Improving ACK Reply of DSR Protocol for Mobile Ad Hoc Network

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Abstract: In this paper, we present our technique to improve the performance of DSR protocol by using ACK reply path as a backup route when an original route fails in Mobile Ad Hoc networks. In the traditional DSR, when the route is no longer in use, a backup route will be initiated to transfer data in route cache. However, if the backup route is also failed, it will affect the overall network performance. We modify the DSR so-called as Modified DSR protocol (MDSR) so that the source node can still receive ACK reply from destination node when an original route is broken, which means data packets can be transferred along with the ACK path. MDSR deploys the idea of TCP-BuS to solve unnecessary resending of lost data packets. We implement and perform our proposed model in NS2 and the results show that the performance of modified DSR is better than the traditional DSR protocol in End to End delay, packet delivery ratio and routing load.

Key-Words: - Ad Hoc, Wireless Network, DSR protocol, ACK, Performance

1 Introduction

Mobile Ad Hoc network (MANET or Ad Hoc Network) [1] is a non-infrastructure mobile network, which is completely established by mobile nodes of wireless connection. There is none of routers and servers, but each mobile node plays the role of a router. Mobile nodes connect directly with each other to transfer data. Ad hoc network can be widely used in war field, wild field, rescue field and the other which needs create communication temporally place. The characters of ad hoc network are bandwidth limited, movement arbitrary, topology dynamic and electric power limited, and the mobile nodes can be laptop, PDA, mobile phone, and the other wireless communicate devices.

Since the advent of Defense Advanced Research Projects Agency (DARPA) packet radio networks in the early 1970s [2], various routing protocols have been developed for mobile ad hoc networks. Generally, these routing protocols can be summarized as: Table-Driven routing protocol, On-Demand routing protocol and Hybrid routing protocol. In Table-Driven routing protocol, each mobile node maintains one or more tables to store routing information, and update the routing information when the topology of ad hoc network changed. DSDV [3] (Destination-Sequenced Distance-Vector) and CGSR [4] (Clusterhead Gateway Switch Routing) belong to this routing protocol. On-Demand routing protocol creates routes only when the source node is going to send data packet to a destination node, such as AODV [5] (Ad Hoc On-Demand Distance Vector), DSR [6] (Dynamic Source Routing) and so on. ZRP [7] (Zone Routing Protocol) is a kind of Hybrid routing protocol, which combines Table-Driven and On-Demand in the protocol.

As the characters of Ad Hoc network, the topology changes frequently, which make a route is no longer to use and efficiency of data transmission is decreased.

In this paper, we present a modified DSR protocol, called MDSR which uses ACK reply path as the backup route to transfer data packets when an original route is failure, in order to reduce the end to end delay and routing load, increase the data packet delivery ratio. This paper is organized as the following: Section 2 is related work, discuss DSR protocol and its weakness. In section 3, we introduce our proposed MDSR model and discuss the work processing. Section 4 presents the experiment configuration of our proposed in NS2. In section 5, we analysis and discuss the results in end-to-end delay, routing load and packet delivery ratio. The final section describes the conclusion and future work.

2 Related Work

DSR (Dynamic Source Routing) is an on-demand routing protocol that only establishes routes to destinations for active flows. It is based on the concept of Source Routing. Routing information is recorded into each packet directly in order to be used in ad hoc network. DSR protocol consists of two major phases: Routing Discovery and Routing Maintenance.

2.1 Routing Discovery

The route discovery process of DSR is by a source node broadcasting an RREQ packet to all its neighbors; the RREQ packet appends the each node's id to its route record when it is forwarded by these nodes. In this way, the RREQ is flooded throughout the network, and it includes all the nodes' information of the path when it is received by the destination node. Then, the destination node sends an RREP return to the source after choosing the optimum route from the multiple RREQs. Source node would append the route record which is in RREP to the routing table and all data packets which would be sent to destination node will include the route record in it. Intermediate nodes just check the route record of packets and forward them as the route. Then, a RREP packet is generated when the RREQ reaches to the destination. Afterwards it will be sent back to source. On the receiving RREP, source node records the route with destination node as the data delivery route.

2.2 Routing Maintenance

The meaning of Routing maintenance refers to each DSR node maintains a route cache; it records the route information of hop-by-hop which can reach to the other node of the network. Otherwise, every node can snoop from the data packet which is transmitting by the neighbor. The process of the snooping can be used to analysis the route information which is recorded in the front of data packet, the node records route information to its route cache if the route is a new one. Thus, more and more route information would be record to the route cache by the node and reduce the time of Flooding to broadcast RREQ. Meanwhile, the bandwidth of each node can also be saved. The processing of routing maintenance detects the changing of network topology, and it knows whether the route is still available or not.

When an intermediate node removes from the range of wireless transmission or it is shutdown, the route is no longer to use. When the upstream node detects the route is failure by MAC layer protocol, it sends a RERR message to its upstream and source node. On the receiving RERR, source deletes all route information which includes the failure route from its route cache. If necessary, source node reinitiates a route discovery process in order to establish a new route to destination node. DSR can maintain a multiple route for one destination node. If the main route is failure, a backup route can be used to transfer data. Thus, this mechanism avoids DSR initiates flooding of RREQ frequently.

2.3 Weaknesses of DSR

DSR cannot decide whether a route of route cache is still available or expired. If the backup route has been used but it is expired, the end-to-end time delay will increase rapidly. Thus, the routing maintenance is not perfect applicable to be used in a topology changing quite frequently network. Otherwise, when the route is reestablished, all the data packets which have not been ACKed yet by destination node will be resent by source node. Some of these data packets are unnecessary to be resent, because they can be buffered by the intermediate nodes.

3 Model of Modified DSR

As we know, source node generally awaits the ACK packets for data packets transferred previously, which aim is to ensure that the data packets are received by destination node successfully. Sometimes, the path of ACK transmission is not same with data packets'. As the character of DSR, each data packet records its routing information on the front of it. Thus, when a route is broken but source node can still receive ACK, Modified DSR (MDSR) protocol just exchanges the source and destination addresses of ACK, in order to update the routing information of source node to destination node. In this paper, we use the ACK path as a backup route to transfer data packet when an original route is no longer to use in DSR. We consider the situation of the ACK path is different with data delivery route only (Figure 1).

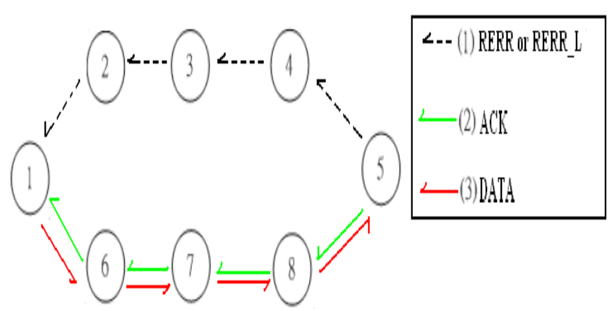

Figure 1. Modified of DSR (MDSR) Protocol

3.1 Modified Part of DSR

We modify the RERR (Route ERRor) message of DSR by adding two new flags which are L and S.

the flag of L is used to indicate whether the Local Repair mechanism is initiated or not by the intermediate node when it found a route failure. And S is used to show whether the local repair is successful or not. See figure 2, we add two new flags on the original RERR message.

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Option Type |Opt Data Len|  Error Type  |L|S|Reservd|Salvage|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Error Source Address                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   Error Destination Address                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
.                                                               .
.                   Type-Specific Information                   .
.                                                               .
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
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Figure 2. The Format of RERR Message

If the flag of L is set to 1, that means this route error message is RERR_L. When an intermediate node detects a route broken, it sends the RERR_L message to source node and initiates Local Repair. The other intermediate nodes which have transferred the RERR_L to source node will buffer the data packet which they are forwarding. If the flag of L is set to 0, that means the Local Repair mechanism is not initiated and the intermediate nodes will drop the data packet which they are forwarding. If the flag of S is set to 1, that means this route error message is RERR_S. The intermediate nodes will start to send the data packets which they buffered before to destination node when they receive the RERR_S. on the other hand, if the flag of S is set to 0, means the Local Repair is failure or time out, the intermediate nodes will drop the data packets which they buffered before and source node will reselect a route to transfer data packet.

Otherwise, when source node receive message of route failure, it will monitor whether an ACK which is from the destination node still can be received or not. If the ACK is received by source node, which means there still is a path from source to destination nodes is available. Thus, the data packets can be transferred along with the ACK path to destination node.

3.2 Lost Packet Resending

The lost data packets will be sent again when a route has been successfully repaired and reestablished. But some of these data packets are unnecessary to. MDSR employs the idea of TCP-BuS [8] to solve unnecessary resending of lost data packets.

3.2.1 Upstream Route Failure

When a route failure occurs at the upstream of the route, a pivoting node (node 2) sends RERR message to source node n1 (Figure 2). The other intermediate nodes drop the data packets which they are forwarding (data 22 and data 23). On the receiving RERR, source node stops to send data packet and keep a record of the sequence number of the data which is sent latest (which sequence number is 24 in this case). When the source node receives first duplicate ACK, it restarts to send data packet which sequence number is latest'+1 (data 25) along with the path of ACK. When the source node receives second duplicate ACK, it starts to resend the data packet which sequence number is between ACK's and latest' (it is 22~24 in this case) along with the path of ACK also before a new optimum route is established.

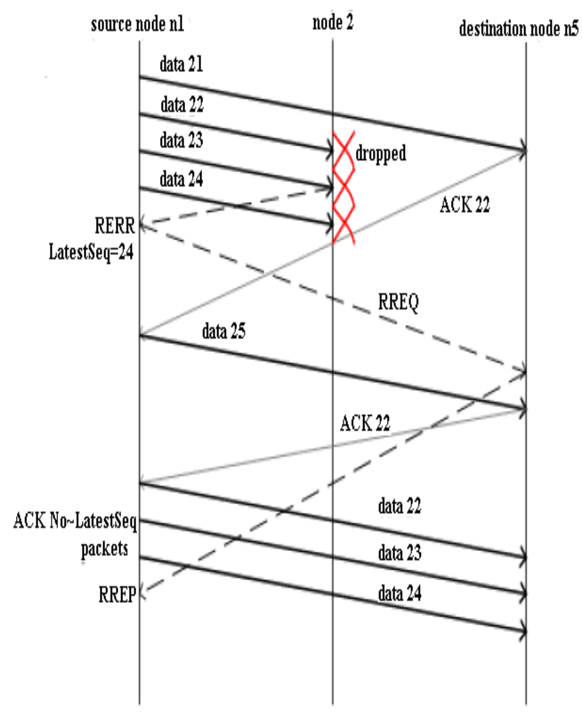

Figure 2. Upstream Route Failure

3.2.2 Downstream Route Failure

If the source node receives a RERR_L message, which means the route failure is occurred at the downstream of the route and Local Repair mechanism has been initiated by an intermediate node. The other intermediate nodes which has forwarded the RERR_L to source node, will buffer the data packets which are they forwarding (data 23 and data 24) (Figure 3). On receiving the RERR_L, source node n1 does the same thing with last case before it receives the second duplicate ACK. When the source node receives the second duplicate ACK, it starts to resend the data packet which sequence number is same with the ACK's along with the ACK path. When the local repair is successful, the destination node sends a RERR_S to source; each intermediate node will start to send the data packet which has been buffered before to destination node. On receiving the RERR_S, source node does not still use the ACK path to transfer data but the original route.

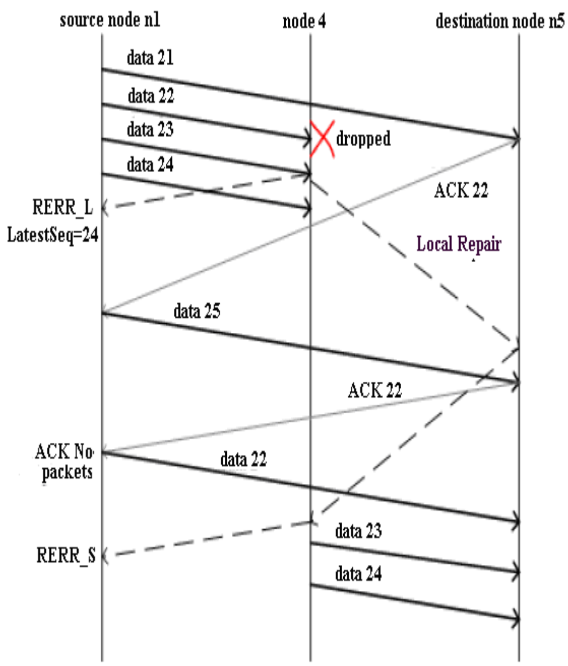

Figure 3. Downstream Route Failure

4 Experiment Configuration

In this paper, we use NS2 [9] (Network Simulator 2) to simulate our proposed model and evaluate the performance of MDSR with DSR.

4.1 Parameter

We simulated a scenario of 20 mobile nodes active in a square area of 800m×600m. Nodes move inside with random waypoint mobility, the maximum velocity is 20m/s. CBR (Constant Bytes Rate) stream have been selected between the nodes. The size of each packet is 512 bytes and the sending rate of source is 1 packet per second. As soon as the mobile node reaches its destination, it will stop for a short period of time, which is 0 second, 50s, 100s, 150s, 200s, 250s and 300s, and then selects a destination randomly to move until the simulation ends. Simulation time has been set to 300 seconds. We use Cbrgen and Setdest tools of NS2 to create the Traffic Overload and nodes movement Scene files which we required as above.

4.2 Performance Metrics

After the end of each simulation, a .tr file will be created by NS2 automatically. This .tr file is a Trace file which is used to analyze the whole process of the simulation. We can understand all details of the simulation through analyze the .tr file. In this paper, we evaluate the performance of MDSR with DSR in the most important performance metrics as follows:

4.2.1 Average End to End Packet Delay

It is the average time of each data packet is received by destination node from the source. The data packets which are lost in simulation are not to be considered and recorded.

1. Record the time of source sends a data packet:
start_time[packet_id] = time;
2. Record the time of destination receives the data packet:
end_time[packet_id] = time;
3. The end to end delay for each data packet:
packet_duration = end - start;
4. Average end to end delay:
Delay = duration_total / packet_number;

4.2.2 Packet Delivery Ratio

It is the ratio of the number of data packets is received by destination node to the data packets is sent by source node. The data packets which are lost for the end of simulation are not to be considered and recorded.

1. Record the time of source node sends a data packet:
start_time[packet_id] = time;
2. Record the highest Packet ID at the present:
highest_packet_id = packet_id;
3. Record the number of received data packet:
packet_received++;
4. Record the time of destination node receives the data packet in simulation:
end_time[packet_id] = time; time<=300s

5 Results Analysis

5.1 Average End to End Packet Delay

As we can see from Figure 4, the average end-to-end delay of MDSR is reduced compare with DSR. That is because we used ACK path as the backup route to transfer data packets when an original route is failure, which saved the time of route rediscovery and reestablishment.

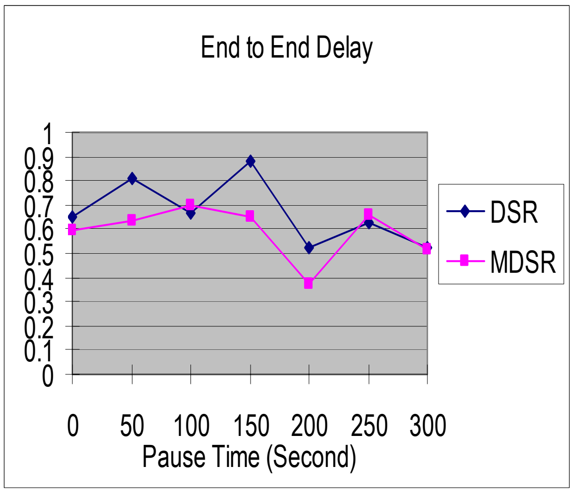

Figure 4. Average End to End Packet Delay

5.2 Packet Delivery Ratio

Figure 5 shows that MDSR has a high packet delivery ratio in comparison to DSR. As we have mentioned before, some data packets are not dropped but buffered by the intermediate nodes when a route is failure, so these data packets are not necessary to be resent by source node. To summarize above, the performance of MDSR is better than DSR in Ad Hoc Network.

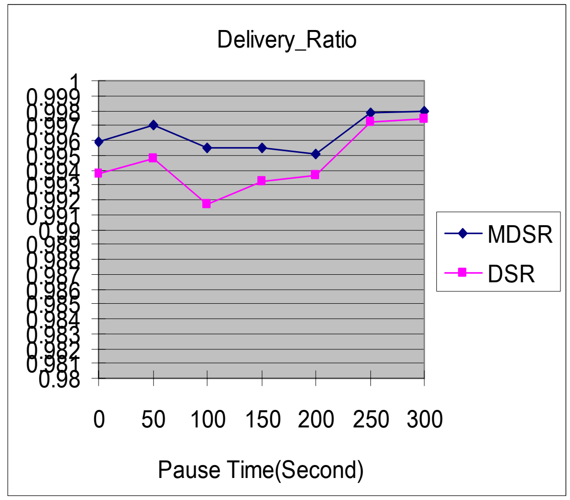

Figure 5. Packet Delivery Ratio

6 Conclusion

This paper presents DSR protocol in Ad Hoc networks. To enhance the performance of DSR, MDSR has been introduced which using ACK path as the backup route when the original route is no longer to use and solved the problem of data packets which are unnecessary to resend. The intention of the mechanism is to reduce the waiting time of data transmission before route is reestablished. In doing so, the average End to End packet delay will be reduced as well as the routing load. Besides, the packet delivery ratio will be enhanced. The simulation results show that the new protocol has better performance than DSR protocol.

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