# MANET Routing Protocols Evaluation: AODV, DSR and DSDV Perspective

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**Abstract.** Mobile Ad Hoc Network (MANET) is a set of mobile nodes that communicate with each other to configure an immediate network without utilizing any of infrastructure, the centralized access point or centralized administration in multiple hop manner. There are a lot of routing protocols have been proposed in MANET which are different from each other in the performance and the mechanism. Therefore, the performance study of those protocols in different scenarios is needed. This paper presents the performance comparison between Dynamic Source Routing (DSR), Ad hoc on demand distance Vector Routing (AODV) as reactive routing protocols and Destination Sequenced Distance Vector (DSDV) as a proactive routing protocol to precisely determine which protocol is more effective. Network Simulator (NS) version 2.35 has used to simulate and evaluate the performance of these protocols in terms of the packet delivery ratio, average throughput, average end-to-end delay, and packet loss ratio with respect to the variable number of nodes.

## 1 Introduction

Mobile Ad Hoc Network (MANET) is a set of mobile nodes that communicate with each other to configure an immediate network without utilizing any of infrastructure, the centralized access point or centralized administration in multiple hop manner, so the network in MANET is infrastructure-less [1]. MANETs are a dynamic topology, where the wireless nodes in MANET work as both router and host to maintain the activation of the communications network. The nodes in MANET are arbitrary can move out or join the network freely and in a random fashion, they can organize themselves [2-3]. In MANET, the nodes collaborate with each other in the job of routing packets from the source node *S* to the destination node *D* as every node in the network is capable of communicating just with those nodes that positioned within its transmission radius R, simultaneously, *S* node and *D* node can be located at a range very higher than radius those nodes. So, the nodes in MANET need to reroute the packets to other nodes to enable the communication among the nodes that are located outside the transmission range. Thus, the node in MANET changes its link case orderly with other mobile nodes [4].

In recent studies, there are a lot of routing protocol have been proposed in MANET which witnessed a huge interest by researchers. Where the study in [5] has presented a comparison of LAR and OLSR routing protocols in the detection of the forest fire based on MANET. It has used MATLAB simulator to evaluate the performance of these protocols, where the results showed that LAR is better and more efficient than OLSR in detecting the fires and LAR is consumed energy lesser than OLSR. This study [6] presents an evaluation between DSR and AODV routing protocols under mobility model with TCP and UDP traffic sources. It has been shown that AODV is better than DSR in the high mobility conditions. The authors in [7] have presented a comparison in MANET between TCP and UDP for temporarily ordered routing algorithm (TORA) and optimized link state routing (OLSR) with various mobility models. They used NS2 simulation to analyze the performance depending on the different performance metrics like end-to-end delay, packet delivery ratio, and throughput. The results show that TCP is better than UDP in the throughput. Also, TORA in UDP protocol is better than TCP in terms of PDF. This study [8] provides a performance analysis of three different protocols and they are FSR, ZRP and LAR in different pause times. The authors have evaluated these protocols using Qualnet 5.0.2 in terms of the performance measures, where they concluded that LAR is outperformed ZRP and FSR routing protocols. In [9], the authors have evaluated the performance of DSR, LAR and DREAM routing protocols using NS 2 simulator in terms of the performance metrics. The simulation results showed that DREAM has better performance than DSR and the LAR protocol gave the best performance as compared with DSR and DREAM. This study [10] compares the performance of DSDV with OLSR and WRP in terms of packet delivery ratio, throughput, overhead and MAC

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collision using MATLAB. The results showed that DSDV is better than WRP and the performance of OLSR protocol showed the best as compared to other protocols.

## 2 The Routing Protocols in MANET

Routing is the manner that includes the exchange of data from one node to another node in the network. The wireless radios routing in MANET [11] is usually implemented through multi-hop, due to the short range of nodes. Where the message is normally routed by the intermediate mobile nodes.

The routing protocols are available in MANET which defines the routes and transports the packets in the nodes, that is from S node to D node [12]. Various routing protocols have been proposed in MANET. This is important to improve and use the performance of the network properly. There are three main types of routing protocols in MANET namely Proactive, Reactive and Hybrid routing protocols. Figure 1 shows the classification of routing protocols. In proactive protocols, the nodes have a table of routing information. Where the node creates the routes before they are needed. Therefore, the route discovery operation is implemented faster than reactive protocols. Whilst, the nodes in reactive protocols creates the routes just when it is needed. However, the nodes in the hybrid protocols combine the strategies of both reactive and proactive protocols.

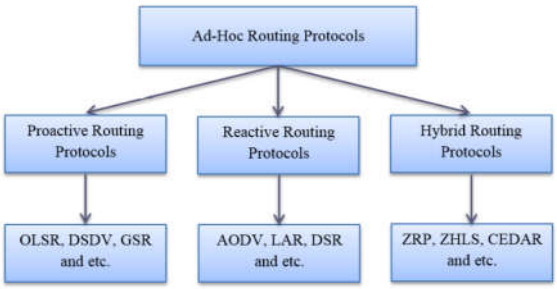


**Fig. 1.** The Classification of Routing Protocols

### 2.1 Ad-hoc On-demand Distance Vector (AODV)

AODV is a kind of reactive protocols. Its methodology is hop-to-hop routing. The node establishes the Route Request (RREQ) if it wants to know the route to a particular destination. Then the intermediate nodes forward the route request and at the same time, these intermediate nodes create a reverse route to the destination [13]. When the node receives the request that has the route to the destination, it establishes a Route Reply (RREP) which includes numeral of hops which are required to arrive the destination. Each node that cooperates in sending this reply to the source node, it creates a forward route to the destination [14]. Figure 2 shows the routing of RREQ and RREP in AODV protocol. This route that has been established from source to destination is a hop-by-hop case. Figure 3 shows the advantages and disadvantages of AODV routing protocol.

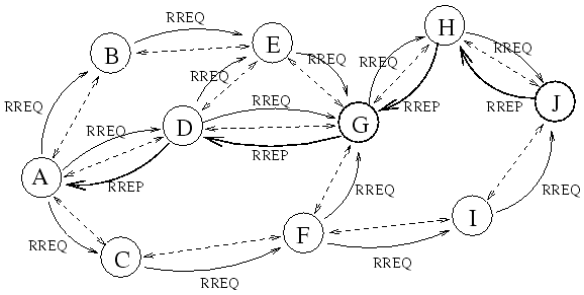


**Fig. 2.** RREQ and RREP in AODV

### 2.2 Dynamic Source Routing (DSR)

DSR is a reactive or on-demand routing protocol. This protocol has been designed to reduce the bandwidth wasted via the control packets in wireless networks and that via deleting the periodic table-update messages required in the table-driven approach [15]. In DSR protocol, there is no need for network infrastructure or administration, due to these networks fully self-configured and organized. The source routing is a method which the source packet defines the complete sequence of nodes through which to forward the data packets. The source routing does not need to keep the routing information via the intermediate hops. Figure 3 shows the advantages and disadvantages of DSR protocol [16].

### 2.3 Destination Sequenced Distance Vector (DSDV)

DSDV is one of the most widely known proactive or table-driven routing protocols for MANETs [17]. The routing algorithm of DSDV is depended on the numeral of hops to arrive at the destination node. To transmit the data packets among the nodes in the network, DSDV protocol utilizing routing tables which are stored in every node. DSDV protocol has three major characteristics which are: decreasing the high routing overhead, solve the "count to infinity" problem and avert the loops. Each mobile node contains a table of routing information which includes all the routes to the destinations and another information [18]. Figure 3 shows the advantages and disadvantages of DSDV protocol.

| Protocols | Advantages | Disadvantages |
|---|---|---|
| AODV | In AODV, route discovery process is in on demand, which is more efficient in dynamic nature of mobile ad-hoc network. | Due to on demand manner, it won't check route in periodic interval so transmission of data after discover the rote is taking some more delay. |
| DSR | The route is created only when it is required and the nodes utilize the route cache information efficiently to reduce the overhead and collision. | The route maintenance mechanism does not locally repair a broken link.<br>The delay is higher than in table-driven protocols. |
| DSDV | DSDV was one of the early algorithms available. It is quite suitable for creating ad hoc networks with small number of nodes. | DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth. |

**Fig. 3.** The Advantages and Disadvantages of AODV, DSR and DSDV Routing Protocols.

## 3 Simulation Scenarios

In this study, we have used ns-2.35 network simulator to compare and evaluate the performance of DSR, AODV and DSDV routing protocols in MANET. This simulation has been used a different number of nodes to deeply verify the performance of these protocols in terms of the performance measures. The number of nodes is 10, 20, 30, 40 and 50. Where the nodes have deployed in the network with speed 5ms and they move randomly. Figure 4 illustrates the simulation environment. The transmission range in all nodes is set to be 250m in the network. The simulation area is 600m x 600m and the simulation time is 160 sec. The packet size in this simulation is 512 bytes. Table 1 shows other simulation parameters.

**Table 1.** Simulation Parameters

| Parameters | Values |
|---|---|
| Simulator | NS 2.35 |
| Number of Nodes | 10, 20, 30, 40, 50 |
| Node Speed | 5ms |
| Transmission Range of Node | 250m |
| Simulation Area | 600m x 600m |
| Simulation Time | 160 Sec |
| Routing Protocols | DSR, AODV and DSDV |
| Packet Size | 512 |
| MAC Type | 802.11 |
| Antenna Model | Omni Antenna |
| Traffic Model | TCP |
| Mobility Model | RWP |
| Performance Measures | PDR, Average e2e delay, Average TP and PL |

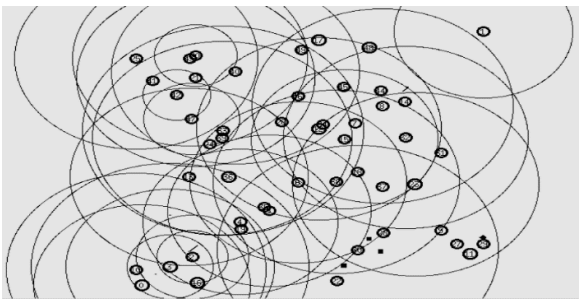

**Fig. 4.** The Simulation Environment

## 4 Performance Metrics

We have used different network performance metrics through our simulation between TCP and UDP. These performance metrics are used to evaluate the performance of the protocols.

### 4.1 Packet Delivery Ratio (PDR)

PDR is the ratio of data packets delivered to the destination to those generated by the sources. It is calculated as follow:

$$PDR\ (\%) = \frac{\sum No\ of\ packet\ received}{\sum No\ of\ packet\ sent} * 100 \quad (1)$$

### 4.2 Average Throughput (TP)

Average TP is the number of bytes received successfully and it is calculated as follow:

$$TP = Number\ of\ Bytes\ Received * 8 * Simulation\ Time * 1000\ kbps \quad (2)$$

### 4.3 Average End-to-End Delay (e2e delay)

Average e2e delay is the average time of the data packet to be successfully transmitted across the network from the source to the destination. It is computed as follow:

$$e2e\ delay = \frac{\sum arrive\ time - send\ time}{\sum number\ of\ connection} \quad (3)$$

### 4.4 Packet Loss (PL)

PL is the different between the number of data packets sent and the number of data packets received. It is calculated as follow:

$$PL = Number\ of\ Data\ Packets\ Sent - Number\ of\ Data\ Packets\ Received \quad (4)$$

## 5 Simulation Results and Discussion

In our simulation, we have compared and evaluated the performance of three different types of routing protocols, they are DSR, AODV which are considered reactive routing protocols and DSDV which is a proactive routing protocol. The simulation has been used ns-2.35 in MANET. Ns-2.35 is a software which is able to handle huge amounts of data efficiently. Also, it is very commonly used software, because of its high capacity to carry out complex mathematical calculations, data analysis and simulations. In this study, the simulation scenario has a different number of nodes. According to the simulation results obtained, Figure 5 shows the performance results of the routing protocols in the throughput. Where AODV has the highest value of throughput, it has achieved 10096.82 of throughput and

the performance of DSR protocol is slightly higher than DSDV protocol where DSR has achieved 5004.56 throughput and DSDV protocol has obtained 4479.68. Table 2 shows the results values of the average throughput for the routing protocols in a varied number of nodes.

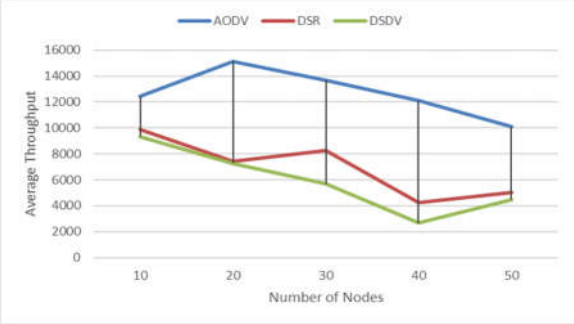


**Fig. 5.** TP Versus Number of Nodes

**Table 2.** The Results Values of AODV, DSR and DSDV in Average Throughput

| Number of Nodes | AODV | DSR | DSDV |
|---|---|---|---|
| 10 | 12424.28 | 9882.86 | 9342.71 |
| 20 | 15123.97 | 7416.21 | 7276.56 |
| 30 | 13684.28 | 8235.16 | 5672.96 |
| 40 | 12105.33 | 4251.59 | 2671.6 |
| 50 | 10096.82 | 5004.56 | 4479.68 |

In PDR as shown in Figure 6, the performance of DSDV is much better than DSR. Where DSDV has obtained 98.87% of PDR at node 10 and 96.64% at node 50. However, AODV is better than DSR in terms of PDR, where AODV has achieved 90.4% of PDR and DSR has achieved 66.67% of PDR. Therefore, it can be seen that the DSDV protocol received a higher amount of data as compared to the AODV and DSR routing protocols. Table 3 shows the results values of PDR for the routing protocols in a varied number of nodes.

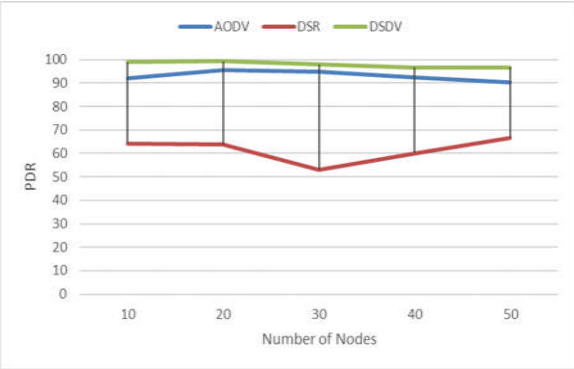


**Fig. 6.** PDR Versus Number of Nodes

**Table 3.** The Results Values of AODV, DSR and DSDV in PDR

| Number of Nodes | AODV | DSR | DSDV |
|---|---|---|---|
| 10 | 92.11 | 64.29 | 98.87 |
| 20 | 95.54 | 63.64 | 99.27 |
| 30 | 94.78 | 52.94 | 97.92 |
| 40 | 92.56 | 60 | 96.67 |
| 50 | 90.4 | 66.67 | 96.64 |

Depending on PDR, the DSDV protocol has the lowest value of PL and DSR has the highest value of PL, where DSDV has 3.36% of PL and DSR has 33.33% at the node 50 as shown in Figure 7. However, AODV protocol has 9.6% of PL. Table 4 shows the results values of PL for the routing protocols in a varied number of nodes.

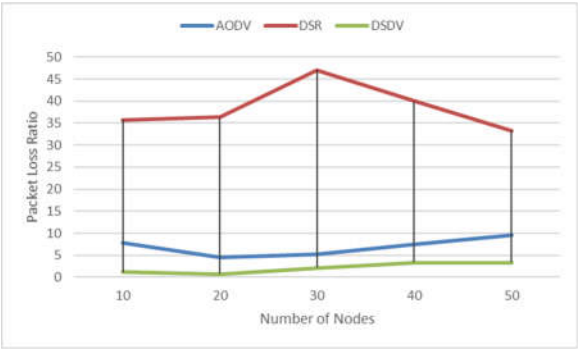


**Fig. 7.** PL Versus Number of Nodes

**Table 4.** The Results Values of AODV, DSR and DSDV in PL

| Number of Nodes | AODV | DSR | DSDV |
|---|---|---|---|
| 10 | 7.89 | 35.71 | 1.13 |
| 20 | 4.46 | 36.36 | 0.73 |
| 30 | 5.22 | 47.06 | 2.08 |
| 40 | 7.44 | 40 | 3.33 |
| 50 | 9.6 | 33.33 | 3.36 |

The routing protocols have different performance in e2e delay, wherein DSR protocol has the lowest value than DSDV and AODV routing protocols. DSR protocol has achieved e2e delay value equal to 0.111149 sec, DSDV

protocol has achieved e2e delay value equal to 0.210932 sec and AODV protocol has achieved e2e delay value equal to 0.165754 sec. Therefore, the results showed that the DSR protocol has the best performance in e2e delay as shown in Figure 8. However, AODV protocol is better than DSDV protocol in e2e delay. Table 5 shows the results values of e2e delay for the routing protocols in a varied number of nodes.

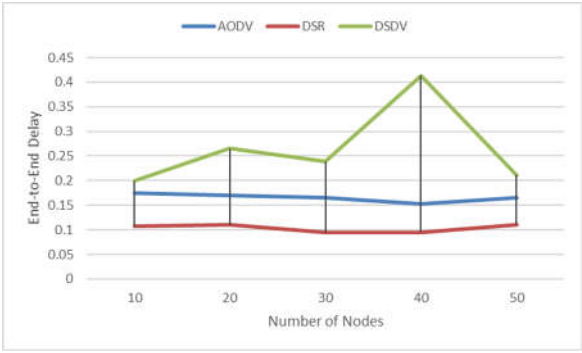


**Fig. 8.** E2E Delay Versus Number of Nodes

**Table 5.** The Results Values of AODV, DSR and DSDV in Average E2E Delay

| Number of Nodes | AODV | DSR | DSDV |
|---|---|---|---|
| 10 | 0.175002 | 0.106881 | 0.199203 |
| 20 | 0.170159 | 0.109682 | 0.265643 |
| 30 | 0.165601 | 0.0945285 | 0.238772 |
| 40 | 0.153284 | 0.095455 | 0.413572 |
| 50 | 0.165754 | 0.111149 | 0.210932 |

## 6 Conclusion

MANET is a set of mobile nodes that communicate with each other to configure an immediate network without utilizing any of infrastructure, the centralized access point or centralized administration in multiple hop manner. In MANET, there are a lot of routing protocols have been proposed which are different from each other in the performance. This paper has presented the performance comparison between Dynamic Source Routing (DSR), Ad hoc on demand distance Vector Routing (AODV) as reactive routing protocols and Destination Sequenced Distance Vector (DSDV) as a proactive routing protocol to precisely determine which protocol is more effective. Network Simulator (NS) version 2.35 has used to evaluate the performance of these protocols in terms of the performance measures with respect to the variable number of nodes. The results have shown that DSDV is better than DSR and AODV routing protocols in terms of PDR and PL, while AODV is better than DSDV and DSR in TP. DSR is better than other protocols in e2e delay. Due to the importance of PDR, this paper concluded that DSDV is the best protocol as compared to AODV and DSR protocols

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