Comparison of AODV and ZRP Routing Protocols: A Simulation Based Analysis

Sunita Swain
Department of Computer Science and Engineering
R.V.S. College of Engineering & Technology
Jamshedpur, India
sunita_swain {at} rediffmail.com

Sanku Sinha
Department of Computer Science and Engineering
R.V.S. College of Engineering & Technology
Jamshedpur, India

Abstract—**A Mobile Ad hoc Network (MANETs) is a kind of wireless ad-hoc network, and is a self- configuring network of mobile nodes where the mobile nodes are free to move randomly, thus making the network topology dynamic. Various routing protocols have been designed which aims at establishment of correct and efficient routes between a pair of mobile nodes. This study is a comparison of two routing protocols proposed for mobile ad-hoc networks. The protocols are: Ad-hoc On demand Distance Vector (AODV) and Protocol Routing (ZRP). The performance of the protocols are analyzed in terms of throughput, average end-to-end delay and normalized routing load which shall provide an insight about the sensitivity of the protocols. Simulation based analysis of the protocols have been carried out using NS-2, an open source simulator.**

Keywords- AODV, ZRP, MANET, NS-2

I. Introduction

In recent years, the mobile computing popularity has increased tremendously. People are getting used to the advantages of having frequent and convenient internet access. So more network functionality is taken by number of laptop users. To allow mobile computers with wireless communication devices to set up a short lived network just for the communication needs for the moment is called as ad hoc network [2].

The wireless mobile computing devices can perform critical network topology functions that are normally the job of the routers within the internet infrastructure [4]. There are many kinds of protocols available which are supported by network infrastucure.Each node in an ad hoc network, if it volunteers to carry traffic, participate in the formation of the network topology. Since the topology of Ad hoc network is dynamic in nature, design of suitable routing protocol is essential to adapt the dynamic behavior of the network. Further that node density and pause time will have significant effect in the performance of the any routing policy due to the fact that an increase in node density will tend to increase the hop count thus changing the topology significantly [5]. The topology of the ad-hoc network depends on the transmission power of the nodes and the location of the mobile nodes, which may change from time to time. One of the main problems in ad-hoc networking is the efficient delivery of data packets to the mobile nodes where the topology is not pre-determined nor does the network have centralized control. Hence, due to the frequently changing topology, routing in ad-hoc networks can be viewed as a challenge. This paper makes an attempt to analyze the performance of two most popular Ad hoc routing protocols, viz. AODV and ZRP. In AODV and ZRP in the fact that they belong to two different routing families. AODV is from reactive routing family where routes are only generated on demand, in order to reduce routing loads [2].Where as ZRP is a hybrid routing protocol which effectively combines the best features of both proactive and reactive routing protocols. The key concept employed in this protocol is to use a proactive routing scheme within a limited zone in the neighborhood of every node, and use a reactive routing scheme for nodes beyond this zone. ZRP consists of the Intra Zone Routing Protocol (IARP), which is proactive in nature and the Inter Zone Routing Protocol (IERP), which is reactive in nature[9]. The rest of this paper is organized as follows: In the next section, brief overviews of both routing protocols have been discussed. Section III discusses the simulation environment in which both the protocols have been tested. Section IV includes analysis of the performance of both the protocols under a varying node density environment with respect to performance metrics such as throughput, average end-to-end delay and packet delivery fraction. Section V provides conclusion, limitation and future work

II. Overview of the Protocol

A. Ad hoc On Demand Distance Vector (AODV):

Ad hoc On Demand Distance Vector Routing Protocol (AODV) is a reactive routing protocol designed for Ad hoc wireless network and it is capable of both unicast as well as multicast routing In AODV, each node maintains a routing table which is used to store destination and next hop IP addresses as well as destination sequence numbers [3]. Each entry in the routing table has a destination address, next hop, precursor nodes list, lifetime, and distance to destination.

To initiate a route discovery process a node creates a route request (RREQ) packet. The packet contains the source node's IP address as well as the destination's IP address. The RREQ contains a broadcast ID, which is incremented each time the source node initiates a RREQ [1]. The broadcast ID and the IP address of the source node form a unique identifier for the

RREQ. The source node then broadcasts the packet and waits for a reply. When an intermediate node receives a RREQ, it checks to see if it has seen it before using the source and broadcast ID's of the packet. If it has seen the packet previously, it discards it. Otherwise it processes the RREQ packet. To process the packet the node sets up a reverse route entry for the source node in its route table which contains the ID of the neighbor through which it received the RREQ packet. In this way, the node knows how to forward a route reply packet (RREP) to the source if it receives one later. When a node receives the RREQ, it determines if indeed it is the indicated destination and, if not, if it has a route to respond to the RREQ. If either of those conditions is true, then it unicasts a route reply (RREP) message back to the source. If both conditions are false, i.e. if it does not have a route and it is not the indicated destination, it then broadcasts the packet to its neighbors. Ultimately, the destination node will always be able to respond to the RREQ message. When an intermediate node receives the RREP, it sets up a forward path entry to the destination in its routing table. This entry contains the IP address of the destination, the IP address of the neighbor from which the RREP arrived, and the hop count or distance to the destination. After processing the RREP packet, the node forwards it toward the source. The node can later update its routing information if it discovers a better route.

B. Zone Routing Protocol (ZRP)

Zone routing protocol is a hybrid routing protocol which effectively combines the best features of both proactive and reactive routing protocols[7]. The key concept employed in this protocol is to use a proactive routing. Proactive routing uses excess bandwidth to maintain routing information, while reactive routing involves long route request delays[9]. Reactive routing also inefficiently floods the entire network for route determination. It acts as a proactive protocol in the neighborhoods of a node (IntrA-zone Routing Protocol, IARP) locally and a reactive protocol for routing between neighborhoods (IntEr-zone Routing Protocol, IERP) globally. The local neighborhoods are called zones, which are different for each node. Each node may be within multiple overlapping zones and each zone may be of a different size. The size of a zone is not determined by the geographical measurement but is determined by a radius of length p,where p is the number of hops to the perimeter of the zone.

III. SIMULATION METHODOLOGY

Simulation based study using Network Simulator NS-2[6] has been used to compare two protocols viz. AODV and ZRP under varying node density assuming that the size of network, maximum speed of nodes and transmission rate are fixed. Tables I and II summarize the parameters used in the communication and movement models for simulation.

A. Communication Model

The simulator assumes constant bit rate (CBR) traffic with a transmission rate of 8 packets per second. The number of nodes varies from 25 to 200 in the denomination of 25, 50,100,200 .

TABLE I. PARAMETERS OF COMMUNICATION MODEL

Parameter	Value
Traffic	CBR
No.of nodes	25,50,100,200
Transmission rate	8packets/sec

B. Movement Model

The realistic mobility pattern of the mobile nodes, the simulation assumes a Random Waypoint Model, where a node is allowed to move in any direction arbitrarily [8, 10]. The nodes select any random destination in the 500m X 500m space and moves to that destination at a speed distributed uniformly between 1 and nodes maximum speed (assumed to be 20 meter per second). Upon reaching the destination, the node pauses for fixed time, selects another destination, and proceeds there as discussed above. This behavior repeats throughout the duration of the simulation (500 seconds). Meanwhile, number of nodes has been varied to compare the performance of the protocols for low as well as high density environment.

TABLE II. PARAMETERS OF MOVEMENT MODEL

Parameter	Value
Simulator	NS-2
Simulation time	500 seconds
Area of the network	500 m x 500 m
Number of nodes	25,50,100,200
Pause time	10 seconds
Maximum speed of nodes	20 meters per second
Mobility Model	Random waypoint

IV. PERFORMANCE METRICS

Three performance metrics have been measured for the protocols:

A. Throughput

Throughput is the number of packet that is passing through the channel in a particular unit of time. This performance metric shows the total number of packets that have been successfully delivered from source node to destination node [7]. Factors that affect throughput include frequent topology changes, unreliable communication, limited bandwidth and limited energy.

$$Throughput = \frac{Received\_Packet\_Size}{Time\_to\_Send} \quad (1)$$

B. Average End-to-End Delay:

A specific packet is transmitting from source to destination node and calculates the difference between send times and received times[8]. This metric describes the packet delivery time. Delays due to route discovery, queuing, propagation and transfer time are included metric.

$$Avg\_End\_to\_End\_Delay = \frac{\sum_1^n (CBR\_Sent\_Time - CBR\_Recv\_Time)}{\sum_1^n CBR\_Recv} \quad (2)$$

C. Normalized Routing Load

Normalized Routing Load is the ratio of total number of routing packet received and total number of data packets received[8] .

$$Normalized\_Routing\_Load = \frac{Number\_of\_Routing\_Pkts\_Recvd}{Number\_of\_Data\_Pkts\_Recvd} \quad (3)$$

V. SIMULATION RESULT AND ANALYSIS

Figures 1, 2 and 3 represent the performance analysis in terms of throughput, average end-to-end delay and normalized routing load respectively. In all the cases the node density varies from 25 to 200.

A. Throughput

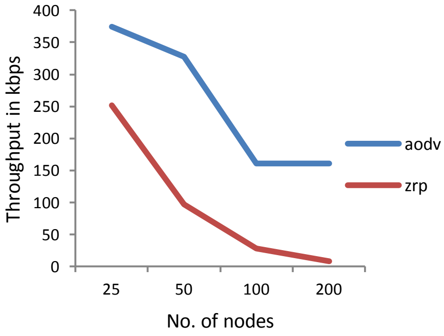

Figure 1. Throughput

B. Ent-to-End Delay

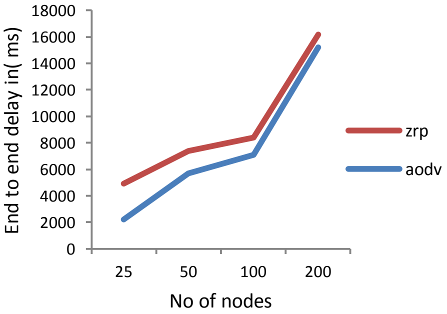

Figure 2. End to end delay

C. Normalized Routing Load

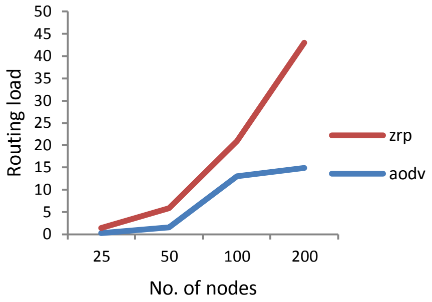

Figure 3. Normalized Routing Load

Fig 1, Fig 2 and Fig 3 indicates that normalized routing load of AODV is always higher than ZRP under any scenario. The performance of ZRP in terms of normalized routing load is not influenced in any way with respect to change in node density. The reactive nature of AODV routing protocol causes more number of control overhead. Therefore, normalized routing load for AODV will always be higher

VI. CONCLUSION

The performance evaluation of the routing protocols AODV and ZRP has been done with respect to metrics throughput, average end-to-end delay and normalized routing load under varying node density. From the result analysis, it has been observed that in high node density the performance of both protocols in terms of throughput and average end to end delay decreases significantly. Due to increase of node density in the network causes more number of control packets in the network for route establishment between a pair of source and destination nodes. This is the cause of performance degradation of the routing protocols in high node density [8]. It has been observed that in low node density the performance of ZRP is better than AODV in case of routing load (up to 50 nodes). The current work has been limited with fixed simulation area (500x500m) with CBR traffic and node density is upto 200 nodes. In Current work, only three performance metrics have been considered to analyze the performance of AODV and ZRP. Inclusion of other performance metrics will provide in-depth comparison of these two protocols which may provide an insight on the realistic behavior of the protocols under more challenging environment.

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