Performance Evaluation of Routing Protocols on Manet

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ABSTRACT

This research work aims at comparing and analyzing the performance of three common reactive protocols deployed on MANET – AODV (Ad Hoc Distance Vector Routing), DSR (Dynamic Source Routing) and DSDV (Destination Sequence Distance Vector). The parameters on which the reactive protocols would be evaluated are end-to-end delay, congestion and packet loss. The results obtained after the analysis would help in selecting a protocol that would best suit a given condition. This work also aims to research and present certain modifications to these protocols to enhance their performance.

KEYWORDS

MANET, Protocol, NS2, AODV, DSR, DSDV

I. INTRODUCTION

MANETs have gained a lot of attention in research in recent times due to their importance in providing dynamic (wireless) nodes to interact thereby eliminating the need for any wired or static infrastructures. The performance of MANETs can be altered by various factors such as the mobility of the node, terrain, number of nodes, energy supply of the nodes and changes in the topology. In such a dynamic networking environment, the performance of MANET protocols also varies with these conditions. A Mobile Ad hoc Network (MANET) is a collection of individual mobile nodes that are independent and can interact with each other using the radio waves. The individual nodes that are in the range of the radio waves can communicate directly, whereas others need the help of neighbouring nodes for the routing of their packets. The nodes are instilled with an interface to communicate with each other. The MANET networks are completely distributed, can work without any static or wired infrastructure and can serve as base stations or access points.[11]

II. ROUTING IN MANET

MANET is a set of nodes that do not require any static infrastructure to be deployed. It is an independent system in which the nodes move about freely and generally, also function as routers. Since the nodes in MANET are not stationary and there are no pre-established base stations, the topology of its networks is highly fluctuating. Due to the limited capacity of the nodes, the data is sent using multiple stations and adjacent nodes. The development of the path while transferring of data should be done in a way that the bandwidth consumption remains minimum. Wireless networks have progressively become more and more used in the computing industry since their emergence in the 1970s. AODV is one of the most important routing protocol for MANET, it uses a combination DSR and DSDV mechanisms for routing by using the on-demand mechanism of routing discovery and route maintenance from DSR and the hop-by-hop routing and sequence number from DSDV. Wireless networking is an emerging technology which helps users in accessing information without being geographically bounded. Wireless networks can be classified in two types:

A. Centralized approach Or Infrastructure Networks

Infrastructure network consists of a number of wired and fixed gateways. A mobile node connects with a bridge (base-station) that is present in its range. The mobile node can move arbitrarily while it is communicating. As soon as any node moves out of range from one base-station, it tries to connect with a new base-station, thereby establishing new route for communication. This process is known as handoff. The base stations are fixed in the centralized approach.

B. Decentralized approach or Infrastructure less (ad-hoc) Networks

In contrast to Decentralized approach, in ad-hoc networks all nodes are mobile and can be connected dynamically in an arbitrary manner. In this approach, a temporary network is established with any already-present infrastructure. MANET is an example of this approach. The wireless ad-hoc networks are self-creating, self-organizing and self-administrating.

III. IEEE 802.11 STANDARD

IEEE 802.11 was used to test the performance of our protocols, since it is the most widely used standard in wireless networks. IEEE 802.11 uses Request-to-Send (RTS) and Clear-to-Send (CTS) control packets for career sensing. Requests are broadcasted using RTS and if a node senses that it can receive packets without any losses, it responds with a CTS packet. Other nodes also detect these RTS and CTS packets and accordingly delay their transmission to avoid packet collision and loss. After the packet has been received, the requesting node transmits an Acknowledgement (ACK) packet to the responder. The responding node transmits the requested data packets seven times if it doesn’t receive an ACK from the requester. If it still doesn’t receive, it generates an error through the hardware.
IV. ROUTING PROTOCOLS IN MANET

Ad hoc routing protocols carry the objective of delivering data packets among nodes efficiently without a predetermined topology or centralized control. The properties which are expected of MANET routing protocols are: distribution should be in such a way to increase its reliability, routing protocols should assume routes as unidirectional links, it should consider its security, it has to be power-efficient. Apart from this they must also follow QoS that is Quality of Service. There are three classifications of MANET routing protocols namely unicast, multicast or geocast routing protocols based on delivery of packets from source to destination [15].

A. Adhoc On-Demand Distance Vector Protocol (AODV)

The ad hoc On-Demand Distance Vector (AODV) constructs a coherent route on demand with minimum control overhead. The protocol constructs efficient route on demand with minimal control overhead and minimal route acquisition latency. AODV is made up of both DSR and DSDV algorithms and it has the basic on demand mechanism of route discovery and route maintenance from DSR and the use of hop-by-hop sequence numbers from DSDV of routing. The destination sequence number can be used to ensure loop-free and to identify the route with the greatest sequence is newer one.

B. Dynamic Source Routing (DSR)

Dynamic Source Routing (DSR) is a routing protocol similar to AODV in that it forms a path on-demand when a request is made by any node. However, it uses source routing instead of relying on the routing table at each intermediate device. To determine source routes, the address of each intermediate node, between the source and destination station, is required. The route information that is accumulated is stored by nodes processing the route discovery packets. The pre-determined paths are used to route packets. For achieving source routing, routed packets contain the address of each device the packet will traverse. The result of which is high overhead for long paths or large addresses, for example IPv6. To avoid using source routing, DSR optionally defines a flow id option that allows packets to be forwarded on a hop-by-hop basis. This protocol is truly based on source routing whereby all the routing information is maintained (continually updated) at mobile nodes [8].

C. Destination Sequence Distance Vector (DSDV)

DSDV is one of the very first algorithms that were available. In the network each station maintains a routing table and each routing table lists the destinations possible. The number of intermediate nodes traversed is noted in each routing table with a sequence number. This sequence number is determined in order to maintain the constancy of routing tables in topology which is dynamically varying. Each station transfers its information from time-to-time and also when any new information is fetched by the station. No assumption is made in regard to the mobile nodes maintaining any time synchronization or about the phase relation of the update period between the nodes. The packets indicate the accessible stations and number of nodes to be traversed to reach accessible station as often in the case of Distance Vector Routing Algorithm [14].

V. DISCUSSIONS AND RESULTS

We simulated the three routing protocols under consideration and examined their performance upon various metrics such as Congestion, End to End delay, Packet loss, and packet delivery ratio.

For our project we have considered two scenarios to understand the behaviour of the three protocols. They are:

A. Varying the Queue length

The length of the queue has been taken as 20 and 100.

1. 20 Queue length

<table>
<thead>
<tr>
<th>Protocol</th>
<th>AODV</th>
<th>DSDV</th>
<th>DSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput</td>
<td>559.39</td>
<td>614.83</td>
<td>557.61</td>
</tr>
<tr>
<td>End-to-End Delay (ms)</td>
<td>150.577</td>
<td>131.403</td>
<td>538.561</td>
</tr>
<tr>
<td>Packet Loss Ratio</td>
<td>0.017</td>
<td>0.006</td>
<td>0.002</td>
</tr>
</tbody>
</table>

1.1 Throughput

According to the graph, DSR has the maximum amount of throughput followed by AODV and DSDV.
1.2 End-to-End Delay

According to the graph, maximum delay has been observed for the DSR protocol followed by AODV and DSDV. DSDV has the least delay amongst the three.

1.3 Packet Loss

It can be concluded from the graph that packet loss for the AODV protocol is the least amongst the three protocol followed by DSDV and DSR. DSR has the highest packet loss.

1.4 Conclusion

Based on the values of throughput, average delay and packet loss. We can conclude that DSDV performed the best for the queue length 20.

2. 100 Queue length

<table>
<thead>
<tr>
<th>Protocol</th>
<th>AODV</th>
<th>DSDV</th>
<th>DSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput</td>
<td>551.11</td>
<td>544.83</td>
<td>557.61</td>
</tr>
<tr>
<td>End-to-End Delay (ms)</td>
<td>143.187</td>
<td>399.646</td>
<td>538.561</td>
</tr>
<tr>
<td>Packet Loss Ratio</td>
<td>0.011</td>
<td>0.006</td>
<td>0.002</td>
</tr>
</tbody>
</table>

2.1 Throughput

It can be inferred from the graph that throughput is maximum for DSR followed by AODV and DSDV.

2.2 End-to-End Delay

According to the graph the end to end delay is maximum for the DSR protocol followed by DSDV and AODV. AODV has the least amount of end to end delay.
The packet loss ratio is maximum for AODV followed by DSR and DSDV.

**B. Varying the number of nodes**

We have varied the number of nodes with 30 and 120 nodes.

### 1. 30 Nodes

<table>
<thead>
<tr>
<th>Protocol</th>
<th>AODV</th>
<th>DSDV</th>
<th>DSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Throughput</td>
<td>531.16</td>
<td>533.75</td>
<td>149.98</td>
</tr>
<tr>
<td>End-to-End Delay (ms)</td>
<td>397.216</td>
<td>367.82</td>
<td>620.036</td>
</tr>
<tr>
<td>Packet Loss Ratio</td>
<td>0.018</td>
<td>0.004</td>
<td>0.004</td>
</tr>
</tbody>
</table>

DSDV yielded the highest throughput, followed by AODV and DSR. Thus DSDV gives the best performance as compared to AODV and DSR.

### 1.2 End-to-End Delay

We compared the three protocols for 30 nodes for the packet delay. The graph clearly indicates that the delay is highest for DSR and similar for AODV. Hence DSR causes a higher delay than AODV and DSDV.
1.3 Packet loss

The packet loss was the highest for AODV, and similar for DSDV and DSR.

1.4 Conclusion

The parameters on the basis of which the results were analyzed clearly indicate that DSDV performs the best. Also, AODV gives a better performance than DSR for most of the parameters. Therefore, if a MANET requires approximately 30 nodes, then DSDV would be the ideal protocol to implement.

2. 120 Nodes

<table>
<thead>
<tr>
<th>Parameter</th>
<th>AODV</th>
<th>DSDV</th>
<th>DSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput</td>
<td>590.15</td>
<td>505.01</td>
<td>497.70</td>
</tr>
<tr>
<td>End-to-End Delay (ms)</td>
<td>492.747</td>
<td>389.503</td>
<td>454.957</td>
</tr>
<tr>
<td>Packet Loss Ratio</td>
<td>0.034</td>
<td>0.001</td>
<td>0.002</td>
</tr>
</tbody>
</table>

2.1 Throughput

The graph clearly indicates that for 120 nodes, AODV possesses the best throughput followed by DSR and DSDV.

2.2 End-to-End Delay

The analysis of the results obtained for delay revealed that AODV had the highest delay, followed by DSR and DSDV. Thus DSDV was the fastest to transmit the packets for 120 nodes.

2.3 Packet Loss

We observed the average packet loss in the three protocols for 120 nodes. It could be observed that AODV had the highest loss followed by DSDV and DSR.

2.4 Conclusion

Based on the results we obtained from studying the values of the parameters DSDV emerges as a clear winner for 120 nodes. While DSR had a consistent...
performance, the performance of AODV clearly deteriorated. Thus AODV is not an ideal protocol for 120 nodes.

V. FUTURE SCOPE AND CONCLUSION

The importance of MANET is gradually increasing. MANETs can applied wherever tradition traditional networks fail such as on uninhabited terrain, outer space etc. MANET has been one of the most active research topics in the domain of networking in the past 10 years. The aim of our project was to contribute to the research in this domain by analyzing the performance of the three most popular protocols, i.e., AODV, DSDV and DSR.

As a part of the paper, we conducted an extensive analysis on AODV, DSD and DSR. We simulated the protocols in broadly two scenarios, varying number of nodes and varying queue length. We compared every protocol with itself.

We conclude that DSDV is the best protocol out of the three. In almost all the scenarios, DSDV presented the least amount of packet loss and delay and high throughput. These salient features of DSDV can be attributed to its quality of maintaining routing tables. AODV also yielded high throughputs in some scenarios. Though DSR didn't perform better than DSDV, an advantage of DSR was that it gave consistent results in different scenarios.

We could also infer from the paper that the on demand routing capabilities of a protocol can get affected by the node density and queue length. Thus, these protocols need further refinement and need more optimized searching and path finding algorithms.

REFERENCES

[14] Tomasz Imielinski, Henry F. Korth, MOBILE COMPUTING