Performance Analysis of Manet Routing Protocols - DSDV, DSR, AODV, AOMDV using NS-2

By G. Shankara Rao, E. Jagadeeswararao, U. Jyothsna Priyanka & T. Indira Priya Darsini
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In this paper we are presenting functionality, benefits, limitations and simulation results for the above mentioned routing protocols.

Keywords: Ad Hoc, MANET, DSDV, DSR, AODV, AOMDV, QoS, NS2.

GJCST-E Classification : C.2.2
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G. Shankara Rao α, E. Jagadeeswarrao β, U. Jyothsna Priyanka γ & T. Indira Priya Darsini δ

Abstract - A Mobile Ad hoc Network (MANET) eliminates the complexity of an infrastructure configuration and allows wireless devices to communicate with each other independent of central infrastructure. It does not rely on a base station to coordinate the flow of messages to nodes in the network. A primary challenge for each device is to maintain the information to route traffic and data packets.

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1. Introduction

There exist three types of mobile wireless networks: infrastructure networks, ad-hoc networks and hybrid networks which combine infrastructure and ad-hoc aspects.

An infrastructure network (Figure 1.1(a)) consists of wireless mobile nodes and one or more bridges, which connect the wireless network to the wired network. These bridges are called base stations. A mobile node within the network searches for the nearest base station (e.g. the one with the best signal strength), connects to it and communicates with it. The reality is all communication is taking place between the wireless node and the base station but not between different wireless nodes.

In contrary to this infrastructure networks, an ad-hoc network (Figure 1.1(b)) lacks any infrastructure. Ad-hoc is a Latin word, which means "for this or for this only." There are no base stations, no fixed routers and no centralized administration.

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Figure 1.1 : (a) An Infrastructure network

1.1 (b) A Mobile Ad-hoc network

A Mobile ad hoc network (MANET) is a group of wireless mobile computers (or nodes); in which nodes collaborate by forwarding packets for each other to allow them to communicate outside range of direct wireless transmission. Ad hoc networks require no centralized administration or fixed network infrastructure such as base stations or access points, and can be quickly and inexpensively set up as needed.

Easy and fast deployment of wireless networks will be expected by the future generation wireless systems. This fast network deployment is not possible with the existing structure of present wireless systems. The recent advancements such as Bluetooth introduced a fresh type of wireless systems which is known as mobile ad-hoc networks. Mobile ad-hoc networks or
"short live" networks control in the nonexistence of permanent infrastructure.

MANET is a kind of wireless ad-hoc network and it is a self-configuring network of mobile routers (and associated hosts) connected by wireless links – the union of which forms an arbitrary topology. The routers, the participating nodes act as router, are free to move randomly and manage themselves randomly; thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet.

Mobile ad hoc network is a collection of independent mobile nodes that can communicate to each other via radio waves. The mobile nodes can directly communicate to those nodes that are in radio range of each other, whereas others nodes need the help of intermediate nodes to route their packets. These networks are fully distributed, and can work at any place without the aid of any kind of infrastructure. This property makes these networks highly robust. In (Figure 1.2) nodes 1 and 3 must discover the route through 2 in order to communicate. The circles indicate the formal range of each node’s radio transceiver. Nodes 1 and 3 are not in direct transmission range of each other, since 1’s circle does not cover 3.

II. Existing System

The MANET routing protocols DSDV (Cluster Based Routing Protocol) and DSR, AODV (Ad-Hoc On-demand Distance Vector) of Proactive and Reactive will be described theoretically in all the books, but we don’t know the practical scenario how they work. To know their behavior practically we have to simulate the protocols with certain parameters. From the existing system we have proposed a system to simulate the results and know the behavior of the protocols DSDV, DSR, AODV, AOMDV and make comparative analysis between them using the Network Simulator -2 (NS version 2).

III. Proposed System

The objective of this work is to evaluate the routing protocols namely DSDV, DSR, AODV, AOMDV based on their behavior. This evaluation is to be carried out through exhaustive literature review and simulation

IV. Classification of Routing Protocols

“Routing is the process of information exchange from one host to the other host in a network.” Routing is the mechanism of forwarding packet towards its destination using most efficient path. Routing protocols are classified as in fig 2.

<table>
<thead>
<tr>
<th>Types of Routing Protocols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proactive (table driven)</td>
</tr>
<tr>
<td>Reactive (on-demand)</td>
</tr>
<tr>
<td>DSDV OLSR DSR AODV TORA AOMDV</td>
</tr>
</tbody>
</table>

Figure 2 : Routing protocols classification

a) DSDV, DSR, AODV, AOMDV PROTOCOLS DESCRIPTION

i. DSDV Description

DSDV is an improved routing protocol of the distributed Bellman-Ford routing algorithm. In this protocol, a table consisting of the shortest distance and the starting node of the shortest path is maintained at every node. Table updates are done with the increasing sequence number provided so as to,

i. Prevent loops

ii. Provide a faster convergence

iii. Avoid the count-to-infinity problem.

Every node in the table-driven routing protocol has route to destination. The routing table is exchanged periodically between the neighboring nodes, so that an up-to-date view of the topology is maintained. If a node sees a change in the network topology, then also the...
The table is forwarded to its neighbor. The table updates are classified into two types.

1. Incremental Updates
2. Full Dumps

DSDV solve the problem of routing loops and count to infinity by associating each route entry with a sequence number indicating its freshness. The DSDV routing table contains the following:

1. All available destinations IP addresses.
2. Next hop IP address.
3. Number of hops to reach the destination.
4. Sequence number assigned by the destination node.
5. Install time.

Fig.3 & Fig.4 shows the Example of DSDV Operation. Fig.4 shows DSDV ‘message Header’ format. And Fig.5 shows the flowchart of DSDV operation.

![Figure 3: Node 1 transmits packet to node 4, forwarding](image)

![Figure 4: Node 4 retransmits packet to the next hop](image)

Advantages

a. Delays are smaller because the routing availability is always provided to all the destinations.
b. Because of the incremental updates in the routing table, the existing wired network Protocols are adaptive to the ad hoc wireless network.
c. All the nodes maintain an up-to-date view of the topology.

Disadvantages

a. The table updates due to broken links causes heavy control overhead during the high mobility.
b. The available bandwidth gets congested even if a small network contains high mobility or a large network contains low mobility. Thus, a large control overhead exists which increases with the number of nodes in the topology. Also, this protocol does not have the scalability factor in the ad hoc wireless networks which contain a high dynamic network topology and a limited bandwidth.
c. Some delay occurs in obtaining the information regarding a specific destination node.

V. **DSR Description**

DSR is an on-demand routing protocol. In ad hoc wireless networks, bandwidth is drained by control packets. Hence, regular table-update messages used in the previous table-driven routing protocols are removed, thereby controlling the bandwidth consumption. DSR is different from the on-demand routing protocols as it does not transmit the frequent beacon/hello packet (to identify its presence) to its neighbors.

During the construction phase of routing, the key feature of DSR is that, a route should be created
with the help of flooding Route Request packets in the topology. A Route Request packet is sent by source to destination, which in turn sends a Route Reply packet back to the source. Here Source node creates a sequence number and traversing path which are sent along with every Route Request packet. The sequence number present on the Route Request packets helps in the prevention of the following.

i. Routing loop formations
ii. Retransmissions of the similar Route Request Packet which is done by an intermediate node through various routing paths.

**Optimizations**

The Basic DSR protocol consists of various optimization methods, in order to enhance the performance of the protocol. The Route Cache is used by the DSR protocol at the intermediate nodes. It contains the information about the routes which are retrieved from the information present in data packets that are to be transmitted. If a Route Request packet is received and a route to the respective destination is obtained, then the intermediate nodes use the information related to the route cache, so as to reply to the source node.

**Advantages**

a. A reactive approach is used in DSR protocol, So that frequent flooding in the network along With the table update message can be eliminated.

b. DSR does not need a path-finding approach, because the routes are established based upon the requirement.

c. The information related to the route cache is used by the intermediate nodes in an efficient way, there by consuming the control overhead.

**Disadvantages**

a. If a broken link is seen then it is not repaired, instead the route discovery process is initiated by the source node.

b. During the reconstruction phase or routing, the state route cache information may lead to inconstancy in the route paths.

c. The connection setup delay is more when compared to the table-driven routing protocols.

d. With an increase in the mobility of nodes, the performance of the protocol decreases.

e. DSR uses a source-routing mechanism and because of which a large routing overhead is required. This overhead entirely depends upon the length of the path.

**Mechanisms**

i. Route Discovery

ii. Route Maintenance
b) Route Maintenance

Route Maintenance is used to handle route break/failures.

Fig. 14. Shows the flowchart of DSR operation

Data(S,G,H,D)

Figure 10: Data packet Delivery to the destination

VI. AODV Description

AODV is based on on-demand routing approach for locating routes. Whenever, a source node needs a path for forwarding data packets, and then only a route is established. The packet consists of the sequence numbers of the destination node so as to identify the most recent path. The difference between AODV & DSR routing protocols is that the latter employs source routing wherein the data packets itself maintains the entire path from source to destination, whereas in the former the source node source node and all the intermediate nodes maintain the information about the next hop taken for transmitting data packets. When no route is established for reaching the destination, then source node broadcasts the Route Request packet throughout the network.

AODV differs from the other on-demand routing protocols, because the data packets in AODV use the destination sequence numbers in order to identify up-to-date path for reaching destination. Every Route Request packet consists of the following information.

i. Source identifier
ii. Destination identifier
iii. Source Sequence number
iv. Destination Sequence number
v. Broadcast identifier
vi. Time to Live

Advantages

a. Routes are established on demand basis.
b. The recent path towards the destination is identified using the destination sequence number.
c. The delay time for establishing connection is very less.

Disadvantages

a. Incorrect routes are identified by the intermediate nodes when the destination sequence number of intermediate node is higher than the sequence number of the source node.
b. If multiple Route Reply packets are generated as a reply to a single Route Request packet, then a greater control overhead may occur.
c. High amount of bandwidth is consumed because of the periodic beaconing.

Figure 14: DSR Flowchart
VII. AOMDV DESCRIPTION

Ad hoc On-demand Multipath Distance Vector Routing (AOMDV) shares several characteristics with AODV. It is based on the distance vector concept and uses hop-by-hop routing approach. Moreover, AOMDV also finds routes on demand using a route discovery procedure. The main difference lies in the number of routes found in each route discovery. In AOMDV, RREQ propagation from the source towards the destination establishes multiple reverse paths both at intermediate nodes as well as the destination. Multiple RREPs traverse these reverse paths back to form multiple forward paths to the destination at the source and intermediate nodes. Note that AOMDV also provides intermediate nodes with alternate paths as they are found to be useful in reducing route discovery frequency. The core of the AOMDV protocol lies in ensuring that multiple paths discovered are loop-free and disjoint, and in efficiently finding such paths using a flood-based route discovery. AOMDV route update rules, applied locally at each node, play a key role in maintaining loop freedom and disjointness properties. Here we discuss the main ideas to achieve these two desired properties. Next subsection deals with incorporating those ideas into the AOMDV protocol including detailed description of route update rules used at each node and the multipath route discovery procedure. AOMDV relies as much as possible on the routing information already available in the underlying AODV protocol, thereby limiting the overhead incurred in discovering multiple paths. In particular, it does not employ any special control packets. In fact, extra RREPs and RERRs for multipath discovery and maintenance along with a few extra fields in routing control packets (i.e., RREQs, RREPs, and RERRs) constitute the only additional overhead in AOMDV relative to AODV.

AOMDV Mechanisms

i. Route Discovery
ii. Route Maintenance

Advantages

- AOMDV is Loop free because loops are overcome by using sequence number.
- Reduce Route discovery time and limit the control messages in Route discover.

Disadvantages

- AOMDV has more message overheads during route discovery due to increased flooding and since it is a multipath routing protocol, the destination replies to the multiple RREQs those results are in longer overhead.
- Congestion may occur due more RREQ and RREP messages.

VIII. Performance Metrics USED

The main goal of this paper is to compare the performance of the above four protocols under different scenario. Comparing the different methods is done by simulating them and examining their behavior. In comparing the four protocols, the evaluation could be done by using the following simulation metrics.

1) Throughput is the average rate of successful message delivery over a communication channel. The system throughput or aggregate throughput is the sum of the data rates that are delivered to all terminals in a network.

\[
\text{Throughput} = \frac{\text{total no. of bytes received}}{\text{Simulation time}} \times \frac{8}{1000} \text{ Kbps}
\]
2) Packet loss or delivery is defined as the number of packets sent and number of packets lost while transmitting in a network.

\[
\text{Packet loss} = \text{total no. of packets sent} - \text{Total no. of packets received}
\]

3) Overhead is defined as the excess traffic generated while transmitting the packet over a network. This leads to dropping of packets before reaching the destination.

\[
\text{Overhead} = \frac{\text{total no. of routing packets Sent}}{\text{total no. of data packets Received}}
\]

4) Delay is defined as the overall time taken from the moment the data.

\[
\text{Delay} = \text{end time} - \text{start time}
\]

5) Packet loss is the number of packets lost while transmitting in a network.

\[
\text{Packet loss} = \text{total no of packets sent} - \text{Total no of packets received}
\]

**IX. SIMULATION ENVIRONMENT**

**Table 1**: Simulation Environment (parameters)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulator</td>
<td>NS-2 (Version 2.35)</td>
</tr>
<tr>
<td>Channel type</td>
<td>Channel/Wireless channel</td>
</tr>
<tr>
<td>Radio-propagation model</td>
<td>Propagation/Two ray round wave</td>
</tr>
<tr>
<td>Network interface type</td>
<td>Phy/WirelessPhy</td>
</tr>
<tr>
<td>MAC Type</td>
<td>Mac/802.11</td>
</tr>
<tr>
<td>Interface queue Type</td>
<td>Queue/Drop Tail or CMUPriQueue</td>
</tr>
<tr>
<td>Link Layer Type</td>
<td>LL</td>
</tr>
<tr>
<td>Antenna</td>
<td>Antenna/Omni Antenna</td>
</tr>
<tr>
<td>Maximum packet in ifq</td>
<td>50</td>
</tr>
<tr>
<td>Area (M*M)</td>
<td>900 * 900</td>
</tr>
<tr>
<td>Number of mobile node</td>
<td>20, 30, 40, 50 nodes</td>
</tr>
<tr>
<td>Source Type</td>
<td>UDP, TCP</td>
</tr>
<tr>
<td>Simulation Time</td>
<td>200 sec</td>
</tr>
<tr>
<td>Routing Protocols used</td>
<td>DSDV, DSR, AODV, AOMDV</td>
</tr>
</tbody>
</table>

**a) Simulation Setup**

**STEPS for simulation:**

**Step 1: Tcl Script file**

```tcl
# Parameter Initialization
set val(chan) Channel/WirelessChannel
set val(prop) Propagation/Shadowing
set val(nettf) Phy/WirelessPhy
set val(mac) Mac/802_11
set val(tfq) CMUPriQueue OR Queue/DropTail
set val(ll) Antenna/OmniAntenna
set val(x) 450
set val(y) 450
set val(tfqlen) 100
set val(nn) 30
set val(stop) 600.0
set val(ro) DSR OR AODV OR DSDV

# Physical Layer
# Shadowing propagation model
Propagation/Shadowing set pathlossExp_3.0
Propagation/Shadowing set std Db_6.0
Propagation/Shadowing set dlst_1.0
Propagation/Shadowing set seed_0
```

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Step 2: Now extract the data from resultant trace file using awk scripts

Step 3: Record the values & run the x-graphs.

The obtained values for each protocol & the results are given below:

a) Simulation Results

i. AOMDV Results

<table>
<thead>
<tr>
<th></th>
<th>20 nodes</th>
<th>30 nodes</th>
<th>50 nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery Ratio</td>
<td>99.51</td>
<td>99.60</td>
<td>97.90</td>
</tr>
<tr>
<td>Throughput</td>
<td>271.33</td>
<td>282.64</td>
<td>111.75</td>
</tr>
<tr>
<td>Overhead</td>
<td>38.38</td>
<td>44.82</td>
<td>103.7</td>
</tr>
<tr>
<td>Delay</td>
<td>112.92</td>
<td>44.85</td>
<td>124.10</td>
</tr>
<tr>
<td>Packet loss</td>
<td>165</td>
<td>144</td>
<td>379</td>
</tr>
</tbody>
</table>

ii. AODV Results

<table>
<thead>
<tr>
<th></th>
<th>20 nodes</th>
<th>30 nodes</th>
<th>50 nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery Ratio</td>
<td>99.167</td>
<td>99.396</td>
<td>96.357</td>
</tr>
<tr>
<td>Throughput</td>
<td>279.66</td>
<td>293.98</td>
<td>75.55</td>
</tr>
<tr>
<td>Overhead</td>
<td>5.723</td>
<td>8.84</td>
<td>38.74</td>
</tr>
<tr>
<td>Delay</td>
<td>102.302</td>
<td>57.032</td>
<td>82.354</td>
</tr>
<tr>
<td>Packet loss</td>
<td>308</td>
<td>244</td>
<td>801</td>
</tr>
</tbody>
</table>

iii. DSR Results

<table>
<thead>
<tr>
<th></th>
<th>20 nodes</th>
<th>30 nodes</th>
<th>50 nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery Ratio</td>
<td>97.08</td>
<td>97.71</td>
<td>76.10</td>
</tr>
<tr>
<td>Throughput</td>
<td>239.66</td>
<td>266.27</td>
<td>135.54</td>
</tr>
<tr>
<td>Overhead</td>
<td>1.476</td>
<td>13.01</td>
<td>20.52</td>
</tr>
<tr>
<td>Delay</td>
<td>129.515</td>
<td>55.782</td>
<td>255.57</td>
</tr>
<tr>
<td>Packet loss</td>
<td>265</td>
<td>11</td>
<td>44</td>
</tr>
</tbody>
</table>

iv. DSDV Results

<table>
<thead>
<tr>
<th></th>
<th>20 nodes</th>
<th>30 nodes</th>
<th>50 nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery Ratio</td>
<td>64.8085</td>
<td>95.7513</td>
<td>28.152</td>
</tr>
<tr>
<td>Throughput</td>
<td>268.26</td>
<td>261.87</td>
<td>42.47</td>
</tr>
<tr>
<td>Overhead</td>
<td>1.476</td>
<td>13.01</td>
<td>20.52</td>
</tr>
<tr>
<td>Delay</td>
<td>129.515</td>
<td>55.782</td>
<td>255.57</td>
</tr>
<tr>
<td>Packet loss</td>
<td>265</td>
<td>11</td>
<td>44</td>
</tr>
</tbody>
</table>
v. Summarized Results

Table 2: Comparison of Protocols AOMDV, AODV, DSR, DSDV

<table>
<thead>
<tr>
<th>Parameters</th>
<th>AOMDV</th>
<th>AODV</th>
<th>DSR</th>
<th>DSDV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packet Delivery ratio</td>
<td>Higher than AODV</td>
<td>High</td>
<td>Medium</td>
<td>low</td>
</tr>
<tr>
<td>Throughput</td>
<td>Slightly similar to DSDV</td>
<td>High</td>
<td>Medium</td>
<td>low</td>
</tr>
<tr>
<td>Overhead</td>
<td>Higher than DSDV and AODV</td>
<td>Medium</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Delay</td>
<td>Slightly similar to AODV and DSDV</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Packet loss</td>
<td>Low</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
</tbody>
</table>

X. Conclusion

In this paper we have evaluated the performance of Destination Sequenced Distance Vector (DSDV), Dynamic Source Routing (DSR), Ad hoc On Demand Distance Vector Routing (AODV) and Ad hoc On Demand Multipath Distance Vector (AOMDV) protocols using (TCL) Tool command language in the NS-2 Simulator. The performance of the protocols was measured with respect to metrics Packet delivery ratio, packet loss, throughput, overhead, delay. The obtained results of this simulation indicate that each protocol has its own significance on a particular QoS metric. It is observed that AOMDV protocol gives better performance as compared to AODV & DSR in terms of packet delivery fraction and throughput, delay. It is also observed that the DSDV has better throughput value. And it is observed that DSR protocol overhead is less. And AODV has higher packet loss. AOMDV incurs more routing overhead than AODV. AODV gives less delay with respect to pause time. The main conclusion of this paper is that the choice of which protocol to use, depends on the properties of the network.

References Références Referencias

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