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Performance Comparison of RAODV and MRAODV Routing Protocols in Mobile Ad Hoc Networks

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Abstract. In mobile ad hoc networks, mobile devices wander autonomously for the use of wireless links and dynamically varying network topology. AODV (Ad-hoc on-demand Distance vector routing) is a representative among the most widely studied on-demand ad hoc routing protocols. AODV and most of the on demand ad hoc routing protocols use single route reply along reverse path. Rapid change of topology causes that the route reply could not arrive to the source node, i.e. after a source node sends several route request messages, the node obtains a reply message, especially on high speed mobility. This increases both in communication delay and power consumption as well as decrease in packet delivery ratio. To avoid these problems, a reverse AODV was proposed which tries multiple route replies. The extended AODV is called reverse AODV (R-AODV), which has a novel aspect compared to other on-demand routing protocols on Ad-hoc Networks: it reduces path fail correction messages and obtains better performance than the AODV and other protocols have. In Modified Reverse Ad Hoc On-demand Vector (MRAODV), the route request packet didn't change and it is like as AODV, but rout reply packet must be changed for route stability estimation purpose. By doing this we applied link stability in RAODV for decrease overhead of discovery and maintenance of routing. This protocol also increased the packet delivery ratio in mobile ad hoc networks.

Keywords: Ad-hoc, AODV, Route Stability, NS-2

1. Introduction

Mobile ad hoc networks (MANET) consist of mobile platform which communicate with each other through wireless links without any predetermined infrastructure. Each node not only is a host but also as a router that maintains routes to and forwards data packets for other nodes in the network that may not be within direct wireless transmission range. Topology of a mobile ad-hoc network often changes rapidly and we need to manage this change and cope with problems raised through this type of networks. If the source and destination nodes are not within the transmission range of each other, then intermediate nodes would be served as intermediate routers for the communication between the two nodes. Moreover, mobile platform moves autonomously and communicates via dynamically changing network. Thus, frequent change of the network topology is a main challenge for many important topics, such as routing protocol, robustness and performance degradation. Recently, some adaptive ad hoc routing protocols have been reported. For example, Associativity Based Routing (ABR) [3] which according to this algorithm, each node periodically transmits beaconing ticks to identify itself, and a stable link exists if a large amount of the ticks are received and accumulated at the receiving node. This protocol selects a shortest route pass through stable links. Another

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protocol that uses stability is Signal Stability-based Adaptive routing (SSA)[4] chooses the route if the receiving signal strengths of radio links along this route are larger than a threshold value; otherwise, the shortest path routing algorithm applies to find another route. However, since the correlation time between two receiving signals or ticks is short for an MANET, these two protocols find stable links and routes from deterministic parameters without considering the variation of signal strengths and network topologies of mobile ad hoc networks.

In this paper we first consider the Ad-hoc On-Demand Distance Vector Routing Protocol (AODV) that uses a demand-driven route establishment procedure, then we present an optimized version of this algorithm namely Reverse AODV (RAODV). For increasing of protocol performance, we use route stability parameter to select the best route between available routes. For path discovery, the route with highest stability will be selected. We then present our routing protocol namely Modified-RAODV (MRAODV) routing algorithm which it can be an extension for RAODV. The MRAODV routing algorithm can present good performance for high mobility environments. In this paper we compared the performance of RAODV and MRAODV.

2. Literature Survey

2.1. Ad-Hoc On –Demand Distance Vector Routing Protocol (AODV)

The Ad-hoc On-Demand Distance Vector outing Protocol (AODV)[1], is one of more common routing algorithm in ad hoc networks and is based on the principle of discover routes as needed. AODV is a reactive algorithm that has some capabilities such as; low processing, memory overhead, low network utilization, and it works well even in high mobility situation. AODV routing algorithm is a prominent method for building routes between network nodes. The request is made on-demand rather than in advance, to account for the continually changing network structure, which is likely to in validate routing tables over time [1]. The routing table stores information about next hop to the destination and a sequence number which is received *request* (RREQ) *packet* to its neighbors. The RREQ has following fields:

< source_addr, source_sequence-#, broadcast_id, dest_addr, dest_sequence_#, hop_cnt >

When intermediate nodes receive a *route request packet,* they update their routing tables for a reverse route to the source and like this process, when the intermediate nodes receive *route reply packet* (RREP), they update the forward route to the destination. The *route reply packet* contains the following fields:

<source_addr, dest_addr, dest_sequence_#, hop_cnt, lifetime>

AODV protocol uses sequence numbers to determine the timeliness of each packet and to prevent creation of loops. AODV algorithm uses Route Error Message (RERR) route failures and link failures propagated by a RERR from a broken link to the source node of the corresponding route. When the next hop link breaks, RERR packets are sent by the starting node of the link to a set of neighboring nodes that communicate over the broken link with the destination.

2.2. Reverse AODV Algorithm

AODV routing algorithm builds a single loop-free path to each other node on the network [5]. One disadvantage of AODV and most on-demand routing protocols is a route reply message loss. In reverse AODV algorithm this problem concerned and one efficient approach proposed. AODV and most of on-demand routing is based on single route reply message. The lost of route reply message may cause a significant degradation of performance. In rout discovery phase, a route reply message (RREP) of AODV obtains by the spending cost of flooding the entire network or a partial area. RREP loss leads to source node reinitiate route discovery process which causes degrade of the routing performance, like high power consumption, long end-to-end delay and inevitably low packet delivery ratio. In RAODV algorithm, loss of RREP messages considered. In reverse AODV (RAODV) [5], destination node uses reverse RREQ to find source node. It reduces path fail correction messages and can improve the robustness of performance. Therefore, success rate of route discovery may be increased even though high node mobility situation.

Route request packet in RAODV like AODV contain following fields where, the source and destination addresses, together with the broadcast ID, uniquely identify this RREQ packet.

TYPE	RESERVED	HOP COUNT
Broadcast ID		
Destination IP Address		
Destination Sequence Number		
Source IP Address		
Source Sequence Number		
Request Time		

Fig. 1: “RREQ Message Format”

TYPE	RESERVED	HOP COUNT
Broadcast ID		
Destination IP address		
Destination Sequence Number		
Source IP Address		
Reply Time		

Fig. 2: “R-RREQ Message Format”

When the destination node receives first route request message, it generates reverse request (R-RREQ) message and broadcasts it to neighbor nodes within transmission range. The reverse request packet contains these fields which show in the above fig.2.

When broadcasted reverse request packet arrives to intermediate node, it will check for redundancy. If it already received the same message, the message is dropped, otherwise forwards to next nodes and when the source node receives first reverse request message, then it starts packet transmission, and late arrived R-RREQs are saved for future use. The alternative paths can be used when the primary path fails communications.

2.3. Modified Reverse Ad Hoc On Demand Distance Vector (MRAODV) Routing Algorithm

RAODV routing algorithm increases performance and when route fails occurs, the source node should select the best route between available routs. In this MRAODV, we apply stability estimation method for rout selection and to increase performance. Breaking radio links among nodes may easily happen due to the changing network topologies.

Therefore, a good design of the ad hoc routing protocol is needed to overcome these problems. Several ad-hoc routing protocols Of MANETs have been proposed in recent years. RAODV algorithm solves this problem with selecting the rout with minimum length in available set of routes that have been already found. Here we change this stage with our approach. One kind of link stability is used in AOSV [6]. In AOSV algorithm for computing link/rout stability, initially every node begins to estimate the stabilities of radio links to its neighbors and for keeping track of the link stabilities between a node and its neighbors, each node periodically broadcasts Hello message (HELLO) including the location of the broadcasting node toward its neighbors. In this protocol, when a node receives Hello messages, this node first calculates the distance between neighboring node and itself from the received HELLOs and for sake of awareness of distance, evaluates the stability of radio link to the broadcasting neighbor. This information is recorded for estimating stabilities of multi-hop routes in follow-up processes. In path discovery process, source node broadcasts RREQ which has new link stability field. Intermediate node sends receive RREQs and rebroadcast them. The intermediate nodes rebroadcast only the RREQ with the maximum value in route stability among received RREQs. In our proposed routing algorithm (MRAODV), when a source node wants to communicate with a destination node, first it broadcasts a RREQ packet. This stage is the like of AODV algorithm. When destination receives a RREQ message, it broadcasts R-RREQ message to find source node. Each intermediate node which receives the R-RREQ message, calculates route stability by equation (1) and the route stability for each router is calculated by the following equation.

$$RS_r = \Pi \; ns_i \qquad (1)$$

Where RS_r is the route stability of the route r,

L_r is the set of available routes and

ns_i is the stability of node i .

The stability of each route can be calculated by following equation:

$$ns_i = \frac{t - t'}{L_{n_t} - L_{n_{t'}}} \qquad (2)$$

Where L_{nt} denotes the location of node n_i at the time t. For t computation of stability for each node we need to obtain t - t′ delay. When source node receives R-RREQ, it will have multiple routes to destination, so it selects stable route to destination node.

According to this fig.3 when one intermediate node moves and causes link breaks then active route fails and a new route must be selected. In AODV, this process is done by initializing route discovery procedure and in RAODV with selecting one available route with minimum hop count. In MRAODV [6], a new route with maximum stability is selected between available routes. We add link stability field to R-RREQ packet. When destination node receives first RREQ, it broadcasts R-RREQ. Every intermediate node which receives R-RREQ packet, it computes link stability and records it. When source node receives R-RREQ packets, it has information about stability of available routs to destination node. So it can select a route with highest stability. When data transmission is started then this information is applied for route maintenance.

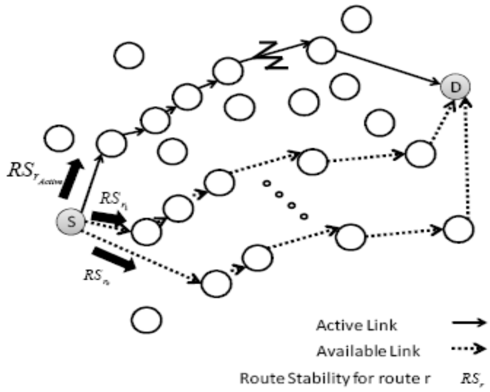

Fig. 3: "Selection of one available Stable route from source node to destination node when active link fails"

When a route established between source and destination, data transmission stage can be started. In high mobility environments, link failure is a common phenomenon which can be occurred. We claim that the MRAODV routing algorithm is suitable for these environments. Source node is aware to stability of the routes which it has found in path discovery stage If an intermediate node in active route moves and link breaks source node cane select a stable route instead of failed rout. Both reverse RAODV and AODV routing algorithms, source node selects new path based on shortest path method and when mobile node moves quickly, these algorithms cannot show good performance. Here, we add link stability parameter to RAODV algorithm to select the best route between available routes set, when active route fails.

3. Performance Results

In this section, we first describe the simulation environment used in our study and then discuss the results in detail.

3.1. Simulation Environment

Our simulations are implemented in Network Simulator (NS-2) . The simulation parameters are as follows:

- Number of nodes: 10, 20, 30, 40, 50, respectively;
- Testing area: 1000m x 1000m;
- Mobile speed: uniformly distributed between 0 and MAXSPEED (we choose MAXSPEED = 2, 5, 10, 25, 50, 75m/s, respectively);
- Mobility model: random way point model (when the node reaches its destination, it pauses for several seconds, e.g., 1s, then randomly chooses another destination point within the field, with a randomly selected constant velocity);

- Traffic load: UDP, CBR traffic generator;
- Radio transmission range: 250 m; and
- MAC layer: IEEE 802.11.
- Each simulation is run for 100 seconds and repeated for 10 times. We compare our proposed R-AODV with MRAODV.

3.2. Results

To evaluate performance of MR-AODV with that of RAODV protocol, we compare them using two metrics:

- Delivery Rate: the ratio of packets reaching the destination node to the total packets generated at the source node.
- Control Overhead: sum of all route request messages, route reply message and route error messages.

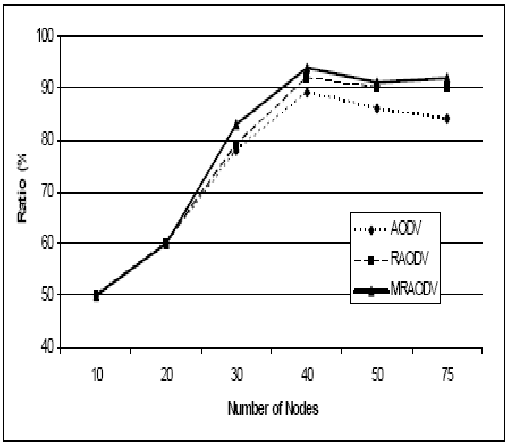

Fig. 4: " Packet Delivery Ratio, when the number of nodes varies"

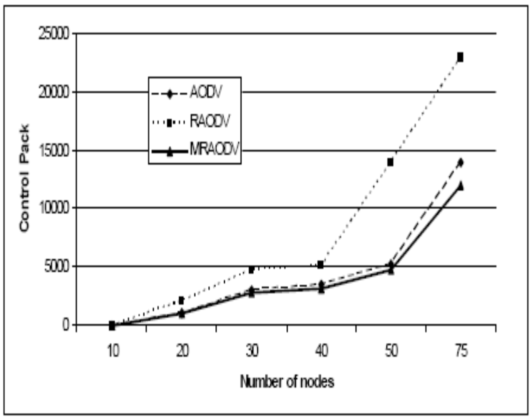

Fig. 5: "Control Packet Overhead, when the number of nodes varies"

4. Conclusion

This paper does the comparison of RAODV and MRAODV routing protocols. In MRAODV we changed route replay packet configuration of RAODV and named it RRREQ. These packets should be transmitted to destination node for building multiple routes. According to the simulation results, this algorithm is better than other version of AODV algorithm.

For the future work, In MRAODV the concept of energy is also included and so assign the priority of different dedicated paths between source and destination on the basis of both energy as well as the stability of nodes or paths.

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