Performance Comparison of Ad-hoc Routing Protocols AODV and DSR

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Abstract—Ad hoc networks are known by many specifications like multi-hop wireless connectivity, frequently changing network topology and the need for efficient dynamic routing protocols that plays an important role. This paper presents a performance comparison between two reactive routing protocols for mobile ad hoc networks: Dynamic Source Routing (DSR), Ad Hoc On demand distance Vector (AODV). Both protocols were simulated using the tool ns-2 and were compared in terms of packet loss ratio, end to end delay, with mobile nodes varying number of nodes and speed. Simulation revealed that although DSR perfectly scales to small networks with low node speeds, AODV is preferred due to its more efficient use of bandwidth.

Keywords —AODV, DSR, MANET, NS-2

I. INTRODUCTION

Mobile ad-hoc wireless networks hold the promise of the future, with the capability to establish networks at anytime, anywhere. Mobile ad hoc networks (MANETs) are collections of mobile nodes, dynamically forming a temporary network without pre-existing network infrastructure or centralized administration. Nowadays a lot of research efforts focus on Mobile Ad-hoc networks.

Routing protocol plays an important role if two hosts wish to exchange packets which may not be able to communicate directly. All nodes are mobile and can be connected dynamically in an arbitrary manner. All nodes of these networks behave as routers and take part in discovery and maintenance of routes to other nodes in the network. This situation becomes more complicated if more nodes are added within the network. An Ad-Hoc routing protocol must be able to decide the best path between the nodes, minimize the bandwidth overhead to enable proper routing, minimize the time required to converge after the topology changes.

This paper presents a performance comparison between two on-demand routing protocols for mobile ad hoc networks: Dynamic Source Routing (DSR), Ad Hoc On demand distance Vector Routing (AODV).

Both protocols were simulated using the ns-2 package and were compared in terms of average throughput, packet loss ratio, and routing overhead, while varying number of nodes and speed. Simulation revealed that although DSDV perfectly scales to small networks with low node speeds, AODV is preferred due to its more efficient use of bandwidth.

II. AD-HOC ROUTING PROTOCOLS

The ad-hoc routing protocols can be divided into two categories:

Table-driven routing protocols: In table driven routing protocols, consistent and up-to-date routing information to all nodes is maintained at each node. These protocols require each node to store their routing information and when there is a change in network topology updating has to be made throughout the network.

On-Demand routing protocols: In On-Demand routing protocols, the routes are created as and when required. This type of protocols finds a route on demand by flooding the network with Route Request packets. When a source wants to send to a destination, it invokes the route discovery mechanisms to find the path to the destination.

In recent years, a variety of new routing protocols targeted specifically at this environment have been developed.

<table>
<thead>
<tr>
<th>TABLE 1: COMPARISON OF TABLE-DRIVEN AND ON-DEMAND PROTOCOLS</th>
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<td>Availability of Routing Information</td>
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<td>Route Updates</td>
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A. Dynamic Source Routing

The Dynamic Source Routing (DSR) protocol is a source-routed on-demand protocol [1]. There are two major phases for the protocol: route discovery and route maintenance. The key difference between DSR and other protocols is the routing information is contained in the packet header. Since the routing information is contained in the packet header then the intermediate nodes do not need to maintain routing information. An intermediate node may wish to record the
routing information in its tables to improve performance but it is not mandatory. Another feature of DSR is that it supports asymmetric links as a route reply can be piggybacked onto a new route request packet. DSR is suited for small to medium sized networks as its overhead can scale all the way down to zero. The overhead will increase significantly for networks with larger hop diameters as more routing information will be contained in the packet headers.

- Two main mechanisms: Route Maintenance and Route Discovery
- Route Discovery mechanism is similar to the one in AODV but with source routing instead
- Route Maintenance is accomplished through route caches
- Entries in route caches are updated as nodes learn new routes, multiple routes can be stored.

B. Ad hoc On-demand Distance Vector Routing

Ad hoc On-demand Distance Vector Routing (AODV) is an on-demand version of the table-driven Dynamic Destination-sequenced Distance-Vector (DSDV) protocol [1]. To find a route to the destination, the source broadcasts a route request packet. This broadcast message propagates through the network until it reaches an intermediate node that has recent route information about the destination or until it reaches the destination. When intermediate nodes forwards the route request packet it records in its own tables which node the route request came from. This information is used to form the reply path for the route reply packet as AODV uses only symmetric links. As the route reply packet traverses back to the source, the nodes along the reverse path enter the routing information into their tables. Whenever a link failure occurs, the source is notified and a route discovery can be requested again if needed.

- Based on standard Distance Vector Algorithm
- Nodes maintain route cache and uses destination sequence number for each route entry
- Does nothing when connection between end points is still valid
- Route Discovery Mechanism is initiated when a route to new destination is needed by broadcasting a Route Request Packet (RREQ).
- Route Error Packets (RERR) are used to erase broken links

III. SIMULATION ENVIRONMENT

A. Simulation Model

The results reported in this paper are based on the study conducted on the basis of simulation tool NS2 that is an object-oriented, discrete event driven network simulator developed at UC Berkely written in C++ and OTcl. The overall simulator is described by a Tcl class Simulator. It provides a set of interfaces for configuring a simulation and for choosing the type of event scheduler used to drive the simulation.

When a new simulation object is created in tcl, the initialization procedure performs the following operations:

- initialize the packet format
- create a scheduler (defaults to a calendar scheduler)
- create a “null agent” (a discard sink used in various places)

We use tcl to configure the topology, the nodes, the channel, to schedule the events, etc.

Mobile Node is the basic ns Node object with added functionalities like movement, ability to transmit and receive on a channel that allows it to be used to create mobile, wireless simulation environments.

The simulation in NS2 can be described as shown in Fig.3 [3]. The scenario file describes the movement pattern of the nodes. The communication file describes the traffic in the network.
Fig. 3. Simulation Procedure

B. Traffic and Mobility models

In this paper we use traffic and mobility model based on Continuous bit rate (CBR) traffic sources. Only 512-byte data packets are used. To change the offered load in the network the number of source-destination pairs and the packet sending rate in each pair is varied. The mobility model uses the random way-point model [13] in a rectangular field. The field configurations used is: 500 m x 500 m field with 10, 20, 50 and 100 nodes. Here, each packet starts its journey from a random location to a random destination with a randomly chosen speed (uniformly distributed between 0-20 m/s). Simulations are run for 100 simulated seconds. Identical mobility and traffic scenarios are used across.

The simulation parameters which have been considered or doing the performance comparison of two on-demand routing protocols is given below in Table-2.

| TABLE 2: PARAMETERS USED IN EXPERIMENT SCENARIO |
| Parameter | Value                   |
| Protocols | AODV, DSR               |
| Traffic source | Constant bit rate CBR |
| Simulation time | 100 seconds           |
| Packet Size | 512 bytes               |
| Max speed | 20m/s                   |
| Area       | 500 m x 500 m           |
| Number of nodes | 10 20 50 100        |
| Mobility model | Random way point |

IV. RESULTS AND DISCUSSIONS

The simulation was implemented with light speeds using the random way-point mobility pattern. In this model, nodes select random way-points within the roaming area, and travel there with a constant speed randomly. After reaching its destination, the node waits for some pause time then moves to the next waypoint. This scenario is applicable to networks such as conferences, wireless sensors, and emergency situations with people walking as nodes. We assume low mobility for ad-hoc energy studies since in a high mobility system the data transmission energy may be negligible compared to the energy used for the mobility. The following four important performance metrics are considered for evaluation of these two on demand routing protocols.

Packet delivery fraction: The ratio of the data packets delivered to the destinations to those generated by the CBR sources.

The following table shows the rate of packet loss for each of the protocols AODV and DSR, simulated under the same conditions with 10 sources and at the same time comparing their rates of control packets used for the routing function.

From this table (Table 3), we find that among all the generated packets in the AODV protocol, 0.44% represents the control packets, whereas in the DSR protocol, 12.34% of control packets. In addition, the rate of successfully received packets by use of the AODV protocol is 92.44% (5431/5875) and the packet lost 7.56% (444/5875). However using the DSR protocol was 87.82% (7500/8540) packets received and 12.18% (1040/8540) of lost packets.

| TABLE 3: STATISTICS OF PACKETS SENT, RECEIVED AND OF CONTROL FOR BOTH DSR AND AODV PROTOCOLS |
| Type | Received | Sent | Generated | Rate |
| Total  | 7500   | 6435 | 8540 | ------ |
| DSR packets Control  | 1042   | 1004 | 1054 | 12,34% |
| Rate  | 87,82%  | Lost : 12,18% |
| Total  | 5431   | 4988 | 5875 | ------ |
| AODV packets Control  | 24     | 16  | 26  | 0,44%  |
| Rate  | 92,44%  | Lost : 7,56% |
Mobility: Mobility is the major parameter of an ad hoc network. Since an ad-hoc network is primarily characterized by its ever-changing topology, so mobility of nodes is an important consideration. Mobility of a node is a function of both speed and movement patterns.

This simulation analysis is made from the Fig. 3 for 10 sources. First we analyze the first parameter Packet delivery ratio with respect varied Maximum speed of nodes.

Figure 3 shows the relative performance test result of the AODV and DSR routing protocols. All of the protocols deliver a greater percentage of the originated data packets when there is little node mobility, converging to 90% delivery ratio when there is no node motion.

The On-demand protocol AODV performed particularly well, while DSR could not achieve good packet delivery ratio when moving more frequently.

End-To-End Delay: Fig. 4 shows the delay comparison of the two protocols. For on-demand-driven protocols, it is hard to say their performance relationship between the pause times.

The curve jumped a lot with the pause time change.

The second parameter Normalized End-To-End delay with varied pause times is analyzed and it is found that for DSR it is less when compared to AODV and we see that it is fairly stable even with increase number of sources.

Further experiments should be done in order to make definitely conclusion.

V. CONCLUSION

In this paper the basic actions related to the two routing protocols namely AODV and DSR were studied in detail. On-demand driven protocols, as AODV, DSR, performed very well for packet delivery with fast movement and mobility rate. AODV seems to perform better than DSR on some situations. However, when mobility increases AODV has generally better performance. The On-demand protocol AODV performed particularly well, while DSR could not achieve good packet delivery ratio when moving more frequently.

DSR is source routing protocol, which means that byte overhead in each packet can affect the total byte overhead when the load offered and size of the network increases. On advantage with source routing is that during route discovery operation it learns more routes. A combination of the protocols can be used for good result.

REFERENCES


