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A NEW ON DEMAND MULTIPATH ROUTING ALGORITHM FOR WIRELESS AD HOC NETWORK

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Abstract—

In recent years, on-demand routing protocols have attained more attention in mobile ad hoc networks as compared to other routing schemes due to their abilities and efficiency. There exist many on- demand routing protocols for mobile ad hoc networks (MANETS). Most of the protocols, however, use a single route and do not utilize multiple alternate paths. Multipath routing allows the establishment of multiple paths between a single source and single destination node and when a path breaks an alternate path is used instead of initiating a new route discovery, hence multipath routing represents a promising routing method for wireless mobile ad hoc networks. Multipath routing achieves load balancing and is more resilient to route failures. Recently, numerous on-demand multi-path routing protocols have been proposed for wireless mobile ad hoc networks. Performance evaluations of these protocols showed that they achieve higher throughput, lower end to-end delay and higher packet delivery ratio in comparison with single path routing protocols. In this paper, we propose a new shortest multiple routing algorithm for MANETs. It is based on DSR, but which makes the destination nodes get the shortest unattached routes correspondingly is that only the destination nodes can respond to the routing request (RREQ), and the intermediate hosts rebroadcast the shorter RREQ packets with some conditions.

Keywords—*Uunipath Routing in MANETs, Multiple routing algorithm*

I. INTRODUCTION

Mobile ad hoc networks consist of a collection of wireless mobile nodes which dynamically exchange data among themselves without the reliance on a fixed base station or a wired backbone network [1]. These nodes generally have a limited transmission range and so, each node seeks the assistance of its neighboring nodes in forwarding packets and hence the nodes in an ad-hoc network can act as both routers and hosts, thus a node may forward packets between other nodes as well as run user applications. MANET nodes are typically distinguished by their limited power, processing, and memory resources as well as high degree of mobility [5]. Due to the limited transmission range of wireless network nodes, multiple hops are usually needed for a node to exchange information with any other node in the network. Thus routing is a crucial issue to the design of a MANET. The key challenge here is to be able to route with low overheads even in dynamic conditions. Overhead here is defined in terms of the routing protocol control messages which consume both channel bandwidth as well as the battery power of nodes for communication/processing [6]. In order to reduce routing overheads, on-demand routing protocols build and maintain only needed routes. In recent years, on-demand routing protocols have attained more attention in mobile ad hoc networks as compared to other routing schemes due to their abilities and efficiency. They are able to organize themselves dynamically with lower memory overhead and lower bandwidth requirement than table driven protocols (proactive protocols). However , as there were still some bottlenecks in the pioneering versions of on-demand routing protocols, more research work has been done to rectify most of these problems. For example, many on-demand routing protocols, such as Associativity Based Routing (ABR), Dynamic Source Routing (DSR) [4,19,20] and Ad hoc On-demand Distance Vector (AODV) [3,17,18] use a single route per data session. Therefore a new route discovery has to be initiated if the active route is broken. Single path on demand routing protocols have been heavily discussed and examined in the past. A more recent research topic for MANETs is multipath on demand routing protocols. Multipath routing protocols establish multiple disjoint paths from a source to a destination and are thereby improving resilience to network failures and allow for network load balancing. These effects are particularly interesting in networks with high node density (and the corresponding larger choice of disjoint paths) and high network load (due to the ability to load balance the traffic around congested networks). Work on single path (or unipath) routing in MANETs has been proposed in [3] [4]. In this paper, we propose a new multiple routing algorithm algorithm based on DSR for MANET.

The rest of paper is organized as follows. At first, the is introduced simply in section2. The new algorithm is given in section3 with a detailed description. Section4 provide the analysis and simulation results of DSR and multiple routing algorithm. Conclusions are in section5.

II. UNIPATH ROUTING IN MANETS

Two main classes of ad hoc routing protocols are table-based and on-demand protocols [10] In table-based protocols [8] [9], each node maintains a routing table containing routes to all nodes in the network. Nodes must periodically exchange messages with routing information to keep routing tables up-to-date. Therefore, routes between nodes are computed and stored, even when they are not needed. Table-based protocols may be impractical, especially for large, highly mobile networks. Because of the dynamic nature of ad hoc networks, a considerable number of routing messages may have to be exchanged in order to keep routing information accurate or up-to-date.

In on-demand protocols [3] [4], nodes only compute routes when they are needed. Therefore, on-demand protocols are more scalable to dynamic large networks. When a node needs a route to another node, it initiates a route discovery process to find a route.

Most currently proposed routing protocols for ad hoc networks are unipath routing protocols. In unipath routing, only a single route is used between a source and destination node. Two of the most widely used on-demand protocols are the Dynamic Source Routing (DSR) and the Ad hoc On-demand Distance Vector (AODV) protocols.

TheDSR protocol is composed of two mechanisms that work together to allow the discovery and maintenance of source routes in the ad hoc network:

- *Route Discovery* is the mechanism by which a node **S** wishing to send a packet to a destination node **D** obtains a source route to **D**. Route Discovery is used only when **S** attempts to send a packet to **D** and does not already know a route to **D**.
- *Route Maintenance* is the mechanism by which node **S** is able to detect, while using a source route to **D**, if the network topology has changed such that it can no longer use its route to **D** because a link along the route no longer works. When Route Maintenance indicates a source route is broken, **S** can attempt to use any other route it happens to know to **D**, or can invoke Route Discovery again to find a new route. Route Maintenance is used only when **S** is actually sending packets to **D**.

Route Discovery and Route Maintenance each operate entirely *on demand*. In particular, unlike other protocols, DSR requires *no* periodic packets of *any kind* at *any level* within the network. For example, DSR does not use any periodic routing advertisement, link status sensing, or neighbor detection packets, and does not rely on these functions from any underlying protocols in the network. This entirely on-demand behavior and lack of periodic activity allows the number of overhead packets caused by DSR to scale all the way down to *zero*, when all nodes are approximately stationary with respect to each other and all routes needed for current communication have already been discovered. As nodes begin to move more or as communication patterns change, the routing packet overhead of DSR *automatically* scales to only that needed to track the routes currently in use.

III. **MULTIPLE ROUTING ALGORITHM**

The congestion or disconnection is happening on one of paths of the ad hoc network where the single path routing attention has been paid to multiple routing [11] [12] whose concept has been used for circuit switched and packet switched networks, as it provides an easy mechanism to distribute traffic and balance the network load, as well as provides fault tolerance. We propose a new multiple routing algorithm named SMSR (the shortest multiple source routing) algorithm. It applies the similar route discovery of DSR protocol, but what is different is that only the destination node can replay the RREP packet and all the intermediate nodes rebroadcast the shortest RREQ(here we recognize the RREQ which includes the fewest hops is the shortest one)by some restrictions. Then, the destination can get some correspondingly shortest disjoint routes. Here only disjoint routes are selected as the link failure in one path will not affect the others. And we also have changed something about route maintenance as it can be more suitable for ad hoc networks. The detailed introduction of the new algorithm is explained as follows:

A. Route Discovery

The source node S initiates route discovery by flooding the network using query messages (RREQ) seeking some routes to the destination when there is no route in its cache.

On receiving the RREQ packet, the intermediate nodes doesn't respond any route reply (RREP) message to the source in spite of that whether there's any route messages about the destination or not, as it can ensure the validity of the routes that have been found in the process of the route discovery. The detailed processing of the intermediate nodes can be summarized as follows:

When the intermediate nodes receive a RREQ, they will first compare with the packet which is in its cache. If the hops that are included in RREQ of the cache is more than that in the new arrived RREQ , the data in the cache should be updated and the new arrived RREQ will be rebroadcasted, or else the RREQ should be thrown away. If it is the first time that the intermediate nodes receive the RREQ, keep and rebroadcast it. In doing so, the shortest route between the intermediate node and S will be found. The reason for us pursuing the shortest route is that it can more or less solve the problem that routes may be easily broken if they are too long because of dynamical changing network topology in a large-scale ad hoc network.

The intermediate nodes will not transfer the RREQ immediately but wait for a fixed delay and doing some handling if they detected that their next hops are the destination nodes. Because we should consider the following problems:

Suppose the node "N" is a intermediate node and its next hop is the destination node. Depending on 1), if the node N receives a RREQ at first time, it will keep the RREQ and transfer it to the destination node. When receives the RREQ again, N should do the comparison, if the result is that the hops of the RREQ is fewer than that in N's cache, N will update the data in its cache and transfer this RREQ to the destination again. In doing so, the destination may receive too much RREQs from the same intermediate nodes, thus, a great much of the burden will add to the destination and cause the meaningless routing overhead as well as the delay. And what the node N do during the delay is that it should compare the RREQs that have received one by one ,finally, choose the shortest one and transfer it to the destination node. Besides, the node N won't transfer any data to the destination until the new route discovery is initiated.

The destination will receive disjoint multiple routes during the delay and do the multiple selecting algorithm, then reply the RREP. The route discovery also can be explained by a simple topology chart with 16 nodes as shown in the Fig2.

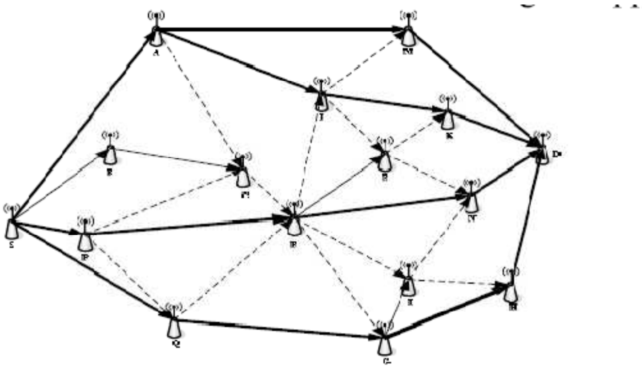


Fig3. Route discovery topology chart

Suppose that the node S is the source node, the node D is the destination node, the real lines mean the routes that will be kept in the caches of the corresponding nodes, the broken lines mean the route that will be finally thrown away, and the thick real lines mean that will be received by the destination node D. Take the node P for example, once firstly receive the RREQ from the source node S, it keeps the RREQ and rebroadcasts it to its next hops E, F and C. On the other side, P will receive the RREQ of the node B in succession as it is the next hop of B. Then, P will do the compare, and find that the hops in the RREQ from B is more than that in its cache kept from S, thus, P will throw away the new arrived RREQ; Take the node N whose next hop is the destination node D for example, once receives the RREQ of node I at the first time, it won't transfer to D immediately but just delay. After a fixed time, N will receive and compare the RREQ from E and F one by one. And as we see, it will select the F's RREQ at last for it is the shortest. The conclusion about above analysis can be summarized as following words. Each route receives by the destination node is disjoint and the correspondingly shortest. These can enhance the route reliability and the data delivery ratio, as well as reduce the difficulty of the selection for the destination node. we propose a simple method for selecting multiple paths as follows:

Firstly, we consider the primary source route which is the route taken by the first query reaching the destination node is a main route for it usually defines the shortest route between the source and the destination. Once receives it, the destination responds by sending a route reply (RREP) message to the source immediately for reducing the delay by any possibility. Then, the destination node waits for a fixed time during which many RREQs from the different intermediate nodes will be received. But only M routes should be kept as the spare route and reply RREPs.

Depending on Fig2. the forms of the routes in RREQs that have been received by the destination are shown as follows:

RREQ1 {S,A,M}; RREQ2 {S,A,J,K}; RREQ3 {S,P,F,N}; RREQ4 {S,Q,G,H}.

By the way, the number of the RREQs that are received by destination should be obviously far more than four in the large-scale mobile ad hoc networks. Suppose the RREQ1 is the first one that arrives D, so it will be recognized as the main route. And the selection of the spare routes based on above aggregation of the RREQs is explained as follows:

*1)*Choose a set of RREQs all of which have the first same intermediate node and make up of a new subset. For example, the intermediate node A is the first same node of RREQ1 and RREQ2, thus, choose them.

*2)*Choose the RREQ which includes the shortest route(here we define the route that have the least hops in RREQ is the shortest route) from the new subset and add to the spare multiple routing table, erase the other RREQs in the subset at the same time.

*3)*If the nodes in one RREQ are not as the same as all of that in the other RREQs, directly add the RREQ to the spare multiple routing table. Otherwise, repeat the 1),2) until there is no RREQ in the aggregation.

*4)*Choose the shortest M routes from the spare multiple routing table and erase the others. But it's not the more the better for M because that too much routes will bring the high routing overhead for route maintenance when consequentially enhance the routing reliability at the same time.

IV. **ANALYSIS**

The Multiple routing algorithm is compared with the DSR protocol in NS2.

A. simulation Environment

We respectively generate 20,25,30 randomly placed nodes in an area of 2km by 2km and compare in two groups. The simulation time is about 30ms. Nodes follow the random waypoint mobility model with varying speeds.

B. Performance metrics

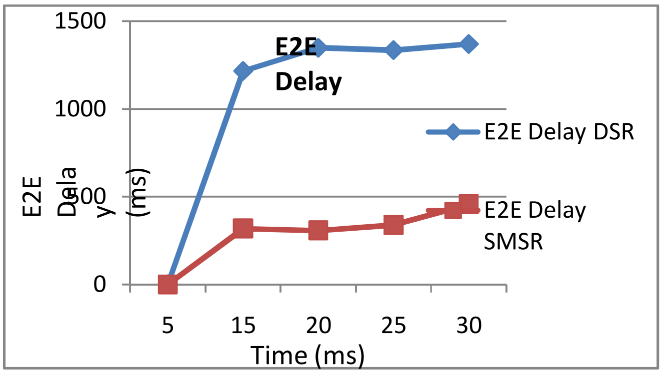
Multiple routing algorithm is compared with DSR in the most important performance metrics as follows:

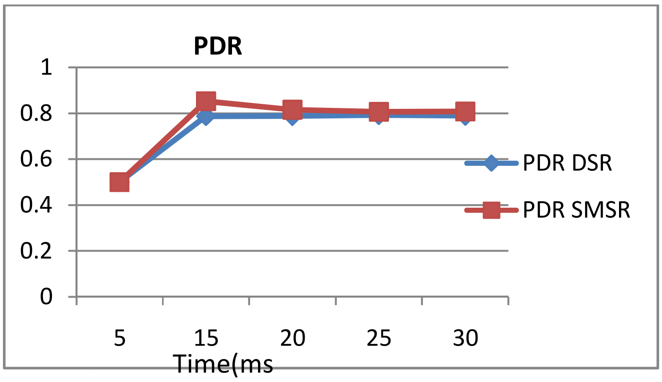
1)Packet Delivery Ratio: the rate of packets received to packets generated.

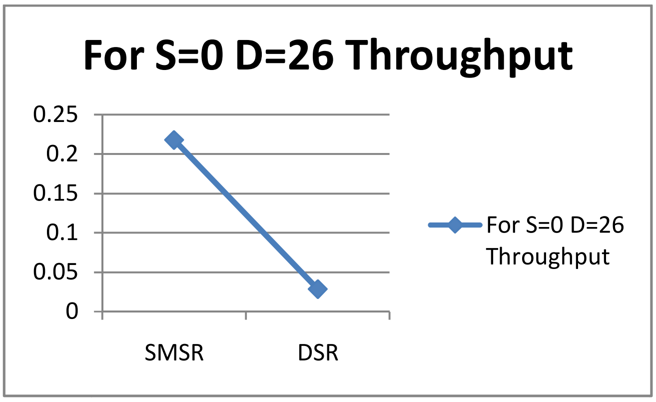
2)Average End to End Packet Delay: the average end to end delay encountered by each data packet.

3)Routing Overhead per Received Packet: Ratio of the total number of routing control packets (including route requests, route replies, and route errors) generated or forwarded to the data packets received correctly at the destination.

C. simulation Results







V. CONCLUSION

In this paper, we propose a shortest multiple routing algorithm based on the DSR protocol. The intention of the algorithm is to get the more topology messages and find the correspondingly shortest routes, then choose the main route whose RREQ firstly arrived at the destination and select other two shortest routes as the spare route. In doing so, the reliability of the route between the source and the destination will be enhanced as well as the validity, besides, the packets loss rate will be reduced as well as the network delay. The simulation results show that the new algorithm is better than DSR protocol. As we see, it is suitable multiple routing algorithm for ad hoc networks. Further work is required in order to fully characterize its performance under various unicast and multicast traffic load conditions and realistic channel environment.

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