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GOODPUT ENHANCEMENT: SMR OPTIMIZATION TECHNIQUE FOR IMPROVING THE DELIVERY RELIABILITY IN MOBILE AD-HOC NETWORK

SURESH KUMAR[1], PRITI DIMRI[2] AND NITIN ARORA[3]

G.B. Pant Engineering College, Pauri-Gwl, Uttarakhand, India
*Corresponding Author: Email- suresh16nirala@gmail.com, [2]pdimri1@gmail.com, [3]nitinarora47@gmail.com

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Abstract- Routing has attracted overwhelming attention in the research of Ad-Hoc wireless networks. In this network, each node must be able to forward packets to other nodes. But some differences from wired networks are (a) asymmetric links, (b) redundant links, (c) Interference, (d) dynamic topology. Due to which additional routing protocols are defined for Ad-Hoc networks. In Ad-Hoc wireless network, we used Split Multipath Routing (SMR) technique for improving the delivery reliability of existing Ad-Hoc wireless routing protocols. We evaluate the performance of our scheme using NS2 network simulator.
Keywords- Ad-Hoc network, SMR optimization Technique, routing protocols, Delivery Reliability, Wireless Network, Wired Network, Proactive Routing, Reactive Routing.

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Introduction

Mobile ad hoc networks (MANETs) 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. All nodes are mobile and can be connected dynamically in an arbitrary manner. There is no static infrastructure such as base station. All nodes of these networks behave as routers and take part in discovery and maintenance of routes to other nodes in the network. Ad hoc networks are very useful in emergency search-and-rescue operations, automated battlefields, crowd control and disaster recovery, meetings or conventions in which persons wish to quickly share information, and data acquisition operations in inhospitable terrain. Ad hoc networks are autonomous networks operating either in isolation or as "stub networks" connecting to a fixed network. They do not necessarily rely on existing infrastructure. No "access point". Each node serves as a router and forwards packets for other nodes in the network. Topology of the network continuously changes.

The bandwidth in this kind of network is usually limited. Nodes are operating in power limited batteries. Moreover, all nodes can be mobile, and the topology changes frequently. Regardless of the application, MANETs need efficient distributed algorithms to determine network organization, link scheduling and routing. Factors such as variable wireless link quality, propagation path loss, fading, multiuser interference, power expended, and topological changes, become relevant issues. The network should be able to adaptively alter the routing paths to alleviate any of these effects. Routing protocol is therefore, play an important role in Ad hoc networks.

In Ad hoc networks, nodes do not have a prior knowledge of topology of network around them, they have to discover it. The basic idea is that a new node (optionally) announces its presence and listens to broadcast announcements from its neighbors. The node learns about new near nodes and ways to reach them, and may announce that it can also reach those nodes. As time goes on, each node knows about all other nodes and one or more ways how to reach them. Routing Protocols can be divided into three categories as shown (Table1), based on when and how the routes are discovered.

On-demand routing is the most popular routing approach in Ad hoc networks, which rely on single path [1]. However, there are many different routes from source to destination because all intermediate hosts can send packets.

Table1- Three different categories of Routing Protocols

Pro-active Routing or table-driven Protocols	DSDV, FSR
Reactive Routing or On-demand routing Protocols	AODV, DSR
Hybrid (Pro-Active/Reactive)	ZRP

In single routing, only a single route is used between a source and destination node. Single path routing protocols cause increases the call blocking probability and decreases overall network utilization. Additionally, single path protocol can increase end-to-end delay and packet loss rate. However, multipath routing protocols which aim to establish multiple paths between sources to destinations can solve these problems. Multipath routing protocols have more benefits than single path protocols such as (a) decrease the call blocking probability and increase overall network utilization, (b) increase the reliability of data transmission (i.e., fault tolerance), (c) decrease end-to-end delay, (d) enhance reliability and avoid broken, (e) higher aggregate bandwidth and (f) beneficial for balancing network load.

Because of the benefits discussed above, in this paper, we perform a simulation study on multipath routing protocol in Ad hoc networks.

The remainder of this paper is organized as follows: Section 2 introduces the split multipath routing technique in MANETs. Section 3 describes the Problems and solution of SMR, Section 4 describes the result analysis on the basic of delivery reliability of the data and Conclusion in Section 5.

SPLIT Multipath Routing Techniques in MANETS

Multipath routing is not a new idea [2]. Multiple paths can also provide load balancing and route failure protection by distributing traffic among a set of disjoint paths. Paths can be disjoint in two ways: (a) link-disjoint and (b) node-disjoint. Node-disjoint paths do not have any nodes in common, except the source and destination; hence they do not have any links in common. Fig. (1) describes the nodes disjoint path from source to destination.

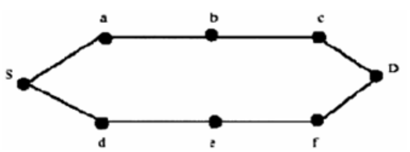

Fig. 1- Two nodes disjoint path from source S to destination D.

Link-disjoint paths Fig. (2), in contrast, do not have any links in common. They may, however, have one or more common nodes.

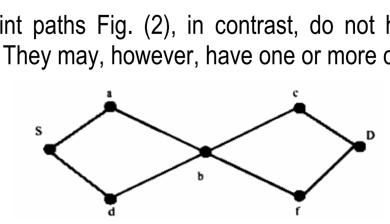

Fig. 2- Two link-disjoint path from source S to destination D

Multiple path routing provides an easy mechanism to distribute traffic and balance the network load, as well as provides fault tolerance. Multipath can be useful in improving the effective bandwidth of communication pairs, responding to congestion and burst traffic, and increasing delivery reliability. Multipath protocols build multiple routes on demand, the traffic is not distributed into multipath; only one route is primarily used and alternate paths are utilized only when the primary route is broken. Split Multipath Routing (SMR)[2-5] is an On-demand routing protocol that builds multiple routes using request/reply cycles. SMR establishes and utilizes multiple routes of maximally disjoint paths. Providing multiple routes helps minimizing route discovery process and control message overhead. When the source node wants to send a packet to a destination, it looks up its route cache to determine if it already contains a route to the destination. If it finds that unexpired route to the destination exists, then it uses this route to send the packet. But if the node does have such a route, then it initiates the route discovery process by flooding the ROUTEREQUEST (RREQ) message to the entire network. The route request contains the address of the source and the destination, and a unique identification number. Each intermediate node checks whether it knows of a route to the destination. If it does not, it appends its address to the route record of the packet and forwards the packets to its neighbors. Because this packet is flooded, several duplicates that traversed through different routes reaching the destination. The destination node selects multiple disjoint routes and sends ROUTE REPLY (RREP) packets back to the source via the chosen routes.

SMR protocol based on DSR builds maximally disjoint paths. To send route reply packet, the responding node must have a route to the source. If it has a route to the source in its route cache, it can use that route. Multiple routes, of which one is the shortest delay path, are discovered on demand. Established routes are not necessarily of equal length. Data traffic is split into multiple routes to avoid congestion and to use network resources efficiently. The main goal of SMR is to build maximally disjoint multipath. We want to construct maximally disjoint routes to prevent certain nodes from being congested, and to utilize the available network resources efficiently. To achieve this goal in on-demand routing schemes, intermediate nodes are not allowed to send RREP back to the source as DSR and AODV [5] even when they have route information to the destination. The destination must know the entire paths of all available routes so that it can select the routes that are maximally disjoint. One of the routes is the shortest delay route, which is taken by the first RREQ the destination receives. Then the destination waits certain duration of time to receive more RREQs and learn all possible routes. It then selects the route that is maximally disjoint to the route that is already replied. If there is more than one route that is maximally disjoint with the first route, the one with the shortest hop count is chosen. If there still remain multiple routes that meet the condition, the path that delivered the RREQ to the destination the quickest between them is selected. In the end, the destination sends another RREP to the source via the other route selected.

In the whole processing of route discovery, only the source nodes maintain route information to destinations and only destinations send RREP to the source. There are some disadvantages of SMR protocol such as: (1) it generates more control packets while building multiple routes and, (2) shows higher routing load.

In this paper we propose an algorithm (Modified Split Multipath Routing) MSMR based on SMR, in order to improve the delivery reliability of packet.

The Problems and Proposed solution of SMR

The problems of SMR

In SMR protocol, instead of dropping every duplicate RREQ, intermediate nodes forward the duplicate packets whose hop count is not larger than that of the first received RREQ. Otherwise, intermediate nodes drop these packets. Although we can get many maximally disjoint multiple paths through this approach, each node floods too many RREQs, which results in higher routing load and makes protocol inefficient.

Simulation Environment

This paper sets simulation environment under NS-2 simulator: Each node has a radio propagation range of 250 meters. We used the IEEE 802.11 Distributed Coordination Function (DCF) [2] as the medium access control protocol, 50 mobile hosts move around a rectangular region of size 1000 meter × 1000 meter [6], and pause time is 0 seconds. The simulated traffic is Constant Bit Rate (CBR). The interval time to send packets is 20ms.The size of all data packets is set to 512 bytes. Each run executed for 100 seconds of simulation time. During simulation experiments, we found out that intermediate nodes forward too many RREQs, only some of which are useful for intermediate nodes, while the others are dropped by the destinations because they timeout. The dropped packets which are forward repeatedly are useless for the destination to send RREP. However, they result in higher routing load. Our simulation settings and parameters are summarized in Table 2.

Table 2- Simulation Parameters

No. of Nodes	50
Area Size	1000 meter × 1000 meter
Mac	802.11
Radio Range	250 meters
Simulation Time	100 s
Traffic Source	CBR
Packet Size	512 bytes
Mobility Model	Random Way Point
Speed	5m/s to 20m/s
Pause Time	0 s

Fig. 3 illustrates the number of the RREQ forward by intermediate nodes and the number of useful RREQ:

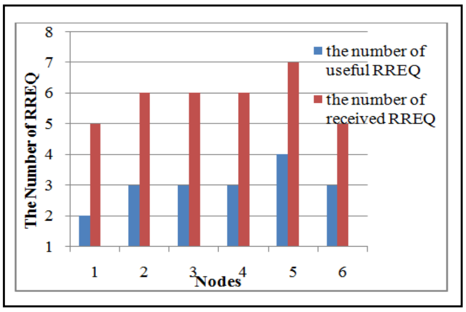

Fig. 3- RREQ received by intermediate nodes

SMR protocol sets timeout variable for the destination. When it times out, the destinations send RREP and drop all the RREQ they receive before. During simulation experiments, only the first three or four RREQ are useful for destinations, the others are dropped finally. There are different timeout thresholds in distinct propagation models. In small model, destinations receive too many useless RREQ if we set the timeout threshold too large.

Fig. (4) illustrates the number of the RREQ received by different destinations and the number of useful RREQ:

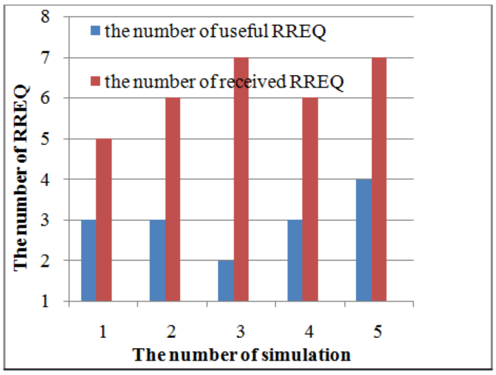

Fig. 4- RREQ received by destinations

The optimization protocol of SMR (MSMR)

From Fig. (3), we found out that although intermediate nodes forward too many RREQs, only three or four of which are useful for intermediate nodes, while the others are dropped by the destinations. To solve this problem, this paper proposes an approach to record the number of RREQ forward by intermediate nodes, and limits this number up to three. When the number of RREQ received by intermediate nodes reaches three, the others are dropped immediately.

This solution not only forwards enough RREQ for destinations, but also decreases the number of RREQ and reduce routing load. It is useless for destinations to wait for too many RREQs and yields longer delays. An approach is proposed in this paper to solve this problem. When destinations receive the first RREQ, they send the first RREP immediately. Then they send another RREP when the number of RREQ they received reaches three. This approach not only gets enough RREQ to send RREP which is maximally disjoint to the route that is already replied, but also brings down end-to-end delay through limiting the number of RREQ received by destinations.

The flow scheme of MSMR

RREQ received by intermediate nodes

Step 1: Intermediate nodes receive RREQ

Step 2: Check whether it is first RREQ, if step yes goto the step 5 else goto the step 3

Step 3: Check whether it is maximally disjoint to the first RREQ, if yes goto the step 4 else goto the step 6

Step 4: Check whether the number of RREQ is upto 3, if yes goto the step 6 else goto the step 5

Step 5: Forward the RREQ

Step 6: Drop the RREQ

RREQ received by destinations

Step 1: Destination node receive RREQ

Step 2: Check whether it is first RREQ, if step yes goto the step 4 else goto the step 3
Step 3: Check whether the number of RREQ is upto 3, if yes goto the step 6 else goto the step 5
Step 4: Send first RREP
Step 5: Send second RREP
Step 6: Drop the RREQ

Result Analysis

We evaluate and compare the performance of MSMR, DSR and SMR protocols under NS-2 simulator in routing load, packet delivery and average end-to-end delay.

Simulation Environment

In the model we have simulated, 50 mobile hosts move around a rectangular region of size 1000 m×1000 m, and pause time is 0 seconds. Each node has a radio propagation range of 250 meters. We used the IEEE 802.11 Distributed Coordination Function (DCF) [2] as the medium access control protocol. A traffic generator was developed to simulate constant bit rate sources. The interval time to send packets is 20ms.The size of all data packets is set to 512 bytes. Each run executed for 100 seconds of simulation time. The mobility model is the random waypoint model, in which a node randomly selects a destination from the physical terrain. It moves in the direction of the destination if a speed uniformly chosen between the minimal speed and maximal speed. The speed is from 5m/s to 25m/s.

Packet Delivery Reliability

We will compare the performance of DSR, MSMR and SMR under different mobile speeds. We evaluate the performance according to the delivery reliability. Packet delivery is the ratio of the number of data packets received by the destination to the number of data packets sent by the source.

Simulation Result

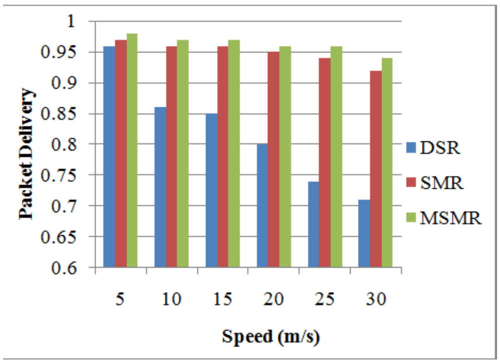

Fig. 5- Packets delivery

As mobility is increased, DSR intermediate nodes which build and rely on single path often reply with stale and invalid routes, and more latency is needed to discover correct routes. In addition, DSR invokes more route reconstruction procedures because single path is instable and can be disconnected easily. However, SMR performs the route recovery only when both routes to the destination are invalidated, so SMR invokes fewer route recovery processes and shows lower routing load than DSR. As the optimization protocol of the SMR, MSMR forwards less RREQ packets than SMR. Therefore, MSMR shows higher packet delivery when mobility is present. Evaluation of MSMR in this framework demonstrates that MSMR enhances the performance of the networks by bringing down the number of control packets. Results show that MSMR algorithm is more effective than SMR and DSR packet delivery.

Conclusion

In this paper we analyze the problems of SMR, and proposes algorithm (MSMR) to solve these problems by means of decreasing the number of RREQ. The results show that the optimization protocol reduces routing load, improves packet delivery, and decreases end-to-end delay. It is better suitable than DSR and SMR in Ad hoc networks.

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