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Evaluating the Performance of packet size and number of nodes on Reactive protocols (AODV – DSR) in mobile networks

Khaled Almarimi[1] , Ezzedin Muftah Enbiah [2], Moammer H.Daw[3]

[1]Department of Computer Science, Science College, Baniwaleed University, Libya

almaimekhaled@gmail.com

[2] Department of Computer Science & IT, College of Technical Science, Baniwaleed. Libya

enbiah@gmail.com

[3]Department of Computer Science & IT , College of Technical Science, Baniwaleed, Libya

Emammer71@gmail.com

Abstract: This research investigates the impact of packet size and number of nodes on the performance of two reactive routing protocols: Ad hoc On-demand Distance Vector (AODV) and Dynamic Source Routing (DSR) in Mobile Ad hoc Networks (MANETs). We evaluate these protocols in simulated MANETs of varying sizes using metrics like throughput, packet delay, and delivery ratio. The results indicate that AODV outperforms DSR in terms of packet delay for all network sizes, while DSR shows a higher throughput and packet delivery ratio. (This study utilizes the NS2 simulator for network simulations).

Keywords: Routing Protocols, DSR, AODV.

Introduction

Wireless communications and mobile computers have witnessed great growth in the past few decades, as a result of the widespread availability of the necessary equipment and their low cost. Many communication devices such as cell phones, laptops, and smartphones have the ability to connect wirelessly to the Internet to exchange data. The main goal of wireless communications technology is to eliminate the need for wired connections and achieve the possibility of communication anywhere and at any time. Moreover, establishing a network with a wired infrastructure entails a higher cost than a wireless network, which makes the latter a suitable option. There are many types of wireless networks currently available, including: Mobile Ad-hoc Network (MANET).

Mobile ad hoc networks (MANETs) are self-organizing networks without a fixed topology. In such a network, each node acts as a router and host at the same time, and all network nodes are equivalent to each other and can move out of or join the network freely. Mobile nodes within coverage range of each other can communicate directly and transmit the necessary information. All network nodes have a wireless interface to communicate with another node in range. This type of network is completely distributed and can operate anywhere without the help of any fixed infrastructure such as access points or base stations.

Since MANET networks do not rely on a fixed infrastructure and do not have a central administration, they are considered an independent system consisting of wireless nodes that move randomly and quickly and organize themselves. Therefore, the topology of the AD-HOC network is considered a dynamic network that changes quickly and in an uncontrolled manner. It is expected, which results in a constant change in communication between nodes. Therefore, any failure in communication between two nodes on a specific path leads to a complete failure of communication between the source and the target.

In this paper Conduct an analytical study of single-path routing protocols in the MANET ad-hoc network. Evaluating the performance of single-path routing protocols in MANET ad-hoc networks of different sizes using the NS2 simulator, according to a number of quality specifications: (throughput - packet delay rate - load resulting from routing packets).

Literature Review

Several studies have investigated the performance of reactive routing protocols (like AODV and DSR) in Mobile Ad hoc Networks (MANETs).

S. Zafar and K. Manzoor [2016] compared AODV, DSR, and DSDV using NS2 simulator, focusing on throughput, delay, and packet delivery ratio. They found DSR outperforms AODV and DSDV in large, highly mobile networks. However, their work doesn't explore the impact of packet size, which is a key focus of this research[12].

Vivek Soi et al. [2017] compared AODV and DSR using MATLAB, analyzing the effect of varying node numbers and speeds on performance. Their work highlights the importance of considering node density, which aligns with our investigation of node count[13].

While P. Sarao [2018] analyzes AODV, DSR, and DSDV, his study focuses on low mobility scenarios, which may not be directly applicable to our research that considers a wider range of mobility patterns[10].

N. Basil and E. Elsayed [2024] compared these protocols using OPNET, highlighting the advantage of on-demand routing (like AODV) in high mobility conditions. Their work using a constant bit rate traffic model complements our study's focus on packet size variations[9].

This research builds upon these existing studies by specifically investigating the impact of packet size and number of nodes on the performance of AODV and DSR in MANETs. We utilize the NS2 simulator to evaluate these protocols under varying network conditions.

Classification of routing protocols in MANET networks:

Routing protocols in MANET networks are divided into three main sections:

1- **Proactive Protocols:**

In which each node maintains a routing path for each node within the network, this is done through periodic updates, which means increased load and the absence of sleeping nodes. This type relies on traditional routing strategies previously used in wired networks. Here, routes are calculated in advance to all nodes, whether necessary or not. . An example is the DSDV (destination sequenced distance vector) protocol[14].

The advantage of this type of protocol is that it has little delay because the routing information is ready and available at the moment of transmission. But on the other hand, it is more consuming of network resources because it provides updated routing information even if the unexpected changes do not affect the transmitted data. The weakness of this mode is the large routing overhead, as well as the large consumption of storage space due to maintaining routing tables.

2. Reactive Protocols:

In it, the path is formed only when it is needed, which means less overhead than proactive protocols, in addition to saving the energy consumed in the nodes. An example of this type of protocol is (Ad-hoc on demand distance vector) AODV. And the DSR (Dynamic Source Routing) protocol.

3. Hybrid protocols.

These protocols combine both of the previous methods. Among the protocols that work within this type of routing is ZRP (zone routing protocols), in which the network is divided into regions. The proactive protocols method is used within a specific region, while the reactive protocols method is used for routing between different regions. This style Protocol suitable for large networks[3].

The following figure shows the routing protocols used in MANETs.

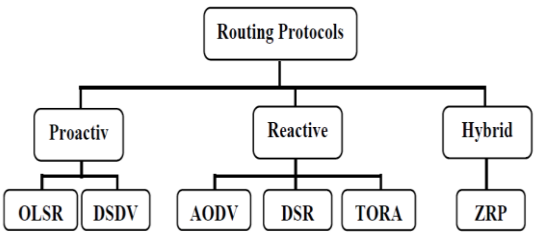


Figure 1. routing protocols in MANETs

Simulation using Simulator NS2:

NS2 stands for Network Simulator Version 2. It is an open-source event-driven simulator designed specifically for research in computer communication networks. The NS2 is a powerful and an important simulator in wireless networks and it has the following features:

1. It is a discrete event simulator for networking research.
2. It provides substantial support to simulate bunch of protocols like TCP, FTP, UDP, https and DSR.
3. It simulates wired and wireless network.
4. Object oriented support
5. Discrete event scheduler

Steps to conduct a simulation within NS2:

1. Achieve the protocol by adding a set of source codes written in TCL and AWK to NS2.
2. Description of the simulation in TCL Script.
3. Run the simulator.
4. Analysis of generated tracking files

performance Metrics:

In this study, we used three criteria to evaluate the performance of the AODV and DSR protocols .

1-Productivity standard (Throughput): It is the total data flow rate over a unit of time, measured in kilobits per second(kbps), and is the quotient of dividing the received bits by the simulation time, as shown in equation (1).

$$Throughput = \frac{\text{TotalBitsReceived}}{\text{Simulation Time}} \quad (1)$$

2-standard data packet delay rate (Average End-to-End Delay): It is the average time consumed by data packets to reach from the sending node to the receiving nodes, and this delay time includes all possible delays experienced by data packets, measured in seconds, and this criterion is important for delay-sensitive applications, as shown in equation (2).

$$Average\ End-to-End\ Delay = \frac{Total\ Time}{Total\ Data\ Packets\ Received} \quad (2)$$

Total Time: is the time required for all data packets to arrive from the source node to the target node .

Total Data Packets Received: is the number of data packets connected to the target nodes.

As the delay for data packets is due to the process of Route detection, retransmission, processing, storage in queues and propagation delays.

3- Packet Delivery Ratio: Represents the percentage of the number of received data packets over the number of transmitted data packets , this parameter is calculated by the following equation (3):

$$PDR = \frac{Received\ Pakets}{Send\ Packets} \times 100 \quad (3)$$

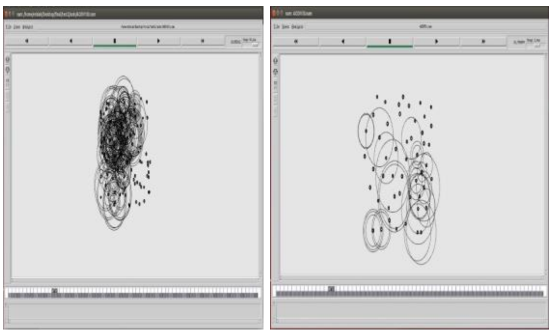
Received Packets: number of received data packets.

Sent Packets: number of data packets sent.

This is an important criterion because it tells how reliable the routing protocol is .

Results and Discussions

In the simulation model, seven networks of different sizes (25 nodes, 50 nodes, 75 nodes, 100 nodes, 125 nodes and 150 nodes) are tested using two data packet sizes, namely (1500 and 3000) and the data was generated in each network by both protocols AODC and DSR.



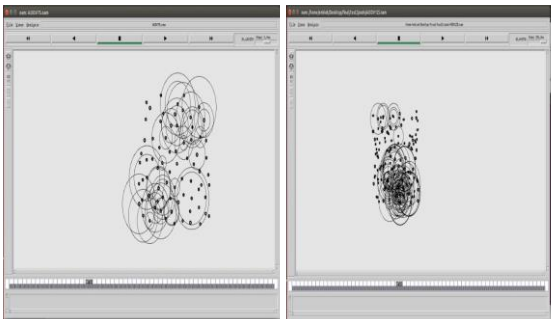


Figure 2. Simulation Screenshots

Table (1): Simulation results of the AODV protocol

			AODV					
	25	50	75	100	125	150	Packet Size_ 1500	
Start Time	10	10	10	10	10	10	Agents	5
Stop Time	85	90	93	90	92	90		
Received	1312	1652	2538	1500	1083	4388		
Average throughput kbps	0.1398 22	0.16431 5	0.2420 71	0.1499 47	0.1048 72	0.4379 27		
Average End-to-End Delay	323.99 8	341.935	419.07 8	296.64 8	298.58 8	244.13		
sent packets	1614	2088	2713	1748	1309	4609		
received packets	1312	1652	2538	1500	1083	4388		
forwarded packets	7054	6081	7910	7258	7679	8856		
Packet Delivery Ratio	0.8128 87	0.79118 8	0.9354 96	0.8581 24	0.8273 49	0.9520 5		
Start Time	10	10	10	10	10	10	PacketS ize 3000	
Stop Time	87	90	97	90	96	92		
Received	787	854	1432	700	509	2312	Agents	5
Average throughput kbps	0.0811 81	0.08478 9	0.1302 97	0.0695	0.0468 44	0.2246 77		
Average End-to-End Delay	366.72 9	440.315	612.36 7	344.32 5	417.28 4	421.01 5		
sent packets	999	1128	1545	878	635	2513		
received packets	787	854	1432	700	509	2312		
forwarded packets	4048	3416	5009	3756	4063	4519		
Packet Delivery Ratio is	0.7877 88	0.75709 2	0.9268 61	0.7972 67	0.8015 75	0.9200 16		

Table(2): Simulation results of the DSR protocol

	DSR							
	25	50	75	100	125	150	packet Size_ 1500	
Start Time	10	10	10	10	10	10	Agents	5
Stop Time	85	90	90	90	90	90		
Received	1648	2192	2682	1626	1414	4144		
Average throughput kbps	0.17496 9	0.21839 5	0.267322	0.161984	0.141106	0.410169		
Average End-to-End Delay	1256.06	837.761	791.95	1174.25	1046.36	567.695		
sent packets	1689	2219	2709	1649	1457	4196		
received packets	1648	2192	2682	1626	1414	4144		
forwarded packets	11987	13618	14540	13984	16596	17774		
Packet Delivery Ratio is	0.97572 5	0.98783 2	0.990033	0.986052	0.970487	0.987607		
Start Time	10	10	10	10	10	10	PacketSize_ 3000	
Stop Time	85	92	90	91	90	91		
Received	916	1316	1396	920	705	2069	Agents	5
Average throughput kbps	0.09714 4	0.12808 5	0.139296	0.090357	0.069904	0.203952		
Average End-to-End Delay	2067.94	1438.85	947.969	1404.95	1610.09	797.756		
sent packets	958	1396	1425	953	737	2112		
received packets	916	1316	1396	920	705	2069		
forwarded packets	8813	9820	9361	11181	14346	16962		
Packet Delivery Ratio	0.95615 9	0.94269 3	0.979649	0.965373	0.956581	0.97964		

we compared the performance criteria of both considered protocols AODV and DSR as shown in Table (1) and table (2).

Throughput:

Table (3) productivity of the two studied protocols

nodes# / Protocol	25	50	75	100	125	150
AODV	0.139822	0.164315	0.242071	0.149947	0.104872	0.437927
DSR	0.174969	0.218395	0.267322	0.161984	0.141106	0.410169

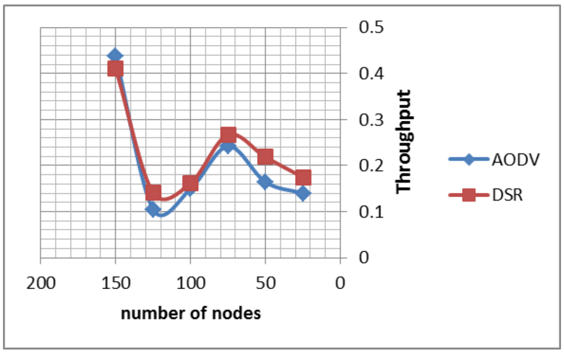


Figure (3) comparison of the two considered protocols

Considering data shown in Table No. (3) and the scheme shown in Figure (3), we concluded the following result: the productivity in the DSR protocol is better than the AODV protocol in small networks, and the larger the network size, the productivity in the DSR decreases until the result became better in the AODV when the number of nodes became 150 nodes. Therefore, the DSR protocol is not suitable in large networks in terms of productivity, but it is better in small networks.

Average End-to-End Delay :

Table (4) data packet delay rate for the both protocols

Nodes # / Protocol	25	50	75	100	125	150
AODV	323.998	341.935	419.078	296.648	298.588	244.13
DSR	1256.06	837.761	791.95	1174.25	1046.36	567.695

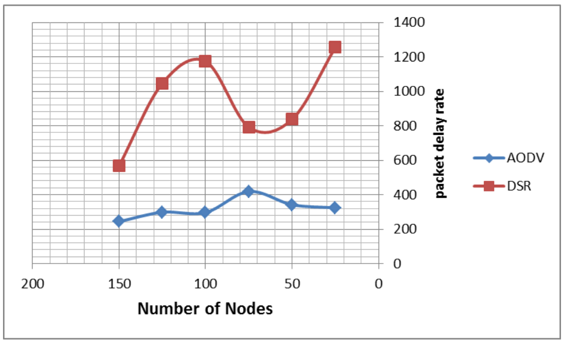


Figure (4) data packet delay rate diagram for the two considered protocols

Based on Table (4) and the scheme shown in Figure(4), we can say that: the AODV protocol is better than the DSR protocol in terms of the delay rate in the arrival of data packets in all sizes of the studied networks.

Packet Delivery Ratio

Table (5) percentage of data packet delivery by the both protocols

# Node / Protocol	25	50	75	100	125	150
AODV	0.812887	0.791188	0.935496	0.858124	0.827349	0.95205
DSR	0.975725	0.987832	0.990033	0.986052	0.970487	0.987607

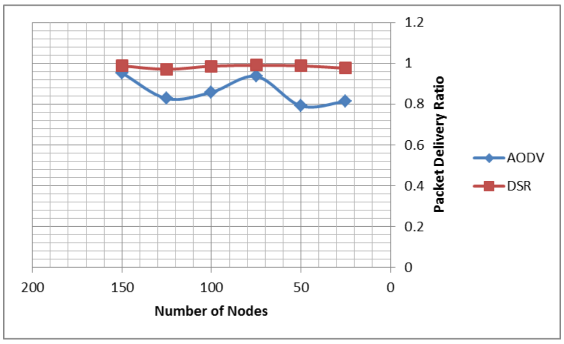


Figure (5) data packet delivery ratio for both protocols

This results shows that the DSR protocol performance is better than the AODV protocol in the percentage of data packet delivery, but the AODV protocol is close to DSR performance as number of nodes increases, AODV performance increases as number of node increases while performance of DSR decreases.

We performed the same similar experiments, using 3000-bit packets, and we got the following results:

Throughput:

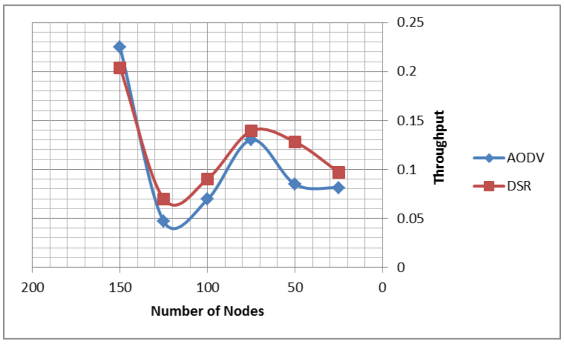


Figure (6) throughput values of both protocols with a packet size of 3000 bits

Average End-to-End Delay

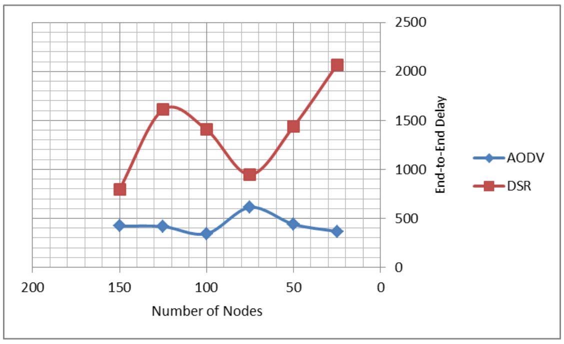


Figure (7) data packet delay rate for both protocols with a packet size of 3000 bits

Packet Delivery Ratio

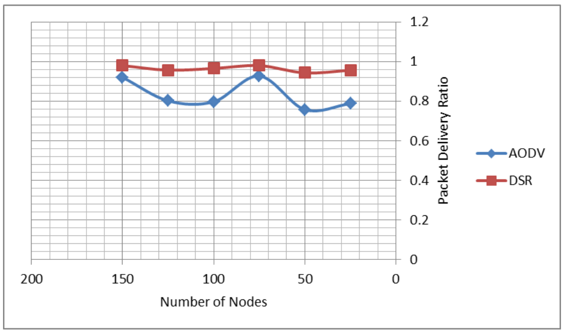


Figure (8) The packet delivery ratio of both protocols with a packet size of 3000 bits

We can conclude that the results of the comparison between the 1500-bit and 3000-bit packet sizes are similar in terms of the difference in performance to the studied standards, the difference in both was that by increasing the packet size, productivity decreases, delay increases and the percentage of data packet delivery decreases.

Conclusion

This research investigated the impact of packet size and number of nodes on the performance of AODV and DSR protocols in MANETs. Our results using the NS2 simulator indicate that AODV outperforms DSR in terms of packet delay for all network sizes. However, DSR exhibits a higher throughput and packet delivery ratio, especially in larger networks. These findings suggest that the optimal protocol choice depends on network characteristics and application requirements. For delay-sensitive applications in small to medium MANETs, AODV may be preferable due to its lower packet delay. Conversely, for large networks prioritizing throughput and packet delivery, DSR might be a better fit.

Limitations of this study include the use of a specific mobility model and a fixed traffic pattern. Future research could explore the impact of different mobility models and traffic patterns on the performance of these protocols. Additionally, investigating hybrid approaches that combine the strengths of AODV and DSR could be a promising direction for further study.

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