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Throughput Enhancement by Robust Routing in MANET

Manikonda Aparna Motahar Reza*

Department of Computer Science and Engineering

National Institute of Science and Technology

Berhampur, India

***Abstract*— An ad hoc wireless network is highly impacted by the dynamic stochastic process of its underlying links which leads to link breaks during data transaction. Hence, to provide uninterrupted data transaction many routing algorithms have link recovery and maintenance procedures to minimize the loss of data. However these procedures do not guarantee reliable data transmission in some special application conditions with harsh requirements on Packet delivery ratio and link quality. In this paper, we introduce an algorithm called robust route AODV which is a modification over AODV to improve the performance of the network by finding those routes which can stay intact for a certain period of time.**

***Keywords*—Ad-hoc networks RR-AODV, AODV, Robust routes, Throughput .**

I. INTRODUCTION

Mobile Ad hoc networks are the special kind of networks where information is relayed from one point to another point without any centralized supervision. Each mobile node is equipped with a wireless transmitter and receiver using antennas through which nodes can communicate directly with other nodes within their wireless transmission range. In general, mobile nodes in ad hoc networks are free to move randomly and organize themselves arbitrarily. The network topology may change with time as the nodes move or adjust their transmission power, so it can change rapidly and unpredictably. A central challenge in the design of ad hoc network is in maintaining routes and links between these mobile nodes.

Different algorithms have been developed to improve the link quality. A large amount of work has been done to improve the quality of service in Manets [1-4], as well as extending existing protocols with QoS features [5-9, 11]. Most of such performance analysis work is based on simulation studies with several design parameters in commercial settings.

In this paper we have proposed an algorithm called RR-AODV which is a robust route AODV [10] an improvement over the basic AODV routing protocol to enhance the throughput by finding robust routes. In the proposed scheme each node proceeds to identify the best acceptable route to be used next, so as to forward the received packet. In RR-AODV the advantage is that it tries to find out the stable route at every node which in turn minimizes the route drops by improving the throughput.

The rest of the paper is organized as follows. Section II briefly describes the working principle of AODV. Section III Describes our proposed method RR-AODV and presents the details of the packet structures with the conventional AODV. Section IV presents the simulation environment and experimental results. Finally conclusions and future work is drawn in Section V.

II. THE AODV ROUTING PROTOCOL

The AODV routing protocol (Perkins et al., 2003; Belding-Royer & Perkins, 2003) is an on demand routing protocol based on the DSDV protocol (Perkins & Watson, 1994). The main characteristics of AODV are to use the periodic beaconing for neighbour sensing and sequence numbering procedure of DSDV and a flooding-based route discovery procedure. The protocol consists of two parts: route discovery and route maintenance.

A. Route discovery

Whenever a source needs a route to a destination, it first checks whether it has a route in its route cache (routing table). If it does not have a route, it initiates a route discovery by flooding a route request (RREQ) packet for the destination in the network and, then, waits for a route reply (RREP) packet. When an intermediate node receives the first copy of an RREQ, it sets up a reverse path to the source using the previous hop of RREQ as the next hop on the reverse path. In addition, if there is a valid route available for the destination, it unicasts an RREP back to the source via the reverse path; otherwise, it rebroadcasts RREQ. Duplicate copies of RREQ are immediately discarded upon reception at every node. The destination on receiving the first copy of an RREQ forms a reverse path in the same way as intermediate nodes, and it also unicasts an RREP back to the source along the reverse path. As RREP proceeds towards the source, it establishes a forward path to the destination at each hop. Note here that the destination generates RREPs only when its destination sequence number is grater than or equal to the destination sequence number of the RREQ received.

B. Route Maintenance

Route maintenance is done by means of route error (RERR) packets. When an intermediate node detects a link failure (e.g., via a link-layer feedback), it generates an RERR. RERR propagates towards all sources having a route via the failed link, and erases all broken routes on the way. A source upon receiving RERR initiates a new route discovery if it still needs the route. Apart from this route maintenance mechanism, AODV also has a timer based mechanism to purge stale routes.

III. PROPOSED SCHEME

In this section we briefly describe our proposed algorithm RR-AODV which stands for Robust Route AODV. In RR-AODV the original AODV is modified during the route discovery phase. The key idea for finding the robust route is to use a metric called robust route index which is computed as weighted sum of path hop-length, and average speed between the individual nodes with nodal delay identifiers. In this algorithm during the route discovery phase each node forwards the RREQ packet to the highest robust route index among multiple RREQ packets received. Unlike in AODV, here each node waits for a prescribed amount of time in collecting the several RREQ packets and then selects an RREQ packet that provides acceptable robustness level while offering the shortest route among all such received RREQ packets.

A. Algorithm

This section describes the RREQ forwarding procedure at every node. This algorithm is carried out during route discovery at every node that receives an RREQ packet, i.e., if a node receives an RREQ packet, this routine is immediately called and run by the node. The steps of the algorithm are described below.

1. Begin
2. A [] = {a_1}; // keep track of received RREQs (including Robust route index).
3: // A is an array subscript *i* in set element a_i represents the order of receipt
4: set the timer as Wt; // Wt is the waiting time for response message
5: while (Wt!= 0)
{ // repeat lines 5~7 until the timer reaches 0
// receives successive RREQs until the predetermined RREQ waiting time expires
6: if any successive RREQ arrives, append it into *A[]*;
7:Wt=Wt-1;
8: }
8: *c* = |A|; // count the number of elements in array *A*[]
9: if(c==1){
    forward a_i ;
    if it is the destination node then
    {
    issue RREP packet
    else
    {
        modify the packet;
        forward a_i ;
    }
}
10: else{ // if there are two or more RREQs received
11: sort A in decreasing (non-increasing) order of RRI;
12: if there are one or more RREQs within the highest RRI in A {
13: select the first-arrived one among them;
14: forward the selected one;
16: }
17: else forward the RREQ with the highest RRI;
18: }
19: return; // afterwards, RREQ packets are ignored

B. Route request procedure

In this section we briefly describe the Route Request packet structure of RR-AODV which is shown in fig. 1. Here few additions are made to the routing table entries of original AODV to find the robust route. We add an RRI which is a robust route index a sum of hop length, average speed between the individual nodes and nodal delay identifiers. As in AODV if either the destination or any intermediate nodes having a fresh route to the destination generates a route reply RREP in response to the RREQ. When a source node needs to send a packet to a destination node while there is not a valid route in the routing table, it broadcasts a route request packet RREQ to find a route to the destination node. A RREQ packet contains RRI which forwards the packet to the highest RRI. When each node receives the RREQ, it computes the RRI and stores these values in the routing table of node. If the node does not have a valid route to the destination node in the routing table, it rebroadcasts the RREQ. If each node has a valid route to the destination node in the routing table when it receives the RREQ, it sends the RREP to the source node. During the route discovery process, when each node receives the RREQ that it has been already processed, it discards the RREQ, which guarantees loop freedom.

Option Type	Flags		Hop Count
SRC IP address	Dest IP address		
Src Seq Num	Dest Seq Num		
RREQ ID	RRI	WT	

Fig 1. Route Request packet structure

In Fig. 2 Node 1 broadcast the RREQ packets to find the best possible route to the destination by considering the RRI with the different set of nodes with in the transmission range.

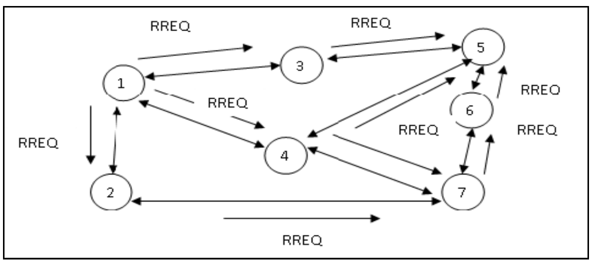

Fig 2. Broadcasting of route request packet

When a source node wants to send a message to some destination node and does not already have a valid route to the destination, it initiates a path discovery process. When an intermediate node receives an RREQ it does the following steps:

- If it is the intended destination then it waits for a prescribed time called WT which is a wait time also known as threshold time in collecting several RREQ packets, which can be determined by RREQ_ID. It then proceeds to examine the RRI index carried in the header of the packet. The node then selects an RREQ packet that provides acceptable robustness level while offering the shortest route among all such received packets. The destination issues a RREP packet to the source node across the selected route.

- If it is not the destination then it modifies the RREQ packet and forwards the RREQ packet.

C. Route Reply procedure

This section describes the route reply procedure of RR-AODV. Route reply packet structure is same as AODV is shown in fig.3. After broadcasting the route request, the source node waits for reply some amount of time, before retransmitting the request again. Till that time, the data packets that are to be transmitted are stored in a buffer.

Reserved	Type	Hop Count
Dest Seq Num	Dest IP address	
Src IP address	Lifetime	

Fig.3: Route Reply packet structure

The node that selected an RREQ packet that provides acceptable robustness level while offering the shortest route among all such received packets. The destination issues a RREP packet to the source node across the selected route.

D. Route Maintenance

During data transmission if there is an interruption due to the movement of intermediate node, then the node that tries to send data will detect a link break. Then it tries to salvage the packet, to find an alternate robust route to reach the destination. If there is any route, then it will send data through that new route. Otherwise, it creates a 'Route Error' packet and sends it to the source node to indicate the failure of the link. When forwarding the route error packet the intermediate nodes remove the route table entries corresponding to the node, which moved and then forward the packet. On receiving the error packet, the source node also removes the entries corresponding to the node and tries to find another route to the destination in its route table.

IV. SIMULATION ENVIRONMENT

A. Simulation model and parameters

We use ns2 [11] to simulate our proposed protocol. In our simulation, the channel capacity of mobile hosts is set to the same value: 2mbps. We use the DCF of IEEE 802.11 for wireless LANs as the MAC layer protocol. It has the functionality to notify the network layer about link breakage.

Our simulation settings and parameters are summarized in table below:

TABLE I

Parameter	Value
Number of simulated Nodes	20-40-60-80-100
Area size of topography (m)	1000 m
Area size of topography (m)	1000 m
Wireless range	250 m
Packet size	512 byte
Send rate of traffic	4 packets / s
Traffic type	Cbr
Speed	2 to10 m/s
Pause Time (s) at simulation	100s
Simulation Time	100

Table 1:Simulation parameters

In our simulation, mobile nodes of sizes 20,40,60,80,100 move in a 1000mX1000m rectangular region for 100 seconds simulation time. We assume each node moves independently with the same average speed. All nodes have the same transmission range of 250 meters. In our simulation, the minimal speed is 2m/s and maximal speed is 10m/s. the simulated traffic is Constant bit rate (CBR)

B. Performance Metrics

We compare our RR-AODV protocol with the AODV protocol. We evaluate mainly the performance according to the following metrics, by varying the nodes as 20, 40, 60, 80, and 100.

1) Control overhead: The control overhead is defined as the total number of routing control packets normalized by the total number of received packets.

2) Average end-to-end delay: The end-to-end-delay is averaged over all surviving data packets from the sources to the destinations.

3) Average Packet Delivery Ratio: It is the ratio of the no. of packets received successfully and the total no. of packets sent.

C. Results

In this experiment, we measure the performance of the protocols by varying the no. of nodes as 20, 40, 60, 80, 100.

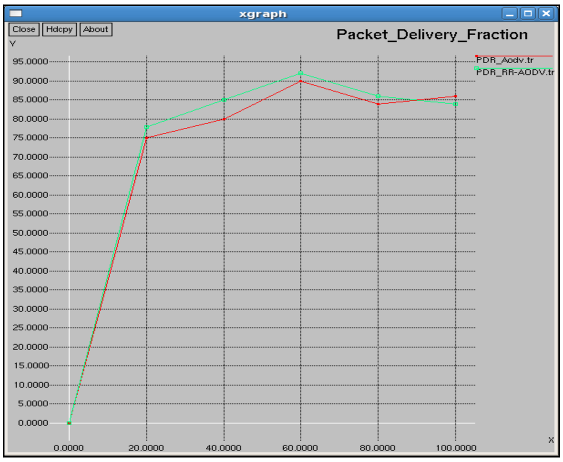

Fig4. Packet delivery fraction vs. number of mobile nodes

Fig 4, highlights the relative performance of network topology, we can see that the packet delivery ratio for RR-AODV increases, when compared to AODV, since it utilizes robust links. But as the number of nodes grows on increasing there will be a drop in the packet delivery ratio this is due to network traffic

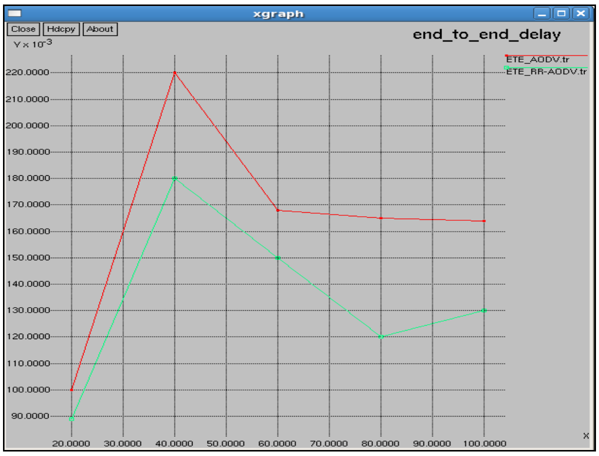

Fig 5, End to End delay vs. number of mobile nodes

Fig. 5, highlights the variations in average end to end delay, we can see that the average end-to-end delay for the proposed RR-AODV protocol is less when compared to the AODV protocol.

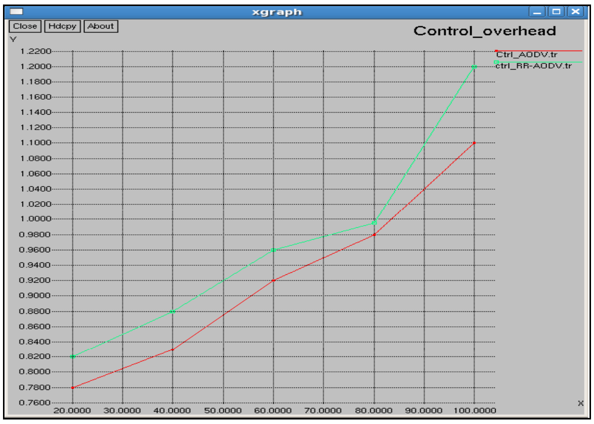

Fig 6, Control overhead vs. number of mobile nodes

Fig. 6 shows the control overhead of the protocols. The RR-AODV values are considerably high as compared with AODV. This is a kind of side effect paid to achieve robust delivery and high performance. As the no. of nodes increases, the normalized overhead is increased as expected.

V. CONCLUSION

In this paper we proposed a new mechanism called RR-AODV which works well under low mobility and tends to improve the packet delivery ratio by finding stable routes. How ever the routing overhead increases when the network size becomes large. Therefore clustering could be considered to improve the network performance and scalability. The security challenges of our proposed protocol will be the subject of our future work.

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