A NOVEL APPROACH TO FIND THE ALTERNATIVE PATH FOR ROUTE MAINTENANCE IN AODV

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Abstract- Mobile Ad-hoc Network (MANET) is a Network, which permits the mobile nodes to commune in lack of a permanent Infrastructure. Nodes in MANET communicate via wireless multi hop links. MANET provides a good platform for any time anywhere networking. Due to frequent node movement routing algorithm in wired network is not suitable for MANET. Several separate routing algorithms have been designed for MANET. Among this, AODV is the most popular routing algorithm. AODV is the on demand routing algorithm and two phases of this are route establishment and route maintenance. Route maintenance is the major issue in AODV when there is only one path is established between source and destination. Wireless link breakage is higher in ad-hoc networks due to the node movement, so alternative paths are needed for the route maintenance. This paper explores the need for saving the alternate path for path maintenance and also gives a new idea for finding an alternative path in AODV during link failure.

Keywords-MANET; routing protocol; AODV

I. INTRODUCTION

Ad-hoc networking [5] is an emerging area of study as it utilizes a diversity of applications. Mobile ad-hoc network (MANET) can change locations and configuring by itself on the move. MANET is a self organized and self maintained network. The nodes in the network are self sufficient and capable of acting as either router or source. This network consists of wireless mobile nodes and uses wireless connection for communication. The main attraction of MANET network is its infrastructure less property.

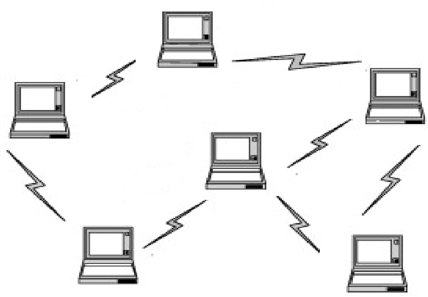

Figure 1. Mobile ad hoc network

Ad hoc network is a reconfigurable network since it can form with any number of mobile nodes at any time. Because of this potentiality the network is very useful when the infrastructure is not available or very costly, also it is very easy to deploy. There is no central administrator in MANET as shown in Fig. 1. So the design of routing protocol for ad-hoc network is a complex task. Efficient routing protocols [11] are needed for the network as the link failure is high due to the dynamic network topology and the packet drops as it travels through multiple hops. Routing protocols for static network are not suitable for MANET.

Link failure probability, high error rate, dynamic topology and power consumption are needed to be considered. An excess of routing protocols has been projected for mobile ad-hoc networks. The routing protocols are mainly classified into two families, proactive and reactive [9]. In proactive routing, the routes are automatically computed and stored in the routing table when the network is configured and are independent of communication. The routing tables are periodically exchanged and update the routing table accordingly. This increases the network overhead. Routing protocols such as DSDV (Destination Sequenced Distance Vector) and OLSR (Optimized Link-State Routing) [13, 14] are of this type. They are also known as table driven routing. Another style of routing is reactive or on-demand routing. It finds the route whenever a source wants to deliver data to an unknown destination. Ad-hoc routing protocols such as AODV (Ad-hoc On-demand Distance Vector) and DSR (Dynamic Source Routing) [14] are examples of this type. On demand routing protocol does not require the exchange of periodic routing table update and it does not have a map of the network. This reduces the network overhead.

Ad-hoc On-demand Distance Vector (AODV) [8, 9] protocol has become very popular among on demand protocols. The original AODV does not utilize multiple paths. The protocol creates and preserves routes only on demand. It is based on hop- by-hop routing strategy. Researchers have been made several improvements on AODV timely [10]. The purpose of this paper is to study the route establishment and to enhance the route maintenance in AODV algorithm. The paper also examines the major challenges in link breakage due to the dynamic topology of MANET. Delay in route discovery and frequent route discovery process can cause the performance adversely. The multipath on-demand protocols are helpful to lighten the problem by finding multiple paths in a single route discovery process. . The new route discovery is needed only when all routes to the destination fail. This proposal tries to find an alternate route whenever there is a problem in existing path without invoking the route establishment process.

The rest of this paper is organized as follows. Section 2 gives an idea of AODV routing protocol. Section 3 elaborates the need for route maintenance in AODV. Related works are explained in section 4. Path maintenance scheme is discussed in section 5 and a conclusion is made in section 6.

II. Briefing of AODV

The two mechanisms which are supported by AODV [9] are route establishment and route maintenance. When a source node needs a route to destination, it invokes a route establishment process. The route discovery is a broadcast process and it includes a route request (RREQ) packets starts from source to destination and waiting for a route reply (RREP) packet. AODV uses dynamic route table entries at intermediate nodes. When an intermediate node receives a RREQ packet it first checks whether a valid route is available to destination. If a valid route is available, the intermediate node generates a RREP back to the source. Otherwise the RREQ packets are rebroadcasted. So a large network with many nodes can make use of the benefit of dynamic route setup on demand.

A. Route Establishment and Route Maintenance

When a source node starts a communication to the destination, it initiates a route request and the message is broadcasted. The RREQ packet encloses some fields, shown in Table 1.

TABLE I. RREQ Packet

Source address
Source Sequence Number
Broadcast Id
Destination Address
Destination Sequence Number
Hop Count

As the broadcast id is incremented for each route request, the node can discard duplicate copies of the RREQ. An intermediate node receiving a RREQ and if a valid route is available to the destination it can send a route reply (RREP) through the reverse path to the source, else the node rebroadcast the RREQ. The two sequence numbers, the source sequence number and the destination sequence number, included in the RREQ packet are used to maintain freshness information about the reverse route to the source and how fresh a route to the destination must be before it can be accepted by the source respectively. If the intermediate node has found a route to the destination, it determines whether the route is valid by comparing the destination sequence number in its own table entry to the destination sequence number in the RREQ. A higher Sequence numbers signifies a fresher route. If the destination sequence number is greater than that recorded by the intermediate node, the intermediate node must not use its recorded route to respond to the RREQ. Instead, the intermediate node rebroadcasts the RREQ. The intermediate node is responded only when it has a route with a sequence number that is greater than or equal to that contained in the RREQ. Then the node unicasts a RREP back to its neighbour from which it received the RREQ as depicted in Fig. 2. A RREP contains some fields, shown in Table 2.

TABLE II. RREP PACKET

Source address
Destination Address
Destination Sequence Number
Hop Count
Life Time

When the RREP travels back to the source, each node along the path sets up a forward pointer to the node from which the RREP came, updates its timeout information for route entries to the source and destination, and records the latest destination sequence number for the requested destination. The RREQ and RREP messages are shown in Fig. 2.

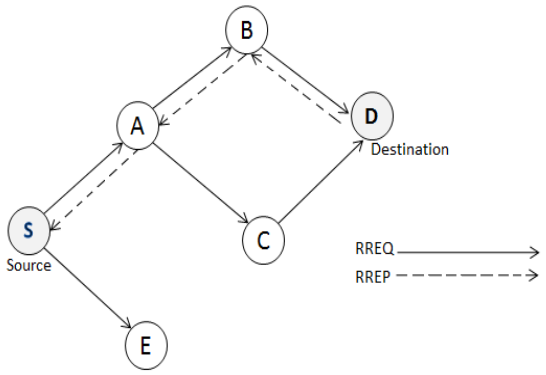

Figure 2. RREQ and RREP messages

In an ad-hoc network the nodes move freely and the probability of link failure is high. The route maintenance in AODV can be done using route error (RERR) packets. When a link is failed a RERR message is sent back to the source node to initiate a route rediscovery. AODV also supports periodic HELLO messages to ensure symmetric links, as well as to detect link failures. A node can keeps track of its Neighbors by getting a HELLO message that each node broadcast at set intervals.

III. NEED FOR AN ALTERNATE PATH IN AODV

In ad-hoc networks the node move freely so there may be a frequent chance of link breakage. The call for multiple paths arises as an alternative for the new route discovery. The on-demand routing protocols instigate a route discovery and route maintenance process whenever there is required. The new route will be chosen from the existing paths while we notice from the initial route discovery. In MANET many multiple paths are available through the same or different intermediate nodes. In single path routing only one route is saved at the destination. When a link fails, the node send a route error (RERR) message and the source node immediately starts the route discovery process, if there is no alternate route is available from the source to destination. The RREQ messages are again broadcasted and find a new route. Many routing protocols support multi path routing [12]. But most of them do not consider multiple paths through an intermediate node.

Consider the scenario in Fig. 2. There are multiple paths available from the source to the destination. Initially the source node S broadcast RREQ and the neighbours A and E sends an RREP if it has a valid route to destination. Otherwise the nodes broadcast the request to its neighbours. The process continues until it reaches the destination or it locates a valid route to the destination. The node D sends an RREP back to the source node. Presently there are two routes available from D to S, D-B-A-S and D-C-A-S. But these two routes are passing through the same intermediate node A. So currently there is only one path is stored at the source node to the destination when considering the intermediate node passes only one RREP. The node A has two routes to the node D. If a link B to D fails, the RERR is generated and the source node starts to broadcast RREQ even if the intermediate node has an alternate route to destination with the same hop count. So there is an unnecessary

RREQ broadcasting and overhead. In the proposed scheme the intermediate nodes plays an important role to avoid needless route discovery process.

IV. RELATED WORK

Many studies and comparisons were carried out by many researchers in order to analyse the performance and behaviour of AODV. Most of the works in this category use single route and do not make use of multiple alternate paths. In AODV [1] routing, when a source wants to transmit a data to a destination, it broadcast a RREQ and waits for a RREP and it keeps only one route table entry for transmitting data. If any link breakage during the transmission, the source node must have to initiate another route discovery process. In AODV the nodes respond at most only once to RREQ, so that it can reduce the total number of RREP messages. Several multipath routing algorithms are proposed by many authors. In EAODV [2] the source node saves only distinct routes to the destination. In EAODV the destination node can respond multiple times to a request but the intermediate node respond only once. The Multiple paths from source to destination are valid, only if the intermediate nodes in the path are distinct [6]. When a node receives a RERR message it checks for an alternate route instead of initiating a new RREQ discovery process. The intermediate node respond only once to a RREQ but the destination node respond k times. In AODV-BR [3] the source node imitates a route discovery process by flooding the RREQ packet and the receiving node either broadcast it or send back a RREP if it has a route to the destination. In this method the intermediate node overhears the RREP packet from its neighbours and marks it as the next hop node to the destination. The alternative routes are stored and it will create a mesh structure.

In AOMDV [4] it computes multiple loop free and link disjoint paths. It provides efficient fault tolerance by using proficient recovery from route failures in dynamic networks. It establishes multiple routes during route discovery. AOMDV introduces an idea of hop count. It finds link disjoint paths. Unlike in AODV, replicas of RREQ are not immediately discarded by the intermediate node. Each copy is checked to see if it gives a new node-disjoint path to the source. Also, in this approach it does not mention how to maintain the alternative paths. The entries for a given destination will time out eventually, the routing table entries must be refreshed based on how recently they have been used for data forwarding.

V. PROPOSAL FOR IMPROVEMENT

To support multi path routing, the source node stores multiple paths to destination. The table at the source node has the following fields.

TABLE III. Source node table

Source
Destination
Sequence number
Nexthop1,hopcount1
Nexthop2,hopcount2
…………………………
Hop count
Expiration time

The multiple routes are represented by nexthop1, nexthop2 etc. When a source node gets a RREP from different intermediate nodes, the route entry table at the source node will store the next hop and hop count. Multiple paths are represented by next hop1, next thop2 etc. The initial path can be chosen according to the shortest path first routing approach.

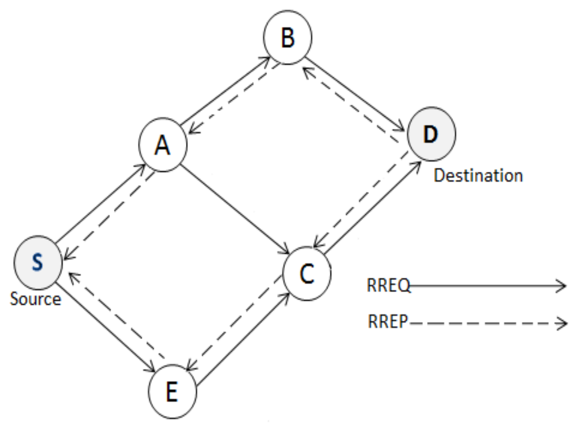

Figure 3. Multipath routing via an intermediate node

In Fig. 3 the source node S initiates a route discovery and the neighbouring nodes A and E forward the request until it reaches the destination, since the intermediate nodes does not have any valid route to the destination. The freshness of the route can be verified from the destination sequence number. The node D gets a RREQ from both B and C. To enable multipath routing the destination node generates multiple route replies (RREP). The source node S gets two different route replies from the destination through the intermediate nodes B, A and C, E.

In normal multipath routing, when a link fails during the data transmission, the RERR message is generated and the source node selects the next shortest path from the route table entries. When the intermediate node A gets RREP from both B and C and it forwards only one route reply as in [2]. In the proposed scheme when an intermediate node gets multiple route replies, it can cache the path in its temporary storage. The node S will have two entries to the destination, S-A-B-D and S-E-C-D. When a link fails in an active route, the node sends a RERR message to the source node. The source node can select the next available route entry from its table. The proposed scheme says, instead of simply forwarding a route error message, the intermediate node can notify the source node by adding next hop and hop count, if it possesses another valid route to the destination. If the link B-D fails, a RERR message is used to notify other nodes that the loss of that link has occurred. When the source node getting a RERR message it can check any valid route is available through the same intermediate node. The source node S has another entry to the destination. The source node can do a comparison between the new routes and already stored alternate path. So it can make use of the new path instead of initiating a new route discovery. By doing so the broadcasting overhead can be reduced.

Another problem with multipath routing is the maintenance of routing table entries. The paths are initially discovered during the route discovery process. A primary path is chosen for the data transmission considering the hop count. If the primary path might have been used for a long time until a link breaks along the path. Then the alternate table entries are expired eventually. If the path S-A-B-D works for a long time, then route entries in C will time out as it did not get a chance to be used for a long time. As a solution to this problem we can send refresh packets when an alternate path is expired while the primary path is being used.

VI. CONCLUSION

The multipath routing enables to reduce the overhead of route discovery process of AODV. The new approach in this paper enhances the AODV by taking the benefit of alternate paths that can be obtained during route discovery. The scheme is more suitable when the network has no disjoint multi paths to the destination. An intermediate node also caches the route information when a RREP packet sent. This also ensures the performance enhancement by reducing the number of route discovery process. Without commences a new route discovery process, the new route can be set up and the active transmission can be continued. This approach does not have any additional computational complexity and this uses the same principle of AODV protocol which is universally accepted.

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