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Performance Analysis of AODV, DSR, DSDV Protocols of MANET in a Grid using Mobility

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***Abstract** Mobile Ad-Hoc Network is a collection of wireless mobile nodes without using any centralized access point forming a temporary network. An attempt to compare three routing protocols namely AODV, DSDV and DSR on different scenarios. Comparison is made on the basis of throughput, end-to-end delay and packet loss by using simulator NS2. In previous papers only one type of scenario is taken to generate the results. In current paper all the scenarios for simulation is taken and then results are analyzed. It is concluded that DSDV performs better in case of throughput in all the three protocols and it outperforms others in case of packet loss. DSR performs better only in case of packet loss. Overall AODV outperforms DSDV and DSR as in high mobility environment, topology changes frequently and AODV can adapt to the changes. Thus for a real time traffic, AODV shows the better performance with its ability to maintain connection by periodic exchange of information required for TCP network.*

***Keywords**- MANET, AODV, DSDV, DSR, QOS.*

1. INTRODUCTION

Mobile cellular networks have been in use and the use of wireless networks is increasingly tremendously.

Three types of mobile wireless networks exist [8]: infrastructure-networks, ad-hoc networks and hybrid networks. An infrastructure-network consists of a group of mobile nodes with some bridges. These bridges called base stations connect the wireless network to the wired network. Communication takes place between two or more nodes by first searching for the nearest base station and information flow takes place between the nodes with the base stations as a bridge between them. In ad-hoc networks, there are no centralized base stations [6], fixed routers and central administration. All nodes move randomly and are capable of discovering and maintaining the routes between them. Each node acts as a router and communicates to other for a short interval of time like: emergency searches, quickly sharable information like meetings etc. A hybrid-network [7] makes use of both the networks: infrastructure and ad-hoc networks. Mobile ad-hoc networks (MANET) is a collection of wireless mobile nodes, which dynamically form a temporary network, without using any existing network infrastructure or centralized administration. These are often called infrastructure-less networking since the mobile nodes in the network dynamically establish routing paths between themselves. Current typical applications of a MANET include battlefield coordination and onsite disaster relief management. Mobile ad-hoc networks (MANET) or "short live" networks control in the nonexistence of permanent infrastructure. Ad-hoc is a Latin word, which means "for this or for this only. Mobile ad hoc network [2] is an autonomous system of mobile nodes connected by wireless links; each node operates as an end system and a router for all other nodes in the network.

A number of characteristics of MANETs are identified:

- A network of hosts, connected by wireless links.
- Network established without a pre-existing infrastructure.
- Routes between nodes may potentially contain multiple hops
- Bandwidth-constrained, variable capacity links.
- Energy-constrained Operation.
- Physical Security.
- Dynamic network topology.
- Frequent routing updates.

2. DESCRIPTION OF PROTOCOLS: DSDV, DSR AND AODV

2.1 DSDV (DESTINATION-SEQUENCED DISTANCE-VECTOR ROUTING PROTOCOL)

DSDV [3] is a table driven algorithm based on the classical Bellman Ford routing mechanism. Every mobile node in the network maintains a routing table in which all the possible destinations within the network and the number of hops to each destination are recorded. Each entry [14] is marked with a sequence number assigned by the destination node. The sequence number enables the mobile nodes to distinguish stale routes from new ones, thereby avoiding the formation of routing loops. Routing table updates the periodically transmitted throughout the network in order to maintain table consistency. To help alleviate the potentially large amount of network traffic that such updates can generate, route updates can employ two possible types of packets. The first is known as a “full dump”. This type of packet carries all available routing information and can require multiple network protocol data units (NPDUs). During periods of occasional movement, these packets are transmitted infrequently. The mobile nodes maintain an additional table where they store the data sent in the incremental routing information packets. New route broadcast contain the address of the destination, the number of hops to reach the destination, the sequence number of the information received regarding the destination, as well as the new sequence number unique to the broadcast. The route labeled with the most recent sequence number is always used. In the event that two updates have the same sequence number, the route with the smaller metric is used in order to optimize the path.

2.2 DSR (DYNAMIC SOURCE ROUTING PROTOCOL)

DSR [3] protocol is an on-demand routing protocol that is based on the concept of source routing. Mobile nodes are required to maintain route caches that contain the source routes of which the mobile is aware. Entries in the route cache are continually updated as new routes are learned. The protocol consists of two major phases: route discovery and route maintenance. When a mobile node has a packet to send to some destination, it first consults its route cache to determine whether it already has a route to the destination. If it has an unexpired route to the destination, it will use this route to send the packet. On the other hand, if the node does not have such a route, it initiates route discovery by broadcasting a route request packet. This route request contains the address of the destination, along with the source node's address and a unique identification number. Each node receiving the packet checks whether it knows of a route to the destination. If it does not, it adds its own address to the route record of the packet and then forwards the packet along its outgoing links. To limit the number of route requests propagated on the outgoing links of a node, a mobile only forwards the route request if the mobile has not yet seen the request and if the mobile's address does not already appear in the route record. A route reply [16] is generated when the route request reaches either the destination itself, or an intermediate node, which contains in its route cache an unexpired route to the destination. By the time the packet reaches either the destination or such an intermediate node, it contains a route record yielding the sequence of hops taken.

2.3 AODV (AD-HOC ON-DEMAND DISTANCE VECTOR ROUTING PROTOCOL)

AODV [3] is a routing protocol builds on the DSDV algorithm. AODV is an improvement on DSDV because it typically minimizes the number of required broadcasts by creating routes on an on-demand basis, as opposed to maintaining a complete list of routes as in the DSDV algorithm. AODV is a pure on-demand route [15] acquisition system, as nodes that are not on a selected path do not maintain routing information or participate in routing table exchanges. When a source node desires to send a message to some destination node and does not already have a valid route to that destination, it initiates a path discovery process to locate the other node. It broadcasts a route request(RREQ) packet to its neighbours, which then forward the request to their neighbours, and so on, until either the destination or an intermediate node with a "fresh enough" route to the destination is located. Each node maintains its own sequence number, as well as a broadcast ID.

3. PROBLEM STATEMENT

1. Evaluation of Ad-Hoc Networks.
2. Get a general understanding of Mobile Ad-Hoc Networks.
3. Evaluation of different type of MANET routing protocols.
4. Detailed evaluation of DSDV, AODV and DSR
5. Generate a simulation environment that could be used for simulation of protocols.
6. Simulate the protocols on the basis of different scenarios: by varying the number of nodes, by varying the mobility of nodes, by varying the number of connecting nodes at a time and by varying pause time.
7. Throughput, End-to-End Delay and Packet Loss of different routing protocols will be compared so as to find the optimal routing algorithm with respect to considered network scenarios.

4. METHODOLOGY

4.1 Selection Techniques for Network Performance Evaluation

There are three techniques for performance evaluation, which are analytical modeling, simulation and measurement [10]. Simulation is performed in order to get the real-event results with no assumption as in case of analytical modeling.

4.2 Random Waypoint Mobility Model

A node, after waiting a specified pause time moves with a speed between 0 m/s and Vmax m/s to the destination and waits again before choosing a new point and speed [10].

NS-2 SIMULATOR

NS (version 2) is an object oriented, discrete event driven network simulator written in C++ and Otcl."

5. SIMULATION ASSUMPTIONS

The following assumptions [12] are considered when building the Tcl script.

1) For simplicity, all flows in the system are assumed to have the same type of traffic source. Each sender has constant bit rate (CBR) traffic with the data rate/number of packet per second.
2) The source node is fixed to some nodes with maximum connection is fixed nodes (to show density condition) and if the nodes are varied for the calculation it is mentioned in the area.

6. PERFORMANCE METRICES

1) **Average End-to-End Delay** It is defined as the average end-to-end delay of data packets within a network. Once the time difference between every CBR packet sent and received was recorded, dividing the total time difference over the total number of CBR packet received gave the average end-to-end delay [10] for the received packets. The lower the end-to-end delay the better the application performance.

$$\text{Avg\_End-to-end\_Delay} = \frac{\sum_{1}^{n}(\text{CBRsentTime} - \text{CBRecvTime})}{\sum_{1}^{n}\text{CBRecv}}$$

2) **Data Packet Loss (Packet Loss):** A packet when arrived in a network layer is forwarded when a valid route to the destination is known, otherwise it is buffered until it reaches the destination [10]. A

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packet is lost when the buffer is full or the time that the packet has been buffered, exceeds the limit.

PLose = DataAgt Sent – DataAgtRecv
Agt – Agent trace (use in new trace file format)

3) **Average Throughput:** It is measured as the ratio of amount of received data to the amount of simulation time and tells about how soon an end user to receive data [10]. A higher throughput implies better Quality of service (QOS) of the network.

7. SIMULATION RESULTS

SCENARIO 1: In this Scenario number of nodes connected in a network at a time is varied and thus varying number of connections, through which the comparison graphs of DSDV, DSR and AODV, is obtained.

PARAMETER	VALUE
Number of nodes	100,150,200,250
Simulation time	50 sec
Routing protocol	AODV, DSDV and DSR
Simulation model	TwoRayGround
MAC Type	802.11
Link Layer Type	LL
Interface Type	Queue
Traffic Type	CBR
Packet Size	512 Kb
Queue Length	50
Pause Time	00 sec
Node Speed	20 m/s

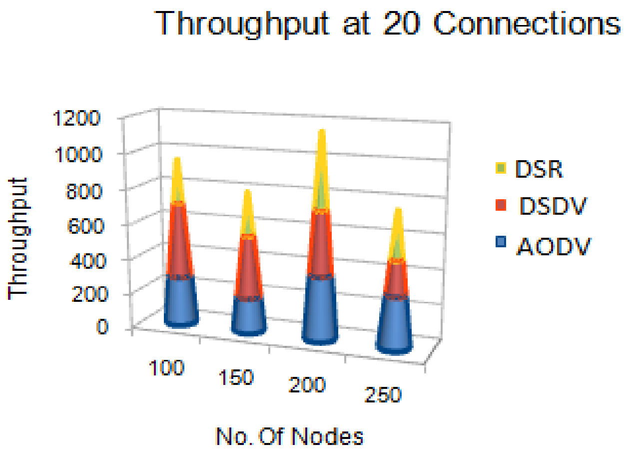

Fig: 7.1: Throughput at 20 connections

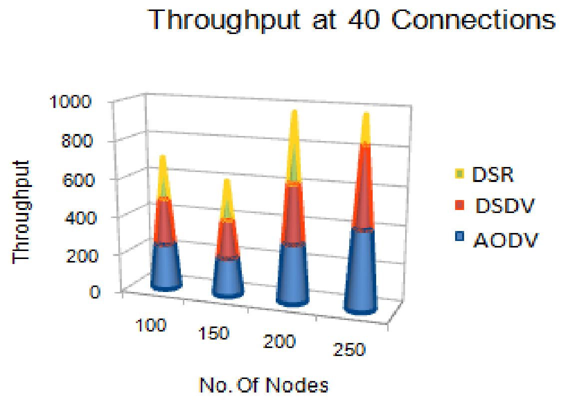

Fig: 7.2: Throughput at 40 connections

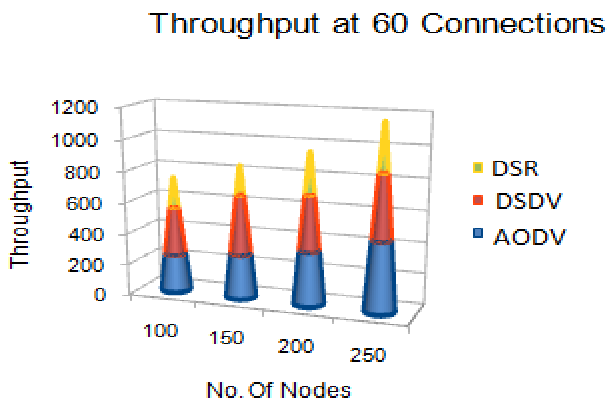

Fig: 7.3: Throughput at 60 connections

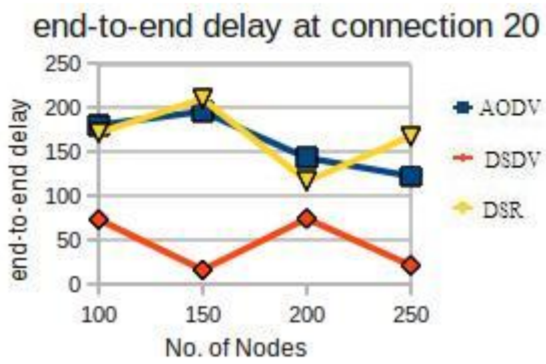

Fig 7.4: End-to-End Delay at 20 connections

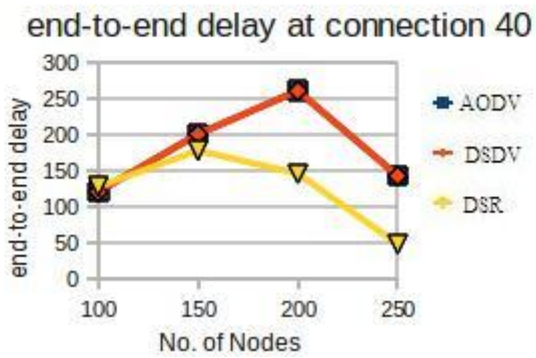

Fig 7.5: End-to-End Delay at 40 connections

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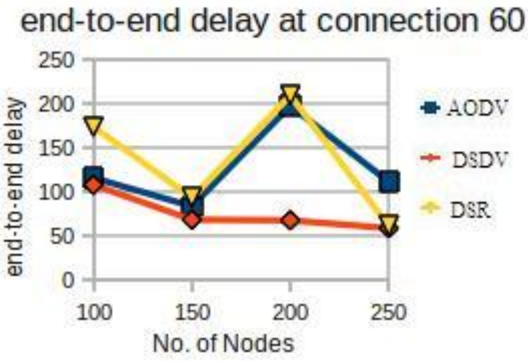

Fig 7.6: End-to-End Delay at 60 connections

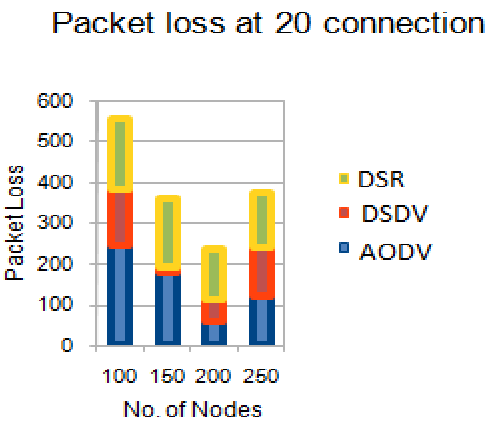

Fig 7.7: Packet Loss at 20 connections

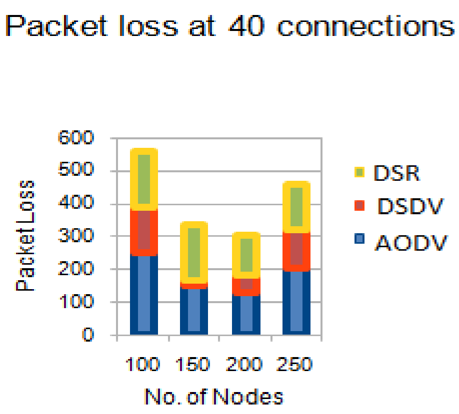

Fig 7.8: Packet Loss at 40 connections

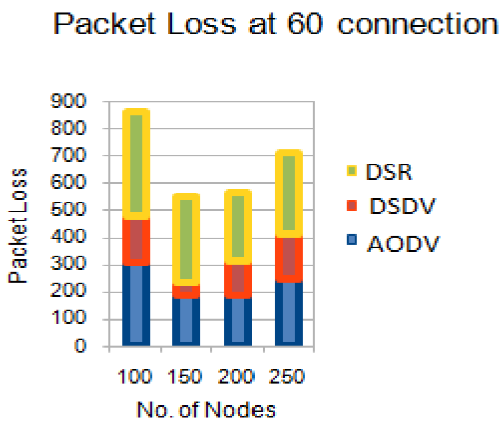

Fig 7.9: Packet Loss at 60 connections

SCENARIO 2: In this Scenario number of nodes connected in a network at a time is varied and thus varying mobility of nodes, through which the comparison graphs of DSDV, DSR and AODV is obtained.

PARAMETER	**VALUE**
Number of nodes	100,150,200,250 with 100 connections
Simulation time	100 sec
Routing protocol	AODV, DSDV and DSR
Simulation model	TwoRayGround
MAC Type	802.11
Link Layer Type	LL
Interface Type	Queue
Traffic Type	CBR
Packet Size	512 Kb
Queue Length	50
Pause Time	10 sec
Node Speed	10,30,50 m/s

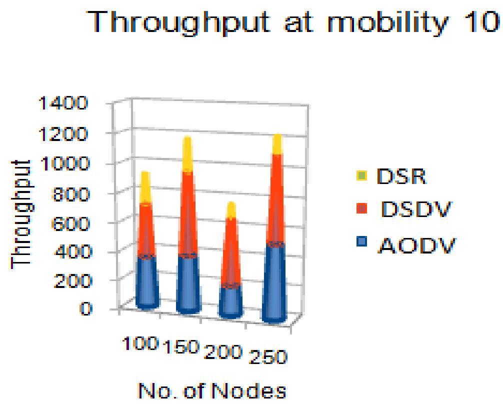

Fig 7.10: Throughput at mobility 10

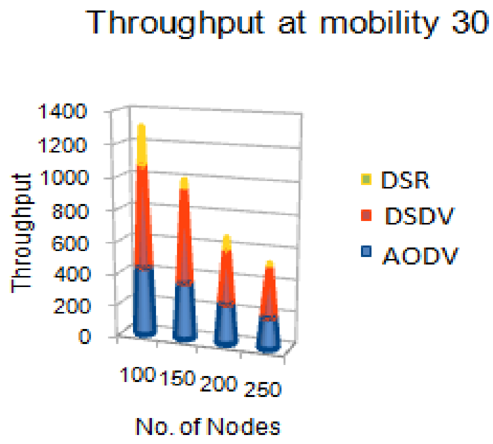

Fig 7.11: Throughput at mobility 30

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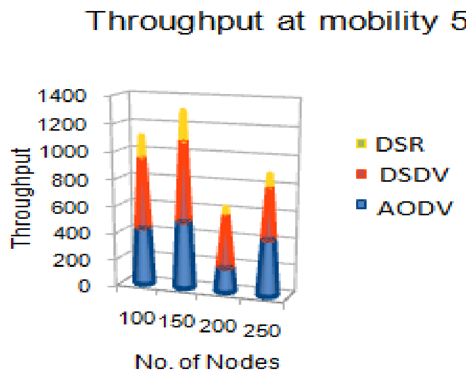

Fig 7.12: Throughput at mobility 50

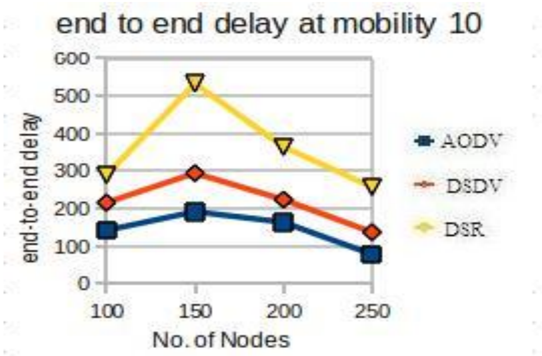

Fig 7.13: End-to-End Delay at mobility10

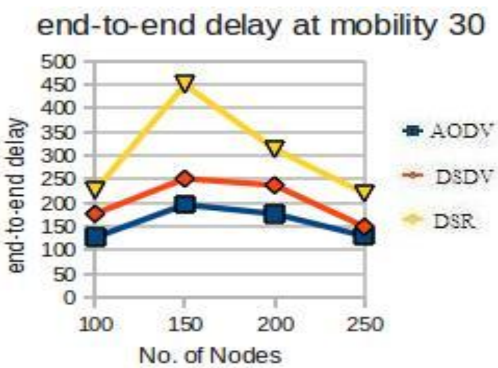

Fig 7.14: End-to-End Delay at mobility 30

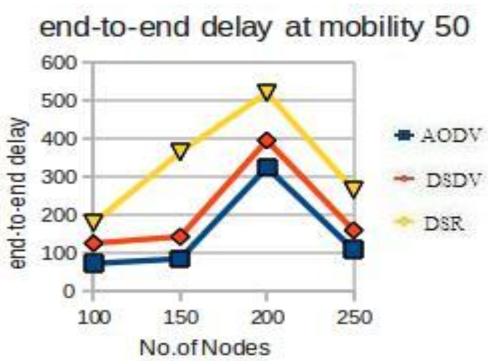

Fig 7.15: End-to-End Delay at mobility 50

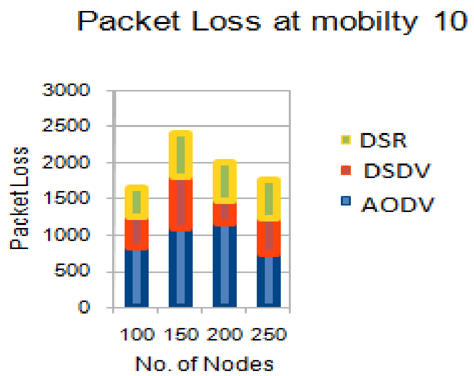

Fig 7.16: Packet Loss at mobility 10

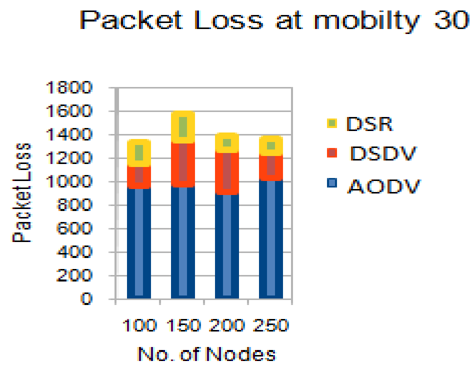

Fig 7.17: Packet Loss at mobility 30

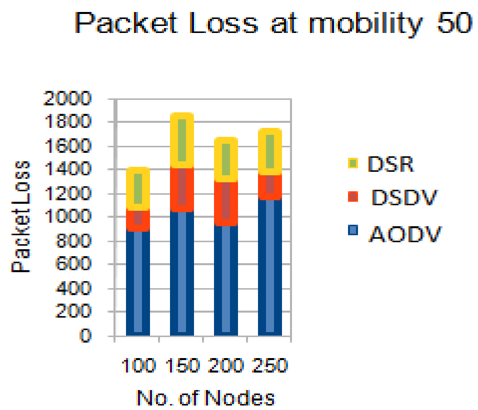

Fig 7.18: Packet Loss at mobility 50

SCENARIO 3 In this Scenario number of nodes connected in a network at a time is varied and thus varying pause time of network, through which the comparison graphs of DSDV, DSR and AODV, is obtained.

PARAMETER	VALUE
Number of nodes	100,150,200,250 with 100 connections
Simulation time	100 sec
Routing protocol	AODV, DSDV and DSR
Simulation model	TwoRayGround
MAC Type	802.11
Link Layer Type	LL
Interface Type	Queue
Traffic Type	CBR
Packet Size	512 Kb
Queue Length	50
Pause Time	10,30,50 sec
Node Speed	10 m/s

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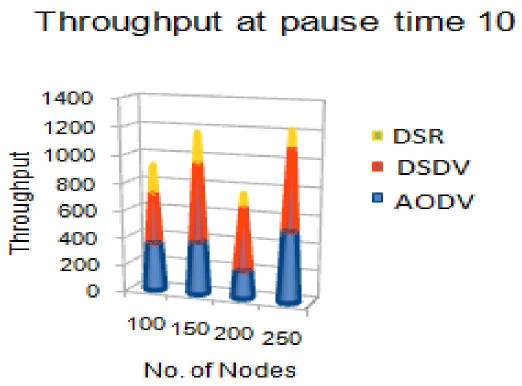

Fig 7.19: Throughput at pause time 10

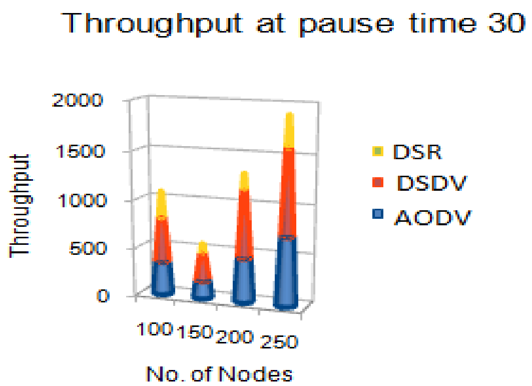

Fig 7.20: Throughput at pause time 30

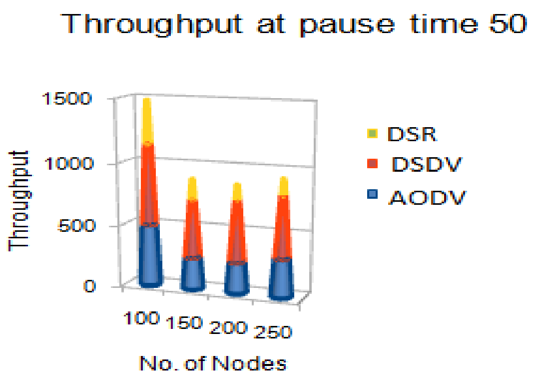

Fig 7.21: Throughput at pause time 50

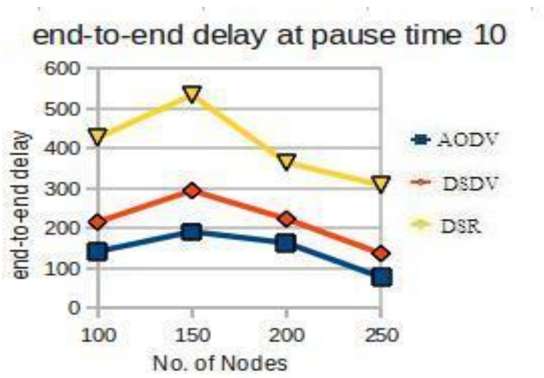

Fig 7.22: End-to-End Delay at pause time 10

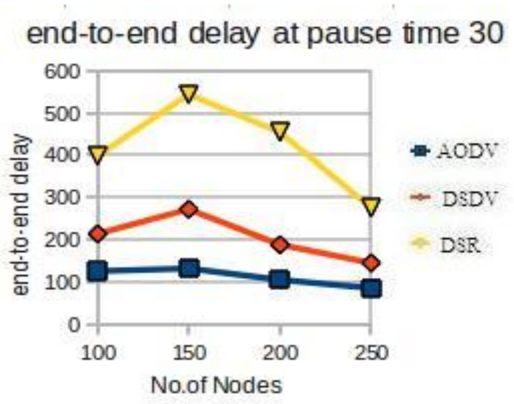

Fig 7.23: End-to-End Delay at pause time 30

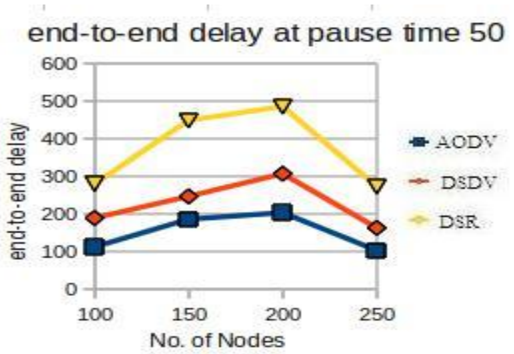

Fig 7.24: End-to-End Delay at pause time 50

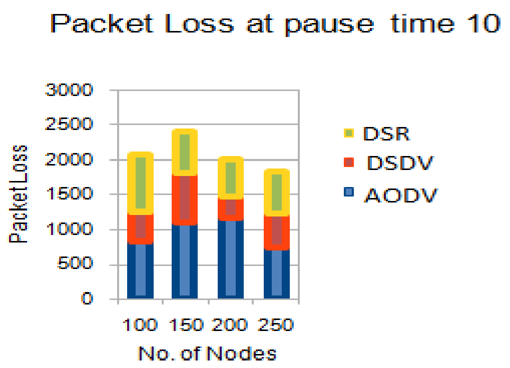

Fig 7.25: Packet Loss at pause time 10

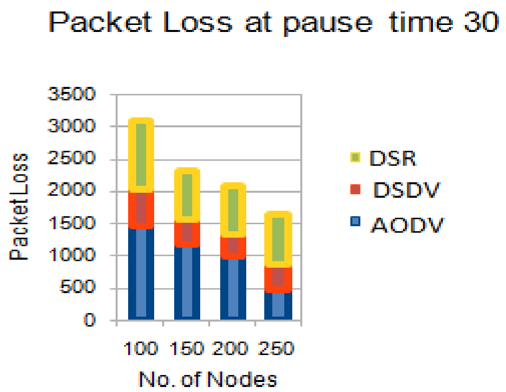

Fig 7.26: Packet Loss at pause time 30

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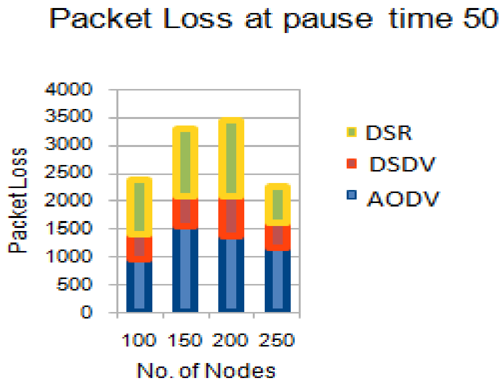

Fig 7.27: Packet Loss at pause time 50

8. RESULT ANALYSIS

8.1 Scenario 1

1) **Throughput:** Fig 7.1-7.3 shows that for increasing number of nodes AODV shows better results than DSDV and DSR.
2) **End-to-End Delay:** Fig 7.4-7.6 shows that all the three protocols show same delay but delay decreases with increasing nodes for DSDV network.
3) **Packet Loss:** Fig 7.7-7.9 shows that DSDV shows better results than that of AODV and DSR.

8.2 Scenario 2

1) **Throughput:** Fig 7.10-7.12 shows that DSDV performs better than AODV and DSR.
2) **End-to-End Delay:** Fig 7.13-7.15 shows that AODV performs better than that of DSDV and DSR.
3) **Packet Loss:** Fig 7.16-7.18shows that ASDV and DSR gives almost similar results where AODV shows worst performance.

8.3 Scenario 3

1) **Throughput:** Fig 7.19-7.21 shows that DSDV outperforms all the protocols in all conditions.
2) **End-to-End Delay:** Fig: 7.22-7.24 shows that AODV shows the better performance in all the protocols.
3) **Packet Loss:** Fig 7.25-7.27 shows that DSDV and DSR performs almost same whereas AODV shows least performance.

9. CONCLUSION

DSDV performs better in case of throughput in all the three protocols and it outperforms others in case of packet loss also. AODV performs better in case of end-to-end delay. DSR performs better only in case of packet loss. At higher node mobility AODV shows worst result in case of packet loss. DSDV performs better than AODV for higher node mobility.

Considering the case of throughput i.e ratio of amount of received data to the amount of simulation time and tells about how soon an end user is able to receive data, from the above research, performance of DSDV considered to be better because DSDV shows better throughput and a higher throughput implies better QOS of the network.

Overall AODV outperforms DSDV and DSR as in high mobility environment, topology changes frequently and AODV can adapt to the changes. Thus for a real time traffic, AODV shows the better performance with its ability to maintain connection by periodic exchange of information required for TCP network.

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