Scenario Based Performance and Comparative Simulation Analysis of Routing Protocols in MANET

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Abstract

Mobile Ad hoc NETwork (MANET) is a set of number of mobile devices (nodes), which provide an environment over a shared wireless medium communicate with each other without the presence of a predefined infrastructure or a centralized administration control. MANET is a self-organizing and self-configurable network having no infrastructure network. It is established a temporary connection where nodes can join or leave the network at any time. Most of the previous research on MANET routing protocols have focused on simulation study by various parameters, such as network size, pause times, node mobility independently, control overhead etc. In this work evaluation has been done on different scenario of three different MANET routing protocols i.e. AODV (Ad Hoc On-Demand Vector), DSDV (Destination Sequenced Distance-Vector) and DSR (Dynamic Source Routing Protocol) on different simulation time with respect to the three performances metric: packet delivery ratio, throughput and average End-to-End delay. All simulation result implement at network simulator-2 (NS-2.35).

Key words:

Routing Protocol, MANET, Wireless Medium, End-to-End Delay, NS-2.

1. Introduction

Mobile ad hoc network is a collection of wireless nodes that do not need to rely on a predefined infrastructure to keep the network connected. MANET is a self-configurable network and nodes are free to move in anywhere within the range of the network, so topology may change and this event is unpredictable. According to these characteristics, routing is a critical issue and we should choose an efficient routing protocol to makes the MANET reliable [4]. Mobile ad hoc network topology is dynamic [5], so due to mobility of nodes, dynamic topology of the network, lack of centralized mechanism

makes MANET more vulnerable. One of the distinctive features of MANET is, each node must be able to act as a router to find out the optimal path to forward a packet.

A number of routing protocols have been studied and their performance comparisons are made by many researchers These protocols can be classified according to the "routing strategy" that they follow to find a path "route" to the destination AODV is perhaps the most well-known routing protocol for MANET [1], which is a hop-by-hop reactive (On demand) source routing protocol [16], AODV only needs to maintain the routing information about the active paths. Dynamic Source Routing (DSR) is a routing protocol for wireless mesh networks [7]. It is similar to AODV to create a route when it required on demand. Two types of operation have performed by DSR first to discover the route for transmission data packets from source to destination and second to maintain the transmission path where packets are delivered. Destination-Sequenced Distance-Vector Routing (DSDV) is a table-driven routing protocol for ad hoc mobile networks.

One of the main goals of this research is to find out the relative performance merits of the existing routing protocols in the different scenario of MANET with different simulation time. The routing protocols selected for the present evaluation research include DSR, AODV and DSDV. These have been selected because they have been widely investigated in the literature over the past few years [3] [4] [6].

This paper is organized as follows: Section 2 describes MANET network model. Section 3 describes Routing protocols in MANET. The performance evaluations of our scheme require for simulation setup is presented in Section 4. Section 5 presents the simulation analysis description, graph & results of this research. Finally, Section 6 describes conclusion of simulation result.

2. MANET Network Model

A mobile ad-hoc network (MANET) is a collection of wireless devices like laptop and PDA and these devices can easily to connect on a wireless medium and form an arbitrary and dynamic network with wireless links and able to transfer and receiving the data by help of Mobile Ad hoc Network protocols. All routing services facilitated by routing protocol of MANET to nodes. Each mobile node works not only as a host but also as a router [2]. Because nodes have a limited range and able to sending the message to another host, but if sender's host exists not in the transmission range, data packets must be forwarded through the network using other hosts which will be operated as routers for delivering the message over the network [6]. MANETs have dynamic nature of topology of

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such network rapidly changed because each network node can freely move anywhere. Due to the limited wireless transmission range of each node, data packets then may be forwarded along hop by hop.

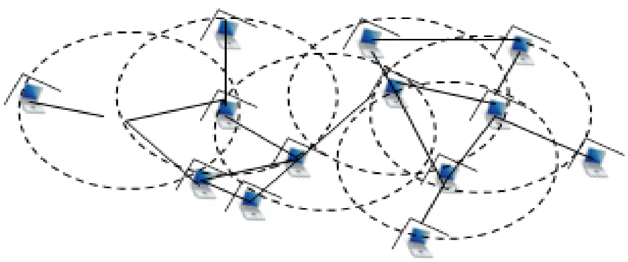

Fig. 1 MANET Network Model

3. Types of Routing Protocols in MANET

A number of MANET routing protocols were proposed in the last decade. These protocols can be classified according to their "routing strategy" because they follow to find a path "route" from source to destination and vice versa [10]. The existing routing protocols in MANETs can be classified into three types. Proactive routing protocols [11] such as Destination-Sequenced Distance Vector (DSDV) routing maintain routing information all the time in routing table and always update the route information by broadcasting update message. Due to the information exchange overhead, especially in volatile environment, proactive routing protocols are not suitable for Ad hoc network [7]. However, reactive routing [10] [11] is started only if source node wants to deliver the data to destination node such as AODV and DSR. Hybrid Protocols [15] are the combinations of reactive and proactive protocols and takes advantages of these two protocols and as a result, routes are found quickly in the routing zone such as Zone Routing Protocol (ZRP) and Temporally Ordered Routing Algorithm (TORA) [11].

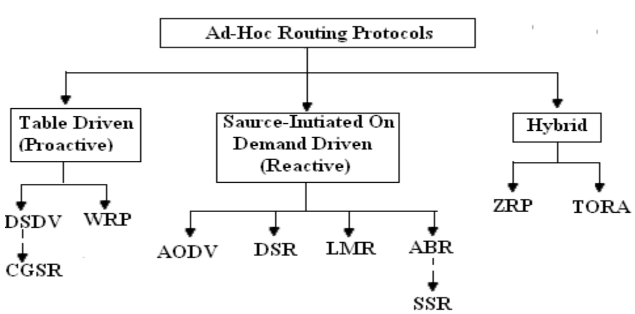

Fig. 2 Classification of MANET Protocols

3.1 Ad hoc On-Demand Distance Vector (AODV)

AODV is a reactive protocol and it discovers routes only when a node wants to deliver data over the network. It is jointly developed in Nokia Research Centre of University of California, Santa Barbara and University of Cincinnati by C. Perkins and S. Das [14]. AODV have the capability of both unicasted and multicast routing. Before transmit the data packet by source node, AODV create a link from source node to destination node by the help of routing table which is maintained by every intermediate node present in the network and its update dynamically because of broadcasting of the HELLO message. By help of this HELLO message every node update own routing information in the routing table like sequence number, IP address etc. AODV defines three types of control messages for route maintenance:

3.1.1 Route Request (RREQ)

A route request message is transmitted by a node requiring a route to a node. Route discovery begins with broadcasting a route request (RREQ) packet [3] by the source node to its neighbors. RREQ packet contains broadcast ID, two sequence numbers, and addresses of source and destination and hop count. The intermediary nodes which receive the RREQ packet could do two steps: If it isn't the destination node then it'll again broadcast the RREQ packet to its neighbors. Otherwise it'll be the destination node and then it will send a unicasted replay message, route replay (RREP), directly to the source from which it was received the RREQ packet.

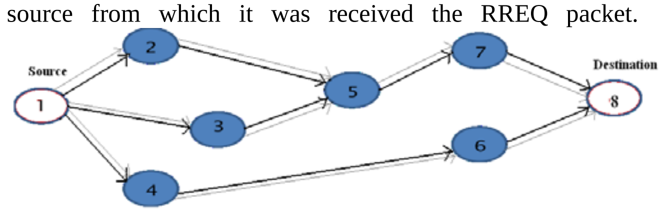

Fig 3 Route Request

3.1.2 Route Reply (RREP)

A route reply message is unicasted back to the originator of a RREQ if the receiver is either the node using the requested address, or it has a valid route to the requested address. AODV transmit on routing table entries to propagate an RREP back to the source and, RREP propagates back to the source, nodes set up forward pointers to the destination. Once the source node receives the RREP, it may begin to forward data packets to the destination. If the source later receives a RREP containing a greater sequence number or contains the same sequence number with a smaller hop count, it may update its routing information for that destination and begin using the better route [7].

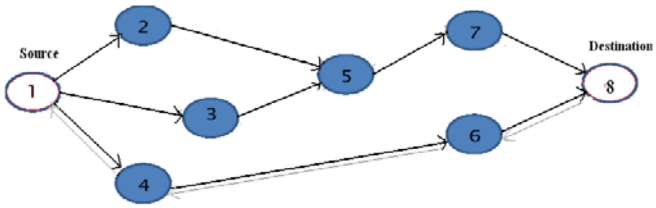

Fig 4 Route Reply

3.1.3 Route Request & Reply (RERR)

When a link breakage in an active route is detected, a RERR message is used to notify other nodes of the loss of the link. The node might learn of a lost link from its neighbors through route error control messages "*RERR*".

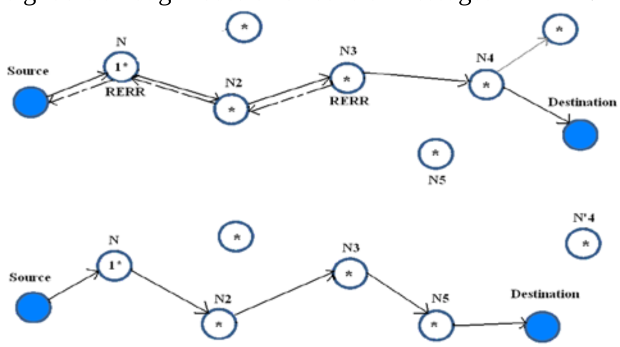

Fig 5 Route Request & Reply

3.2 Dynamic Source Routing (DSR)

DSR [17] is source routing and it's similar to AODV in that it forms a route on-demand when a transmitting node requests one. DSR maintains a *route cache* in which it caches source routes that it has learned. When one host wants to send a packet to another host, the sender first checks its route cache for a source route to the destination. If a route is found, the sender uses this route to transmit the packet. If no route is found, the sender may attempt to discover route by using the *route discovery* protocol [17]. There are two major phases performed by DSR:

1. Route Discovery
2. Route Maintenance

3.2.1 Route Discovery

Route discovery provide service to any host in the ad hoc network to dynamically discover a route to any other host in the network, whether directly reachable within wireless transmission range or reachable through one or more intermediate hops. In route discovery process, a node broadcasts a *route request* packet which may be received by that node within wireless transmission range of it. Each node receiving an RREQ rebroadcasts it, unless it is the destination or it has a route to the destination in its route cache. Such a node replies to the RREQ with a route reply (RREP) packet that is routed back to the original source. RREQ and RREP packets are also source routed. The RREQ builds up the path traversed across the network. The route carried back by the RREP packet is cached at the source for future use. If any link on a source route is broken, the source node is notified using a route error (RERR) packet. The source removes any route using this link from its cache. DSR makes use of source routing and route caching [9]. A new route discovery process must be initiated by the source if this route is still needed.

3.2.2 Route Maintenance

While waiting for the route discovery to complete, the host may continue normal processing and may send and receive packets with other hosts. However, it uses source routing instead of relying on the routing table at each intermediate device [8]. This protocol is truly based on source routing whereby all the routing information is maintained (continually updated) at mobile nodes [11]. Route Reply would only be generated if the message has reached the intended destination node (route record which is initially contained in Route Request would be inserted into the Route Reply.

3.3 Destination Sequenced Distance Vector (DSDV)

DSDV [4] is a table-driven routing protocol for ad hoc mobile networks which is based on the Bellman-Ford algorithm. Every mobile station maintains a routing table that lists all available destinations, the number of hops to reach the destination and the sequence number assigned by the destination node. The sequence number is used to distinguish stale routes from new ones and thus avoid the formation of loops [5]. The stations periodically transmit their routing tables to their immediate neighbors. A station also transmits its routing table if a significant change has occurred in its table from the last update sent. So, by using update information of route, nodes can easily transmit packets to the destination within network.

4. Scenario of Simulation Setup

All extensive simulations were conducted using NS-2.35. NS-2 [13] is simply an event driven simulation tool that is useful for studying the dynamic nature of communication networks. The simulated network consisted of 50, 75 and 100 nodes randomly scattered in 800x800m area at the starting time of the simulation.

4.1 Performance Metric

Some following important performance metrics can be evaluated:-

- **Packet Delivery Ratio:-** The ratio of the data packets delivered to the destinations to those generated by the CBR sources. This performance metric will give us how well the protocol is performing in terms of packet delivery at different speeds.
- **Throughput (messages/second)**: The ratio of the number of data packets sent and the number of data packets received. Throughput of the protocol shows number of messages delivered per one second.
- **Average End-to-End delay (seconds):** This metric is calculated by subtracting "time at which first packet was transmitted by source" from "time at which first data packet arrived to destination". This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays [16] at the MAC, propagation and transfer times.

$$Avg\_end\_to\_en\_delay = \frac{\sum_{1}^{n}(CBRsentTime - CBRrecvTime)}{\sum_{1}^{n} CBRrec}$$

5. Scenario of Simulation Analysis & Result

As already outlined we have taken two On demand (Reactive) routing protocols, namely AODV, DSR and one proactive routing protocol DSDV. For all simulation result evaluate at different simulation time like 50, 100 and 150 sec.at maximum speed of the nodes (pause time) is constant set to 20m/s and the number of nodes is varying as 50, 75, and 100. All simulation parameter are described in below table 1:

Table 1. Simulation Parameter

S.No.	Parameters	Value
1.	Source Type	MAC
2.	Number of Node	50, 75 & 100
3.	Simulation Time	50, 100 & 150 (sec)
4.	Pause Time	5 ms
5.	Environment Size	800x800
6.	Transmission Range	250 m
7.	Traffic Size	CBR (Constant Bit Rate)
8.	Packet Size	512 bytes
9.	Packet Rate	5 packets/sec
10.	Maximum Speed	20 m/s
11.	Routing Protocols	AODV,DSDV & DSR
12.	Simulator Used	NS – 2.35

SCENARIO 1

In this scenario, the performance of protocol compare with respect to their packet delivery ratio measurement, then the number of nodes connected in a network as varying with simulation time and thus varying the number of connections, through which the comparison graphs of AODV, DSDV and DSR is obtained.

Table 2. Packet Delivery Ratio at 50 nodes

Simulation Time (Sec)	50 node		
	AODV	**DSR**	**DSDV**
50	0.7565	0.4925	0.7238
100	0.7047	0.5187	0.7513
150	0.7623	0.8623	0.7405

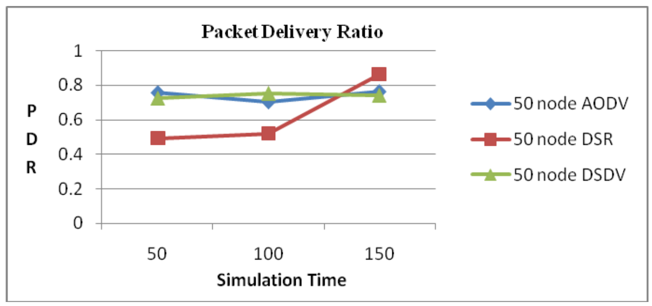

Fig 6 Comparison Graph between Packet Delivery Ratio vs Simulation time at 50 nodes

Table 3. Packet Delivery Ratio at 75 nodes

Simulation Time (Sec)	75 node		
	AODV	**DSR**	**DSDV**
50	0.7313	0.7068	0.5256
100	0.7527	0.4225	0.7277
150	0.7483	0.3612	0.7026

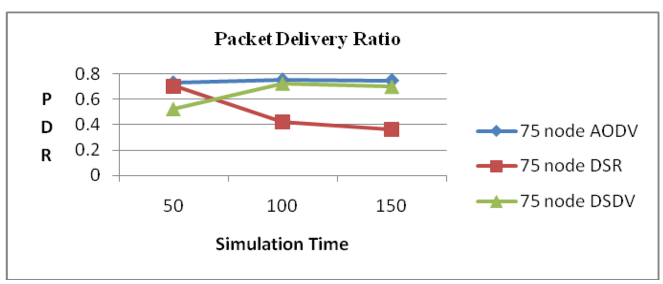

Fig 7 Comparison Graph between Packet Delivery Ratio vs Simulation time at 75 nodes

Table 4. Packet Delivery Ratio at 100 nodes

Simulation Time (Sec)	100 node		
	AODV	DSR	DSDV
50	0.7423	0.6326	0.4223
100	0.7599	0.5562	0.3419
150	0.7278	0.4359	0.4268

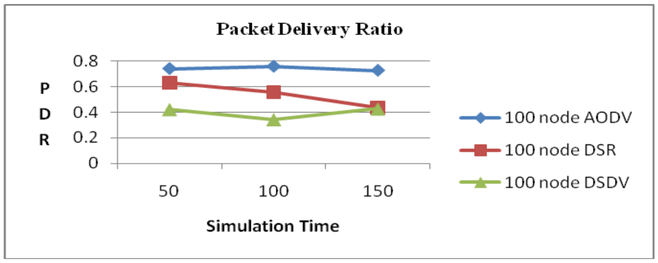

Fig 8 Comparison Graph between Packet Delivery Ratio vs Simulation time at 100 nodes

Packet Delivery Ratio is obtained by the ratio of number of packet transmitted by source node to number of packet received by receiving node in the presence of traffic node environment. So, every network has to design to keep the point of packet delivery ratio. In above scenario 1, Fig 6, depict that the PDR value of AODV and DSDV is higher than DSR at present of 50 node in the network but as the traffic will increase with the number of nodes such as 75 and 100 nodes in the network which is shown in fig 7 and fig 8 respectively, the PDR value of DSDV is worse in greater number of nodes with long simulation time. From the above study, in view of packet delivery ratio, reliability of AODV and DSR protocols is greater than DSDV protocol.

SCENARIO 2

In this scenario, the performance of protocol comparing between average End-to-End delay and simulation time along with presence of traffic nodes 50, 75 and 100 with varying number of simulation time i.e. 50, 100 & 150 sec in the network. The table of simulation result & comparison graphs of AODV, DSDV and DSR protocol shown in below.

Table 5. End-to-End Delay at 50 nodes

Simulation Time (Sec)	50 node		
	AODV	DSR	DSDV
50	43.86	251.83	205.16
100	93.66	454.97	194.34
150	73.09	631.42	203.51

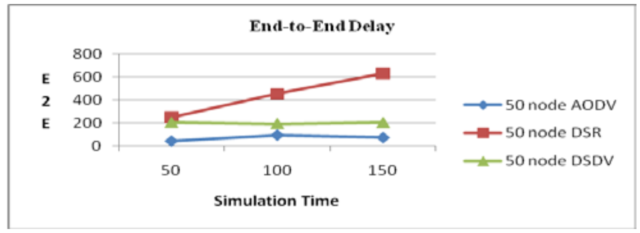

Fig 9 Comparison Graph between End-to-End Delay vs Simulation time at 50 nodes

Table 6. End-to-End Delay at 75 nodes

Simulation Time (Sec)	75 node		
	AODV	DSR	DSDV
50	86.35	103.43	296.65
100	76.15	133.7	240.06
150	77.05	162.73	240.94

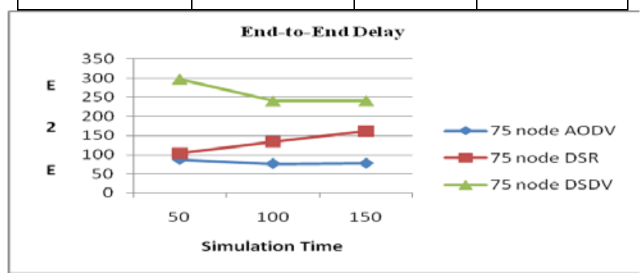

Fig 10 Comparison Graph between End-to-End Delay vs Simulation time at 75 nodes

Table 7. End-to-End Delay at 100 nodes

Simulation Time (Sec)	100 node		
	AODV	DSR	DSDV
50	64.58	86.48	371.23
100	31.97	95.03	442.00
150	30.01	175.71	440.195

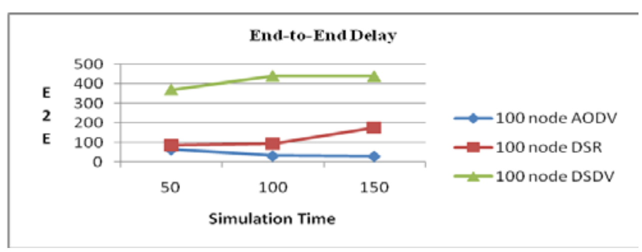

Fig 11 Comparison Graph between End-to-End Delay vs Simulation time at 100 nodes

The measurement values of average End-to-End delay represent that reliability of routing protocol in the network. The comparison of above fig.11 shows that when the speed of node increases with simulation time, average delay of AODV decreases while in DSDV and DSR, average delay increases with the increase in node speed. It means AODV take less time to deliver the data from source to destination as node speed increases in AODV.

SCENARIO 3

In this scenario, the performance of protocol compares with respect to their throughput measurement. The table of simulation result & comparison graphs of AODV, DSDV and DSR shown in below.

Table 8. Throughput at 50 nodes

Simulation Time (Sec)	50 node		
	AODV	DSR	DSDV
50	554.61	987.99	568.5
100	548.64	1037.16	571.43
150	598.55	970.59	562.96

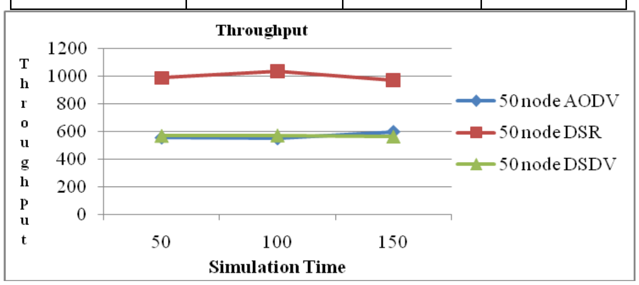

Fig 12 Comparison Graph between Throughput vs Simulation time at 50 nodes

Table 9. Throughput at 75 nodes

Simulation Time (Sec)	75 node		
	AODV	DSR	DSDV
50	722.16	861.61	688.89
100	724.19	779.18	760.06
150	749.34	694.24	770.83

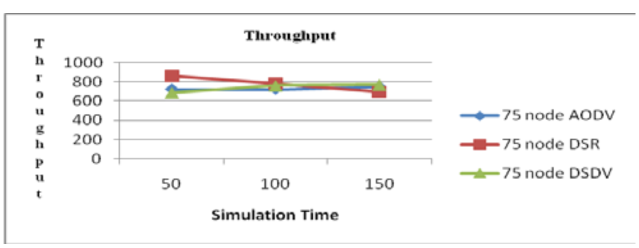

Fig 13 Comparison Graph between Throughput vs Simulation time at 75 nodes

Table 10. Throughput at 100 nodes

Simulation Time (Sec)	100 node		
	AODV	DSR	DSDV
50	756.05	665.55	649.69
100	789.58	360.15	564.98
150	750.45	305.74	680.29

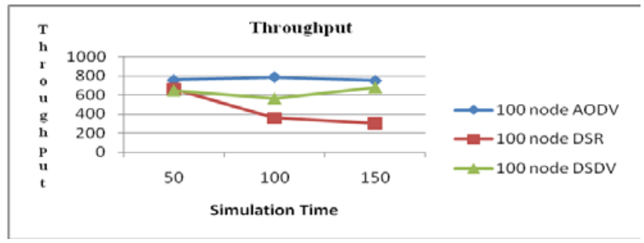

Fig 14 Comparison Graph between Throughput vs Simulation time at 100 nodes

Throughput measures of effectiveness of a routing protocol in the network. When comparing the routing throughput by each of the protocols, DSR has the high throughput at minimum size of network show in fig.12 by comparing all simulation results, the throughput value of AODV increases when the number of nodes and simulation time increases. The throughput value of DSDV slowly increases initially and maintains its value when the number of nodes increases with simulation time while DSR perform well with minimum number of node but as the number of nodes increases its worse perform as the higher simulation time. Hence, DSR shows better performance with respect to throughput in minimum size of network which is shown in fig.12 and fig.13 and AODV perform well in larger size of network.

6. Conclusion

In this paper, we compare three popular routing protocols in the presence of different scenario in network. The performance of DSR, AODV and DSDV routing protocols is analyzed with simulation using NS-2.35 simulator scenario available at 50, 75 and 100 nodes and the simulation time has varied from 50sec, 100sec and 150 sec on the basis of three parameters Average End-to-End delay, throughput, and packet delivery. In this research, we conclude that the AODV performs better in case of packet delivery ratio and throughput but it performs badly in terms of average End-to-End delay at higher number of nodes. In throughput, DSR perform better than AODV and DSDV initially but it decreases substantially when the simulation time increases. DSDV performs better than

AODV for higher node mobility, in case of end-to-end delay but it generates average result in PDR and throughput in large network. After analysis in different scenario of network it can be practical that AODV perform better than DSR and DSDV in case of PDR and throughput in mobility of nodes in long time because it has less routing overhead while DSDV is proved to be best in case of end-to-end delay when nodes have high mobility considering the above said three metrics.

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