A Comparative Analysis of Proactive and Reactive Routing Protocols in Mobile AdHoc Networks

Anonnymous
Faculty of Science & Technology
Bournemouth University
Poole, Dorset
Anonnymous@bournemouth.ac.uk

***Abstract*— A comparative analysis of MANETs and proactive and reactive routing protocols supported by own quantitative evaluation using simulators.**

Keywords*— A Mobile Adhoc Networks (MANET), A. Destination Sequenced Distance Vector Routing Protocol (DSDV), Global State Routing (GSR), Dynamic Source Routing protocol (DSR), Ad-Hoc On Demand Vector Routing protocol (AODV):

I. Introduction

A. MANET Routing Protocol

A MANET is an interesting network style that consists of several mobile networking nodes connected wirelessly in a way that the network is self-configured and self-healing without having a fixed infrastructure. The nodes in a MANET are free to move randomly as the network topology is dynamic in the way it changes. Each mobile node behaves as a router that forwards traffic to other nodes in the MANET [1].

As previously mentioned, a MANET is dynamic and is always changing so the nodes do not actually know the topology of their network but instead must discover for themselves. We will be looking into two of three of MANET's routing protocols: Proactive and Reactive [1].

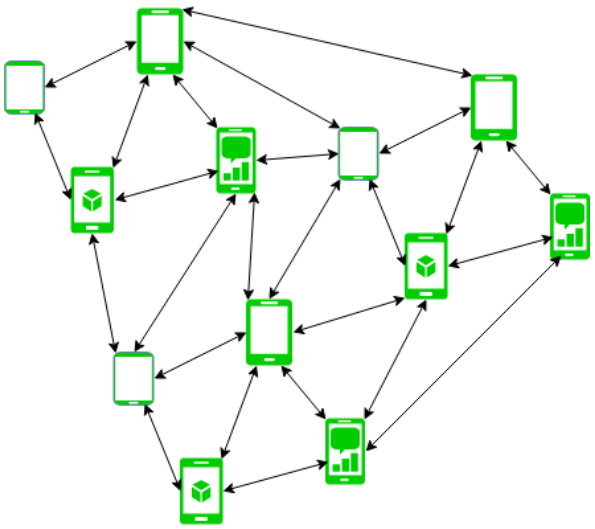


Fig. 1. Mobile ad-hoc Network [1].

B. Research Objectives

The research we are undertaking here aims to evaluate both approaches when it comes to a mobile adhoc network; proactive and reactive and execute several simulations where we can simulate real life scenarios and record the overall performance of the DSDV protocol from a proactive approach and the AODV protocol from reactive.

II. MANET Challenges

Due to the nature of this network and how mobile ad-hoc networks have no base station support and how their nodes communicate wirelessly with each other produces several challenges to a network like this. The wireless hosts are mainly battery operated which introduces a bounded lifetime when there are deployed in a network and will eventually need replacing or servicing [3]. This also introduces challenges when it comes to the reliability, efficiency, and stability of these nodes. Another challenge involved in this network is energy usage as nodes in an ad-hoc network would have less memory than nodes in a wired network due to the wireless aspect. MANET's security is also limited as the nodes are more prone to security threats due to the lack of any physical protection or any firewall in place [1].

Because of these challenges it has become necessary to transfer data between these nodes with minimal delay to lossless power by using compression, it's also important to implement a solution for the previously mentioned security threat by using encryption [4].

III. Proactive

Proactive otherwise known as table-driven routing protocol is where each mobile node in the MANET maintains a separate routing table which stores all information needed to know every route possible to every other mobile node acting as the destination. The disadvantage to a routing protocol such as this is that it becomes tricky working in larger MANET networks considering that the more mobile nodes in the network the bigger the routing table must become to store all possible routes [1].

A. DSDV

The first protocol is the DSDV which is based on the Bellmanford routing algorithm that attempts to solve the issue of having a routing table that is too large. A destination sequence number will be added in addition to every node's routing table and every routing entry and will act as a threshold for any new updates to any routing tables that will only update the routing table for a mobile node if the updated entry features a higher destination sequence number. Eliminating the need for constant updating when not needed [1].

B. GSR

This protocol is based on the Dijkstra's routing algorithm that was not suitable for mobile ad-hoc network as the flooding of link state touting information may slow down the network. GSR solves the issue as each mobile node maintains one list and three tables: adjacency list, topology table, next hop table and distance table meaning that the global state routing information doesn't need to be flooded globally to every node [1].

IV. Reactive

This type of routing protocol is also known as on-demand which each mobile node discovers the route only when they're required or needing to.

A. DSR

DSR as previously mentioned is the routing protocol that allows mobile nodes to only know what route they must take when they need to know which is done by flooding the route request packets throughout the MANET. DSR consists of two phases:

a) Route Discovery:

The requests packets are flooded through the entire MANET and the most optimal path for a node's transmission of data is determined between the source and the destination.

a) Route Maintenance:

This is where the MANET's self-healing feature comes in and the DSR attempts to maintain the ad-hoc network but due to the dynamic nature of a MANET it is common for link breakage resulting in network failure.

B. AODV

AODV is based on DSR and attempts to remove and solve the disadvantage previously mentioned. Route discovery in the network still takes place and it is important to node that each packet head contains the complete path and destination which increases the size overall slowing down a network. AODV solves this by storing the path in the node's routing table whereas DSR stores it in the data packet's header.

V. Comparison and Critical assessment

Each networking routing protocol contains advantages and disadvantages and reasons why and why not use a specific routing protocol. With the proactive approach and each sensor node containing all needed information eliminates the need to flood the network that happens in the reactive approach, yet it means that in theory a reactive MANET can be larger in size due to only sending routing information when needed rather than storing all the information already on a very large number of mobile nodes.

DSDV attempts to solve this problem by knowing when to and when not to update routing information. Having each sensor contain all possible routes is a direct advantage when compared to reactive needed a route maintenance phase eliminating any potential link breakage.

Reactive's approach of AODV solves the issue above meaning some maybe more inclined to use AODV rather than DSDV if they were to need a larger network than what Proactive and DSDV could handle.

VI. Simulation

To begin simulating two different protocols from either approach we first needed to set up an appropriate environment. We downloaded and configured a guess Operating System for Xubuntu-ContikiNG-NS3 which is where we were running our tests. We were using ns-allinone-3.29 and running manet-routing-compare.cc with twice with separate protocols to simulate AODV and DSDV. To provide additional information, I implemented additional modules that show us information such as the energy consumed, total number of packets sent and received as well as ratios for packet loss and delivery with an average throughout. Below we performed several simulations with a variety of changed variables to provide
a detailed and in-depth analysis of both protocols.

Our first simulation, shown in figure 2, we have used the same variables for both protocols; 50 nodes, 10 sinks, 2Kbps, a node speed of 20m/s and a total simulation time of 200 seconds and we can see from the figure of the plotted data as well as the additional information included below that AODV performed much better in this simulation.

AODV ended this simulation with 22,041 packets sent, 18,540 received with 3,501 packets being lost giving us a 15% packet lost and an 84% packet delivery ratio consuming a total of 0.873772J energy consumed. Whereas DSDV ended this simulation with 3,975 packets being sent, 1,354 packets received with the loss of 2,261 packets giving us a 65% packet loss ratio and a 34% packet delivery ration consuming 0.897981J.

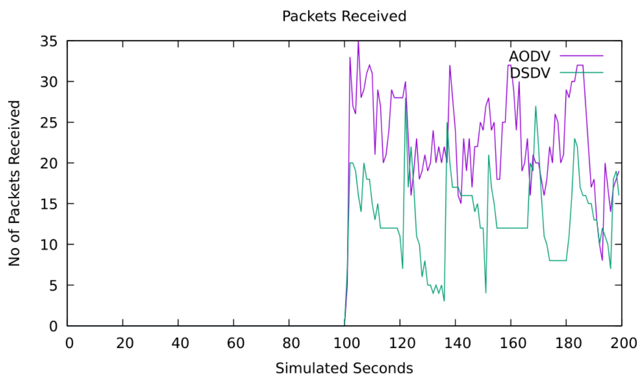


Fig. 2. Same Variables Test.

Our second simulation shows us testing the same variables as before but with one key different; we have changed how many sinks there are for each protocol; AODV has 15 and DSDV has 20 which is shown in figure 3. As you can see from the results of the simulation both protocols have performed similar compared to our first test but from what it appears AODV still appears to be more efficient with less drops in the number of packets received, however there is a high point around 150 seconds of the simulation where DSDV receive the most packets.

In this simulation AODV sent a total of 25,924 packets with 21,954 of them being received meaning 3,972 packets were lost giving it a 15% packet loss ratio and a 84% delivery ratio consuming 0.873772J whereas DSDV sent 7,951 packets and 3,525 of them were delivered and 4,426 of them being lost giving us a 55% loss ratio and a 44% delivery ratio overall, consuming 0.897981J.

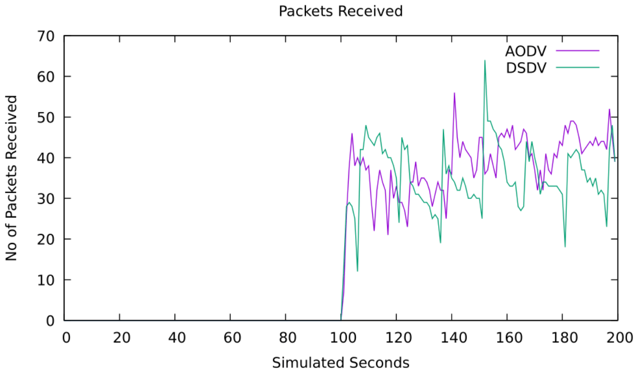


Fig. 3. Different Number of Sinks Test.

To follow up on that statement and hypothesis, our third simulation has the same variables again and like our second simulation we have given AODV 10 sinks whereas we have given DSDV double the sinks at 20. I Previously mentioned that both protocols perform similar in figure 3 with only a 5-sink difference, we are hoping that in doubling the sinks will show DSDV performing better than AODV. Figure 4 are the results from this simulation where we can clearly see that the DSDV protocol has perform significantly better than the AODV protocol thus showing us that for proactive protocols to perform better than reactive protocols or just in this case, more sinks are needed.

We see AODV in this test send a total of 22,041 packets with 18,540 of them being received and 3,501 of them being lost giving us a 15% loss ratio and a 84% delivery ratio consuming 0.873772J. Whereas DSDV sent 7,951 packets with 3,525 of them being received and 4,426 of them being lost giving this protocol a 55% loss ratio and 44% delivery ratio 0.897981J.

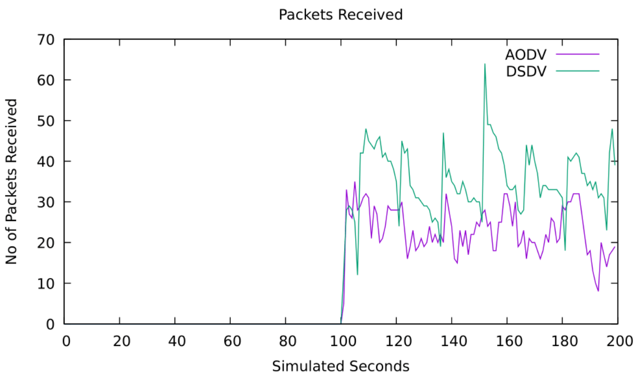
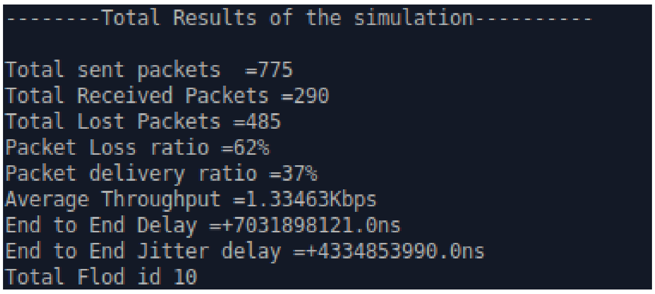


Fig. 4. Further Analysis of Different Number of Sinks Test.

We also wanted to explore what would happen if we were to change other variables rather than just the number of sinks for each protocol. Figure 5 shows our fourth simulation where we have the same variables as those that we ran before but this time we increased the amount of nodes from 50 to 70.

From this test we expect to see less performance from both protocols with an increase amount of nodes as this will increase the amount of stress on both protocols. We can see from figure 5 that both protocols are performing less than when they were sending data to less nodes. From what we can see DSDV received the most packets at 35 whereas last time they were receiving 60 packets. We can also see that the DSDV protocol dropped a lot roughly every 10 seconds.

In this simulation AODV sent 39,653 packets with 32,513 of them being received and 7,140 of them being loss meaning AODV had a overall 18% packet loss ratio and a 81% delivery ratio consuming 0.874314J. Whereas DSDV in this simulation sent 775 packets with 290 of them being received and 485 of them being lost giving us a 62% loss ratio and 37% delivery ratio and consuming 0.897981J.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--------Total Results of the simulation----------

Total sent packets  =775
Total Received Packets =290
Total Lost Packets =485
Packet Loss ratio =62%
Packet delivery ratio =37%
Average Throughput =1.33463Kbps
End to End Delay =+7031898121.0ns
End to End Jitter delay =+4334853990.0ns
Total Flod id 10
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Fig. 5. Simulation Results.

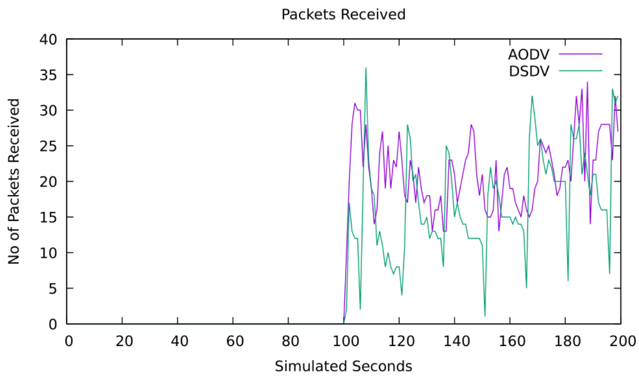

Fig. 6. 70 Node Simulation.

VII. CONCLUSION

We have successfully carried out several simulations all with changes to network factors such as node count, sink count and speed and have successfully recorded key metrics such as the energy consumed, the packets received and lost. It was clear that both approaches and their corresponding protocols performed differently with each having advantages and disadvantages; AODV performed better with less sinks whereas DSDV needed more sinks for packets to be received as seen in figure 4. It will be difficult to recommend what approach to implement as it will be use case specific. However, AODV performed better overall by consuming less energy due to not needing to maintain routing information and sending more packets that was delivered.

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