. It has done comprehensive simulation results of average end-to-end delay, average throughput, packet delivery fraction, routing overhead, normalized routing load and packet lost by varying no of nodes and pause time. DSDV is a proactive routing protocol and suitable for limited number of nodes with low mobility due to the storage of routing information in the routing table at each node. Comparing DSR with DSDV and AODV protocol, byte overhead in each packet will rise whenever network topology alters since DSR protocol uses source routing and route cache. Hence, DSR is preferable for sensible traffic with reasonable mobility. As AODV routing protocol needs to find route by on demand, end-to-end delay will be superior to other protocols. DSDV makes low end-to-end delay assess to other protocols. When the network load is short, AODV performs better in case of packet delivery fraction but it performs poorly in terms of average end-to-end delay. Simulation result shows overall performance of Reactive protocols is better in terms of packet delivery fraction, throughput, packet lost and NRL.

Future work will be to evaluate the protocols by varying the speed, simulation time, packet size and dimensions etc. Also performance can be evaluated by modifying AODV routing protocol.

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