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The Effective and Efficient of AODV Routing protocol for Minimized End-to-End Delay in MANET

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Abstract — Ad-Hoc networking has become a primary concern in order to provide an effective communication between each other without any form of centralized administration. This kind of networking would go-ahead with dynamic asymmetric topologies caused by natural disaster and bears from inherent limitations such as limited bandwidth and power. To overcome this concern a routing protocol is needed. Reactive Routing Protocols is a bandwidth efficient on-demand routing protocol, which means that the originator node initiates the process of route search for a destination node only when it needs to communicate with the destination node. The popular reactive routing protocols are Ad hoc On Demand Distance Vector (AODV) and Dynamic Source Routing (DSR). In this paper, the investigations are done on the efficiency of AODV routing protocol in a bandwidth constrained network by toggling the destination only flag in the AODV header. The throughput is studied and evaluated.

Keywords-component; Ad hoc network, AODV, routing

I. Introduction

Mobile Ad hoc Network (MANET) is a collection of independent mobile nodes that can communicate to each other via radio waves. The mobile nodes that are in radio range of each other can directly communicate, whereas others needs the aid of intermediate nodes to route their packets. These networks are fully distributed, and can work at any place without the help of any infrastructure. This property makes these networks highly flexible and robust.

The characteristics of these networks are summarized as follows:

- Communication via wireless Network.
- Nodes can perform the roles of both hosts and routers.
- No centralized controller and infrastructure.
- Intrinsic mutual trust.
- Dynamic network topology.
- Frequent routing updates.

Advantages and Applications

The following are the advantages of MANETs:

- They provide access to information and services regardless of geographic position.
- These networks can be set up at any place andtime.

Some of the applications of MANETs are

- Defence Development..
- Disaster relief operations.
- Mine site operations.
- Urgent Business meetings.

The disadvantages of MANETs are:

- Limited resources.
- Limited physical security.
- Intrinsic mutual trust vulnerable to attacks.
- Lack of authorization facilities.
- Volatile network topology makes it hard to detect malicious nodes.
- Security protocols for wired networks cannot work for ad hoc networks.

II ROUTING PROTOCOLS FOR MANET

Routing protocols in ad hoc networks vary depending on the type of the network. Typically, ad hoc network routing protocols are classified into three major categories based on the routing information updated mechanism as shown in Figure 1.1. They are proactive (table driven routing protocols), reactive (on-demand routing protocols) and hybrid routing protocols. In addition, protocols can also be

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classified according to the utilization of specific resources, such as power aware routing protocol and load aware routing protocols and so on.

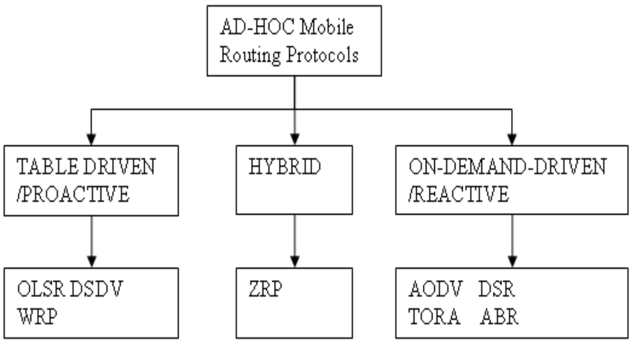

Fig 1.1: Categorization of ad hoc routing protocols

A. Proactive routing protocols

In proactive routing protocols, routes are calculated independent of intended traffic. All the routes from one station to other stations in the network are calculated and saved in the routing table of each node. Once, there is a need of transmission, source node could check from the routing table, the route will get immediately. Some of the proactive routing protocols used in ad hoc networks are Optimized Link State Routing protocol (OLSR), Destination Sequenced Distance-Vector routing protocol (DSDV), and Wireless Routing Protocol (WRP). One of the most famous Internet routing protocol which is also a proactive routing protocol called Open Shortest Path First Routing Protocol (OSPF) is discussed first. After that, representative ad hoc proactive routing protocol OLSR is described.

B. Reactive routing protocols

In table driven routing protocols, to update the table, periodic flood is required as discussed in the previous part. It costs too much data rate to transmit the topology information. The main motivation of the design of on demand routing protocols is to reduce the routing overhead in order to save bandwidth in ad hoc networks. On demand routing protocols execute the path finding process and exchange routing information only when there is a requirement by the station when it want to initialize a transmission to some destination. By using the method of on demand routing, the routing load is decreased a lot. The reference mainly used in this part is [1, pp. 317-323].

C. Hybrid Routing

The Ad Hoc network can use the hybrid routing protocols that have the advantage of both proactive and reactive routing protocols to balance the delay and control overhead (in terms of control packages).

The difficulty of all hybrid routing protocols is the complexity of organising the network according to network parameters. The common disadvantage of hybrid routing protocols is that the nodes that have high level topological information maintains more routing information, which leads to more memory and power consumption.

D. ANALYSIS

There are two approaches to evaluate routing protocols:

- Network Environment Parameters and
- General Performance Metrics of Routing Protocols.

1. Network Environment Parameters

The network context has a strong impact on the performance of routing protocols. The essential network parameters include:

1. **network size**: presented as number of nodes;
2. **connectivity**: the average degree of a node, normally presented as number of neighbors;
3. **mobility**: the topology of the network, relative position and speed of the nodes;
4. **Link capacity**: bandwidth, bit error rate (BER), etc.

The above metrics form the basic subset of network parameters. In order to design realistic mathematical network models, additional metrics are required.

In this model, however, there is a very complex relation between the properties of the routing protocols and those of the mobile nodes. For example, node speed changes have impact on several parameters of the routing protocol functions.

2. General Performance Metrics of Routing Protocols

The major four metrics used for evaluation of the relative performance of ad hoc routing algorithms are as follows:

- **Message delivery ratio:** the total number of messages received at their intended (i.e. Planned or proposed or deliberate) destination divided by the total number of generated messages. It has to be noted that there is a heavy dependence of the measured results and the test duration for certain protocols;
- **control overhead:** this can be measured in terms of number of control packets or as the ratio of the number of control bytes and the total number of bytes transmitted by the network;
- **hop count:** This is also referred as path optimization, the average number of hops that

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successful messages did travel to reach their final destination.

- **end-to-end delay:** the average delay time of all successfully delivered packets.

III AD HOC ON DEMAND DISTANCE VECTOR

The Ad hoc On Demand Distance Vector (AODV) routing algorithm is a popular reactive routing protocol. AODV is capable of both unicast and multicast routing [6]. It is an on demand algorithm, for finding routes, meaning that it builds routes between nodes only as desired by source nodes for transmitted data packets. Routes are maintained till the communication is completed by the node. Sequence numbers are used in AODV routing protocol to maintain the freshness of routes. Advantages of AODV include loop free operation and scalability to a large number of terminals.

AODV has two phases Route discovery and Maintenance

A. Route discovery

When a source node intends to send packets, it checks its routing table to see whether it has a valid route to that destination. If so, it could begin to send packet to the next hop towards the destination. Or else, it does not have the information about a route to the destination, a Route Request (RREQ) packet is sent as a broadcast message. The Route Request (RREQ) message includes Source Identifier (SrcID), the Destination Identifier (DestID), the Source Sequence Number (SrcSeqNum), the Destination Sequence Number (DestSeqNum), the Broadcast Identifier (BcastID) and the value of Time To Live (TTL). RREQ is broadcasted to all neighbors of the node. Neighbors are those who have sent Hello message during the last Hello interval.

If an intermediate or neighbors node receives a Route Request (RREQ) packet, it checks if it is the destination node. If not, it checks if it has seen this Route Request (RREQ) before by checking the request ID and source node If an intermediate or neighbours node receives a Route Request (RREQ) packet, it checks wethers it is the destination node. If not, it checks if has seen this Route request (RREQ) before by checking the requesting ID and source node ID. The intermediate node in turn forward the request to their neighbours until the RREQ message reaches the destination or an intermediate node that has an up-to-date route to the destination. If this is the case the node just drops the packet and does not forward the Route Request (RREQ) any further. In AODV, each node maintains its own sequence number, as well as a broadcast ID. Each RREQ message contains the sequence numbers of the source and destination nodes and is uniquely identified by the source node's address and a broadcast ID. Destination sequence number is used to ensure loop free routing and use of up-to-date route information. Intermediate nodes can reply to the RREQ message only if they have a route to the destination whose destination sequence number is greater or equal to that contained in the RREQ message.

During the process of forwarding the RREQ messages, an intermediate node automatically records the address of the neighbor from which it received the first copy of the RREQ message, thereby establishing a reverse path. If a Route Request is received multiple times, which is indicated by the BcastID-SrcID pair, the duplicate copies of the same RREQ message are discarded. All intermediate nodes having valid routes to the destination, or the destination node itself, are allowed to send Rout Reply packets to the source. Every intermediate node, while forwarding a Route Request, enters the previous node address and it's BcastID. A timer is used to delete this entry in case a route reply is not received before the time expires. Once the RREQ message reaches the destination or an intermediate node with a fresh route, the destination or the intermediate node responds by sending a route reply (RREP) packet back to the neighbor from which it first received the RREQ message. As the RREP message is routed back along the reverse path, nodes along this path set up forward path entries in their routing cache [2].

B. Route Maintenance

A route discovered between a source node and destination node is maintained as long as needed by the source node. The destination node or some intermediate node moves, the node upstream of the break initiates Route Error (RERR) message to the affected active upstream neighbors/nodes. Consequently, these nodes propagate the RERR to their predecessor nodes. This process continues until the source node is reached. When RERR is received by the source node, it can either stop sending the data or reinitiate the route discovery mechanism by sending a new RREQ message if the route is still required.

IV EXPERIMENTAL SETUP

The setup used in our study consists of 40 mobile nodes moving randomly in a subnet of seven kilometer by seven kilometer. Some of the nodes move out of the subnet and return back after a delay d_n. The nodes are programmed to move at various speeds at different trajectories. Initially the nodes are all placed randomly in the subnet. All the nodes were programmed to run AODV routing protocol. In the first phase of the experiment AODV protocol is run with the destination only flag set to '0'. In this mode a route reply RREP is created by the intermediate nodes between the source and destination. During route discovery when a mobile terminal N_k receives a RREQ from another terminal, it first creates or updates a route to the previous hop without a valid sequence number. The terminal then increments the

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hop count value in the RREQ by one, which indicates a new hop through the intermediate node. The next task of the terminal running AODV protocol is to search for a reverse route to the originator terminal. The intermediate node then generates a RREP (route reply) to the originator. In the second phase the destination flag is set to '1'. When the destination flag is set, the intermediate node will not send the generate route replies.

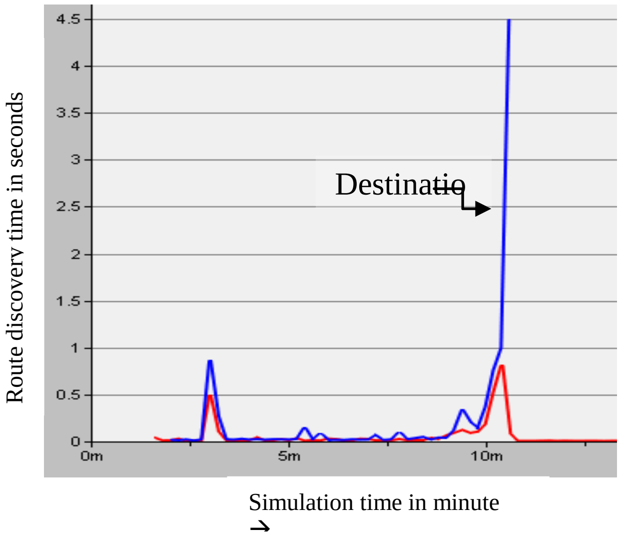

Figure 2 : Route discovery time

From Figure 2. It can be observed that route discovery time is increase drastically if the destination only flag is set when the node is highly mobile and the number of nodes in the subnet is lower than the initial population of 40 nodes. This shows that destination only flag 'set' can adversely affect the network during route discovery in a sparse network. In this paper we studied the effect of destination only flag of the AODV protocol.

The challenge in a bandwidth constrained environment is to reduce the non data traffic and the traffic sent within the route discovery process to a minimum. From figure 3 it is clear that the non data traffic falls down to almost one third of the traffic when the destination only flag is set. As the number of nodes increase and if the nodes are highly mobile in a bandwidth constrained environment, the performance of the system improves. Similarly from figure 3 it can be seen that the total number of route errors is extremely as the cached data in the intermediate nodes are not fully utilized.

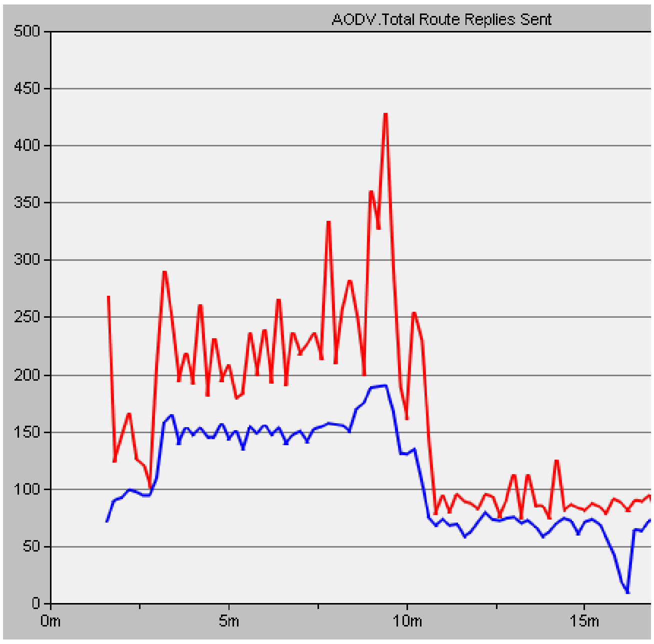

Figure 3 : Total route replies sent

V CONCLUSION

The experimental setup consists of 40 nodes which were highly mobile moving at average speeds. Part of the nodes were designed to move out of the subnet and back so that the subnet becomes sparsely populated for a short period of time. Due to the constrained bandwidth in the network, it has been found that if the destination only flag is set, the QOS of the network does not deteriorate. However further work needs to be done as how to improve the route discovery time when the network is sparse with many nodes moving out of the subnet.

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