Scalability Improved DSR Protocol for MANETs

M.Tamilarasi[1] , Shyam Sunder V R[2] , Udara Milinda Haputhanthri [3], Chamath Somathilaka [4], Nannuri Ravi Babu [5], S.Chandramathi[6] T.G. Palanivelu[7]
[1-7]Department of Electronics and Communication Engineering
Pondicherry Engineering College, Puducherry, India.
Email: [1]tamilarasim@pec.edu;[2]shyamdeva@gmail.com; [4] udara@ gmail.com; [6] schandrarajan@yahoo.com; [7]principal@pec.edu

Abstract

The reactive Dynamic Source Routing (DSR) Protocol is a commonly applied protocol in Mobile Ad hoc networks (MANETs). When the network size is increased, it is observed that the overhead is also getting increased due to the source routing nature of DSR and this in turn reduces the efficiency of DSR protocol. In order to improve the scalability of DSR,in this paper, a modification is proposed for DSR. Simulation results show that the modified DSR (MDSR) has less overhead and delay compared to conventional DSR irrespective of network size.
Key words: MANET, DSR, scalability, overhead, delay.

1. Introduction

MANET is a collection of wireless mobile hosts forming a temporary network without any infrastructure or centralized administration. In such an environment, each node acts as a router or source or destination, and forwards packets to the next hop allowing them to reach the final destination through multiple hops [1]. The role of a routing protocol is very crucial in the implementation of MANET due to its dynamic topology. The routing protocols proposed for MANETs can be divided roughly into proactive and reactive routing protocols [1, 2].

DSR is a simple reactive protocol designed specially for MANETs. DSR allows network to be completely self-organising and self-configuring [3]. Due to the simplicity and robustness of DSR, many research papers on ad hoc routing are based on its augmentation. Per Johansson et al [4] have found that in realistic scenarios, DSR performed better than AODV at moderate traffic load. This indicates the limited scalability of DSR. Jyoti Raju et al [5] compared DSR's performance with Dynamic Source Tree (DST) protocol. Yin Chun Hu et al [6] demonstrated the improvement in the performance of DSR using congestion information through simulations. The authors of [7] have proposed a simple heuristic algorithm for reducing the number of control packets in DSR using Route Reply (RREP) packets. In this paper, we propose an algorithm for modifying DSR to reduce overhead by reducing the number of RREP packets and the header size of DSR data packets. The rest of the paper is organized as follows: Section 2 deals with overhead reduction in the scalability improved DSR. Section 3 presents the simulation results and conclusions are given in Section 4.

2. Scalability improved DSR

2.1. Overview of route discovery mechanism in standard DSR

When source node **S** needs to send packets to a destination node **D,** and if no route to **D** is found in its route cache, **S** initiates *Route Discovery* mechanism [1-4] by

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broadcasting a Route Request (RREQ) message to its neighbors. If the neighbor has lately seen a request from the same source bearing the same id or if its address is already in the route record of the RREQ, it discards the packet. Otherwise, it returns a RREP to **S**, if it knows a valid route to D. When the above conditions are not met, the receiving node adds its own address to the route record of RREQ which contains the route by which the RREQ reached from S, and broadcasts it forward [3]. The RREP will travel in the route indicated by the route record.The propagation of RREQ and RREP packets in DSR are illustrated in Fig.1 and Fig.2 respectively.

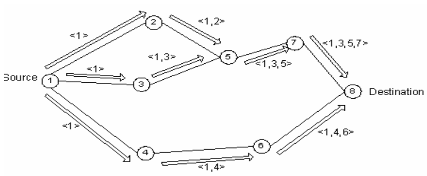

Figure 1. RREQ propagation of DSR

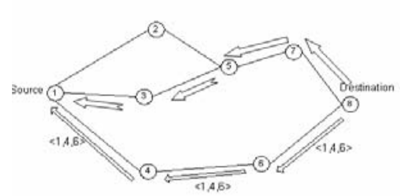

Figure 2. RREP propagation of DSR

2.2. Overhead Reduction in Modified DSR

The drawback of DSR is the number of RREPs initiated by **D** for RREQs bearing same id received via multiple routes. These RREPs may lead to congestion and wastage of battery power. Hence, it is proposed to limit the number of RREPs to only one. This RREP is sent via the route through which **D** received the first RREQ, because it was the most active route for a particular source-destination pair at the moment RREQ was sent. Moreover, through this route data packets can be transmitted fast. Hence, propagation delay can be reduced to a greater extent. Furthermore, it leads to less number of control packets and higher packet delivery ratio. Thus, these modifications in DSR make the data transmission optimum. Figure.3 shows the route reply mechanism in modified DSR.

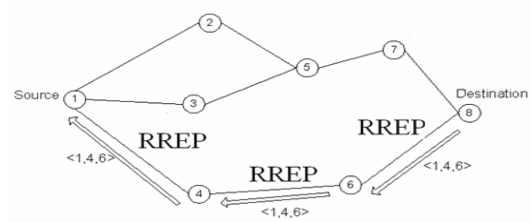

Figure3. RREP propagation in modified DSR (MDSR).

DSR is a source routing protocol in which the data packet header carries complete hop-by-hop source route to destination, thereby increases the overhead and decreases the throughput [2,3]. So, the other drawback of the DSR protocol is the variable header size due to the inclusion of the addresses of intermediate nodes present on the route from source to destination. The data packet format of existing DSR protocol is shown in Fig.4. In order to reduce the overhead, a strategy is proposed in our paper, to modify DSR such that the header of data packet carries only the source and destination addresses as shown in Fig.5.

SNA	INA	INA	INA	DNA	DATA

SNA	DNA	DATA

SNA- Source Node Address; INA- Intermediate Node Address; DNA- Destination Node Address

Figure 4. Data Packet Format of DSR protocol Figure 5. Data Packet Format of MDSR protocol

2.3. Algorithm for overhead reduction

Step 1: Source broadcasts RREQ packets which are heard by nodes within the coverage area.
Step 2: The neighboring nodes re-broadcast the received RREQ till it reaches the destination.
Step 3: Destination initiates a RREP only to the first received RREQ.
Step 4: Every node which receives the RREP checks whether a RREP with same sequence number is already received. If so, RREP is dropped. Else, the following step is performed.
Step 5: Node checks whether its address is present in the RREP. If so, it designates itself as intermediate node and performs the following step. Else it drops the packet.
Step 6: The intermediate node stores the source address, destination address and precursor node address in memory before broadcasting the RREP.
Step 7: Every intermediate node performs steps 4, 5, and 6 till the RREP reaches source node.
Step 8: Upon receiving the RREP, source starts to transmit the data packet. The data packet contains only source and destination addresses in its header.
Step 9: As the data packet travels from source to destination, every node confirms whether it acts as intermediate node for the source destination pair. Only the intermediate nodes broadcast the data packet towards destination. Other nodes drop the packet.
Step 10: After broadcasting data packet, acknowledgement is sent to the precursor node.

3. Performance evaluation

GloMoSim [8] simulator has been used to compare the performance of MDSR and DSR. Simulation time has been set as 900 seconds. Nodes move inside a simulation area of (1500x300) $m^2$with a maximum velocity of 20 m/s according to the random waypoint mobility model. Simulation has been carried out for randomly selected CBR connections.

Number of control packets, packet delivery ratio and end-to-end delay are the performance metrics evaluated as a function of variable network size and pause time for comparing the performance of Modified DSR with that of DSR. Number of control packets is the sum of RREQs, RREPs and Route Error packets. In standard DSR, destination initiates RREP for all RREQs received, but in MDSR, destination initiates RREP only to the first received RREQ. Thus, it is observed from Fig.6 to Fig.9 that the MDSR maintains less number of control packets than the existing DSR, irrespective of pause time value. For 0s pause time nodes move continuously, whereas, for 900s pause time the nodes are stationary. As the pause time decreases, the duration of mobility increases and the probability of link failures increase. Fig.6 shows that the MDSR gives an average of 47% less number of control packets compared to DSR when the nodes are stationary. When nodes move continuously, Fig.9 shows that the MDSR is still able to give an average of 4% less number of control packets compared to DSR.

End-to-end delay is the time taken by a data packet to reach destination from the source. As the network size increases, network complexity increases and hence end-to-end delay increases. In MDSR, besides the reduction in number of control packets, the header size of data packet is reduced and the route cache is limited to contain the addresses of only the source, destination and precursor nodes. All these reduce the processing time of nodes which in turn reduces the end-to-end delay in MDSR compared to standard DSR. Fig.12 shows that the MDSR results an average of 1.3 ms less delay and Fig.13 shows that MDSR results an average of 2ms less delay compared to existing DSR.

Packet delivery ratio (PDR) is reduced as the pause time decreases from 900s to 0s. This is due to the increasing link failures with decreasing pause time. It is observed from Fig.14 through Fig. 17 that the MDSR maintains a better PDR than the existing DSR. This may be attributed to the reduction in number of control packets which reduces the collisions. Simulation results reveal that the performance of MDSR is better than DSR.

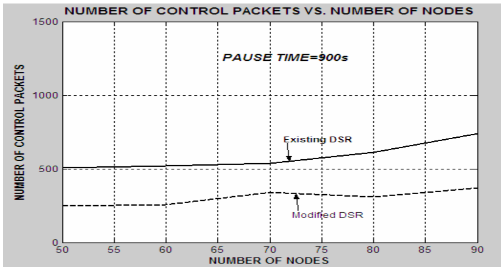

Figure.6 No. of control packets as a function of network size (pause time = 900 s).

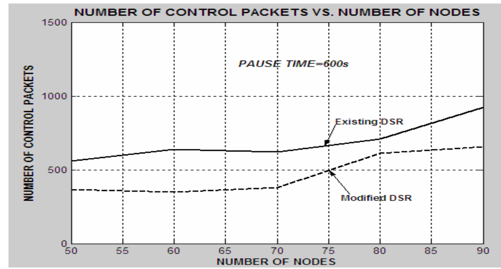

Figure.7 No. of control packets as a function of network size (pause time= 600s).

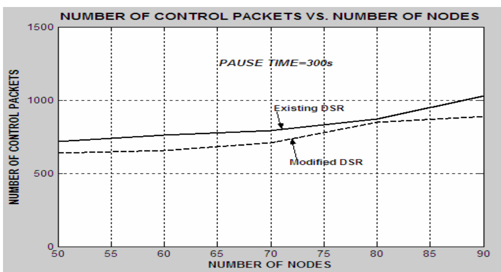

Figure.8 No. of control packets as a function of network size(pause time = 300 s)

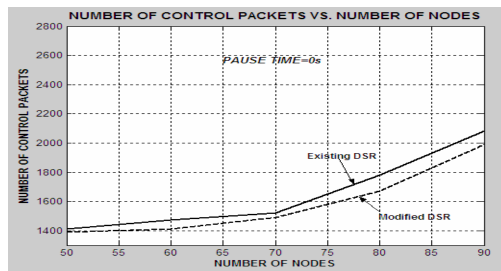

Figure.9 No. of control packets as a function of network size (pause time = 0 s).

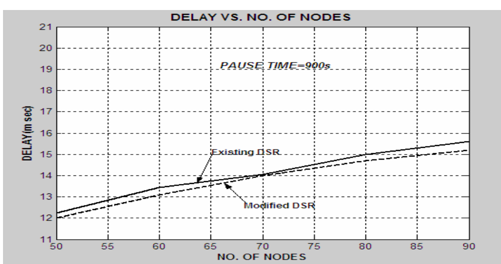

Figure10. Delay as a function of network size (pause time =900 s).

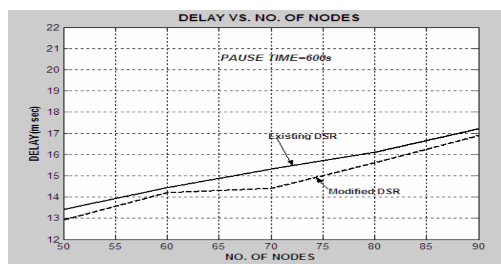

Figure11. Delay as a function of network size (pause time = 600 s).

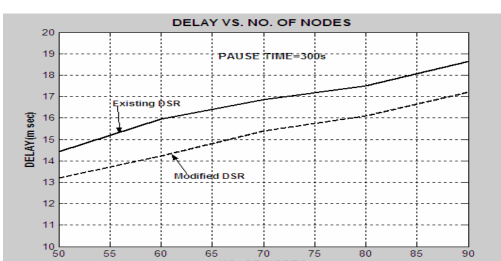

Figure12. Delay as a function of network size (pause time = 300s).

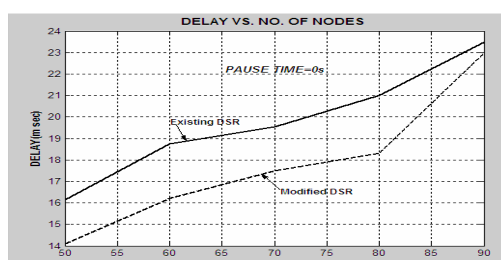

Figure13. Delay as a function of network size (pause time = 0s).

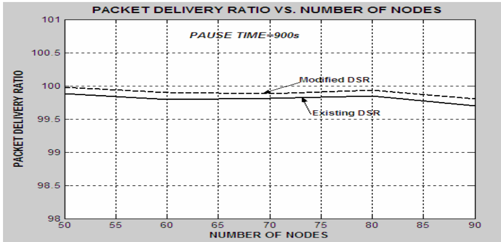

Figure14. Packet delivery ratio vs no. of nodes for a pause time of 900s

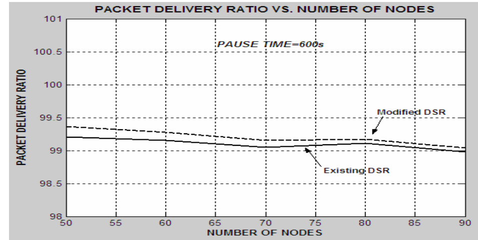

Figure15. Packet delivery ratio vs. no. of nodes for a pause time of 600 s

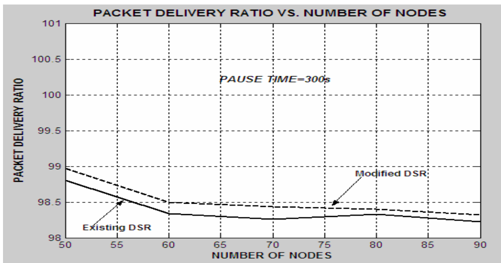

Figure16. Packet delivery ratio vs. no. of nodes for a pause time of 300 s.

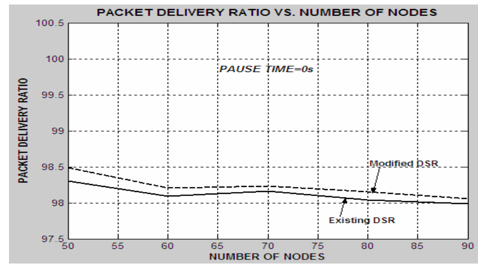

Figure17. Packet delivery ratio vs. No. of nodes for a pause time of 0s

4. Conclusion

In MANETs using DSR protocol, the performance is affected as the network size grows. This is mainly due to the poor scalability of DSR which is attributed to the source routing nature of DSR. In this paper, we proposed an algorithm to modify the DSR protocol in such a way that the header of data packet carries only source and destination addresses instead of the entire path address. Besides this, we incorporated a technique to restrain the destination from initiating many RREPs for a source-destination pair. Simulation results indicate that our algorithm results 47% less number of control packets for a stable network and 4% less number of control packets for a network with continuously moving nodes. The delay is reduced by a maximum of 2ms without affecting the packet delivery ratio.

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