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Performance Analysis of DSR Protocol

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Abstract: ***Ad-hoc networking is a concept in computer communications. Each node participating in the network acts both as host and a router and must therefore is willing to forward packets for other nodes. Routing protocols have central role in any mobile ad hoc network. We analyze DSR Protocol by extensive simulations in ns-2 simulator with various performance matrixes such as Packet Delivery Ratio, End-to-End Delay, Routing Overhead, throughput under various scenarios. Research in this area is mostly simulation based; in computer networks, it is impossible to see the working of routing algorithms by the routers. However, with computer simulations it can be observed easily.***

Keywords: DSR, Routing Protocol, CBR, Request, Source, Destination, Path, Performance Evaluation.

1. Introduction

A mobile ad hoc network is defined as a collection of mobile platforms or nodes where each node is free to move about arbitrarily. Each node logically consists of a router that may have multiple hosts and that also may have multiple wireless communication devices. The routing protocols in MANETs can be categorized in to three different groups: Global / Proactive, On demand/ Reactive and Hybrid routing protocols. In global routing protocols, each node stores and maintains routing information to every other node in the network. In on-demand routing protocols, routes are created when required by the source node, rather than storing up-to-date routing tables. Hybrid routing protocols combine the basic properties of the two classes of protocols mentioned earlier.

2. DSR Protocol - Dynamic Source Routing

DSR is a source routing protocol. This means that the source node adds the whole route up to the destination node to the packets header (Figure 1). As this is the case with most reactive ad hoc routing protocols, DSR is based on the two basic mechanisms namely route discovery and route maintenance. During the route discovery a route is set up on-demand. The route maintenance monitors an established connection during a communication between nodes [1]. DSR is able to operate on networks containing unidirectional links but it works optimal in a network with bidirectional links.

Option Type	Option Data Length	Identifications
Target Address		
Address[1]		
Address[2]		
….		
Address[n]		

Figure 1: DSR data packet header format

2.1 DSR Basic Functions

If a source node originates a new data packet to some destination node, it adds the whole path "source route" in the packet header. The source node searches for a route to that destination in its own route cache table (Figure 2). If it does not find an entry, it initiates a route discovery process to dynamically find a route to the destination node.

First, the RREQ packet (Figure 3) broadcasted by a source nodes include a new field, the route record, which saves the nodes the RREQ packet traverses on it travels towards the destination node[3]. Second, intermediate nodes receiving the RREQ check if their address is included in the route record. Third, if the RREQ packet arrives at the destination node, it checks its route cache for another route to the source node. If it finds one, the destination node generates a RREP packet (Figure 4), adds the route record (from RREQ packet) and sends the RREP back to the source node over its own route. Therefore DSR can work in a unidirectional link field where the revise route is not available and using other routes for replying to the RREQs. Otherwise, the destination node sends the RREP packet over the reverse route back to the source node. If an intermediate node could not forward a data packet, it generates a RERR packet (Figure 5) and sends it back to the source node. Whenever a node receives a RERR message, it deletes all its routes containing the broken link [4], [5].

Destinations	Source Route Record				…
Destination [i]	Address[1]	Address[2]	…..	Address of Dest[i]	…
……	….	….	….	…	…

Figure 2: DSR route cache table packet format

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Option Type	Option Data Length	Identifications
Target Address		
Address[1]		
Address[2]		
….		
Address[n]		

Figure 3: DSR RREQ packet format

Option Type	Opt Data Length	L | Reserved
Address[1]		
Address[2]		
….		
Address[n]		

Figure 4: DSR RREP packet format

Option Type	Opt Data Length	Error Type	Rese rvd	Salvage
Error Source Address				
Error Destination Address				
Type-Specific Information				

Figure 5: DSR RERR packet format

2.2 Additional Features

In addition to the two basic mechanisms mentioned above, DSR protocol provides further features. These features make the DSR more efficient but could also cause some challenges as will be mentioned later in the discussion section [6].

Route Discovery Features

Caching Overheard Routing Information: If a node is forwarding or overhearing any routing packet it updates its own route cache.

Replying to Route Requests Using Cached Routes: If an intermediate node receives a RREQ packet to other destination and has a valid route to the requested destination, the intermediate node unicasts a RREP packet back to the source node.

Route Request Hop Limits: Each RREQ packet contains a "hop limit" or time-to-live "TTL" field in its IP header. The TTL is used to limit the propagation of the RREQ packet with the aim to reduce the routing control packets overhead on the network.

Route Maintenance Features

Packet Salvaging: Packet salvaging occurs if an intermediate node forwarding a data packet detects that the link to the next node is broken and it has another valid route to the destination in its route cache. Otherwise, the node drops the data packet. In all cases, the node sends back a RERR packet toward the source node.

Automatic Route Shortening: If a node is able to overhear a packet carrying a source route, which will come to it later, the node should send back a RREP with the shorter path to the source node. For example: in the Figure 6, where node[d] can overhear the packet when node[b] transmits it to node[c], node[d] returns a RREP with [a-b-d] route source to node[a].

Increased Spreading of Route Error Messages: If a source node receives a RERR, it propagates this RERR to its neighbors by including it in its next RREQ. In this way, the source node does not respond with a new RREP contain the same invalid link.

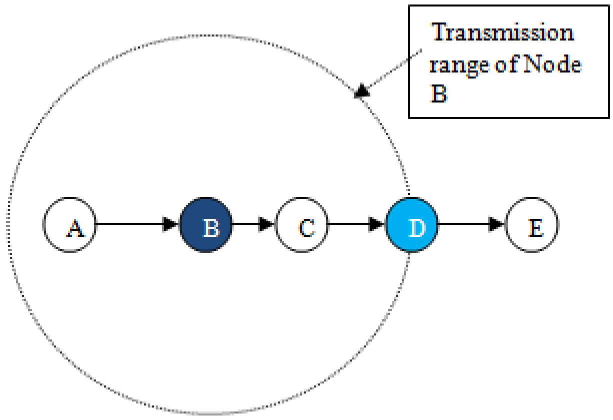
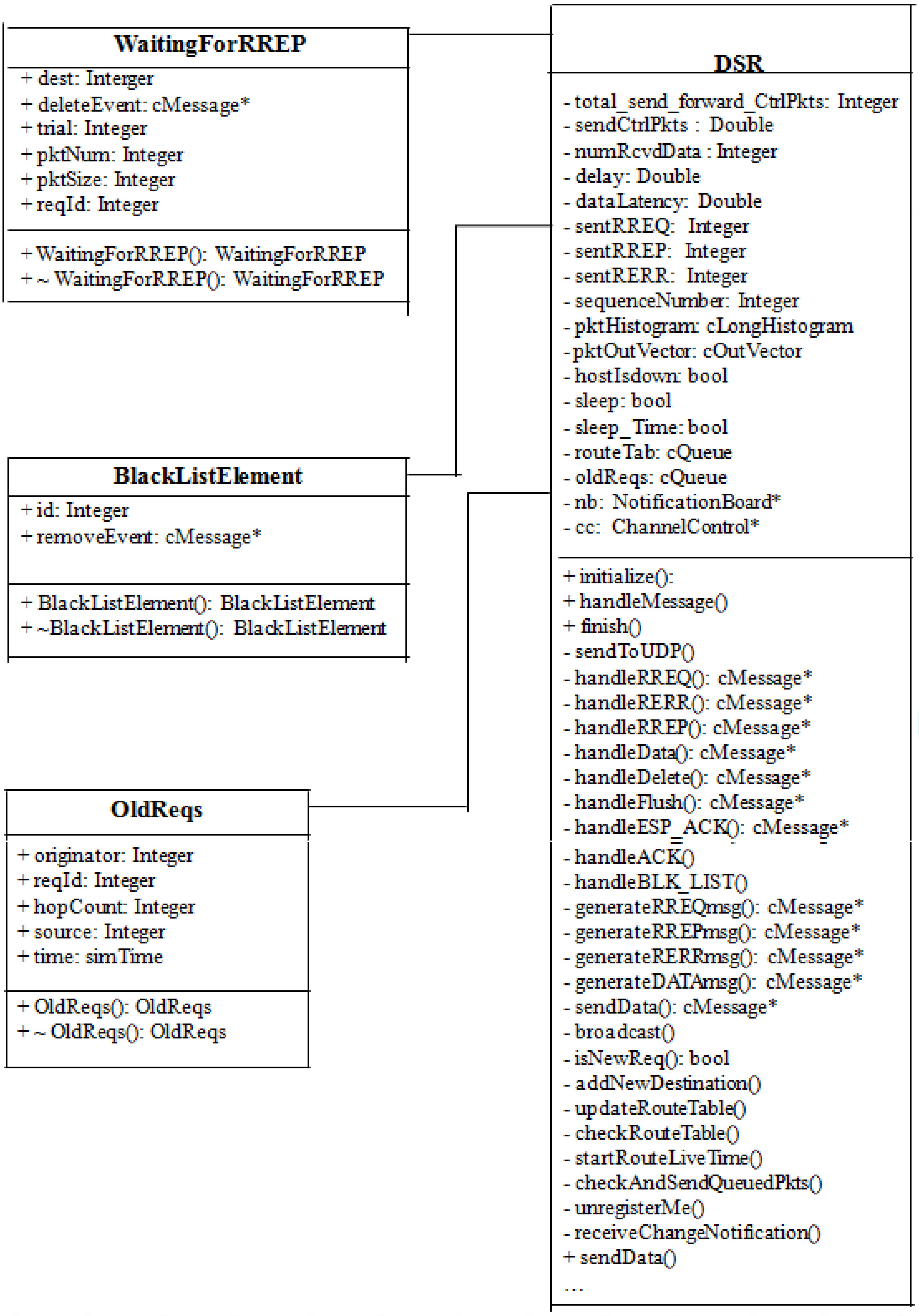


Figure 6: Automatic route shortening

2.3. DSR UML Diagrams

2.3.1. DSR Class Diagram [3], [4], [5]



DSR Route Discovery "RREQ & RREP"

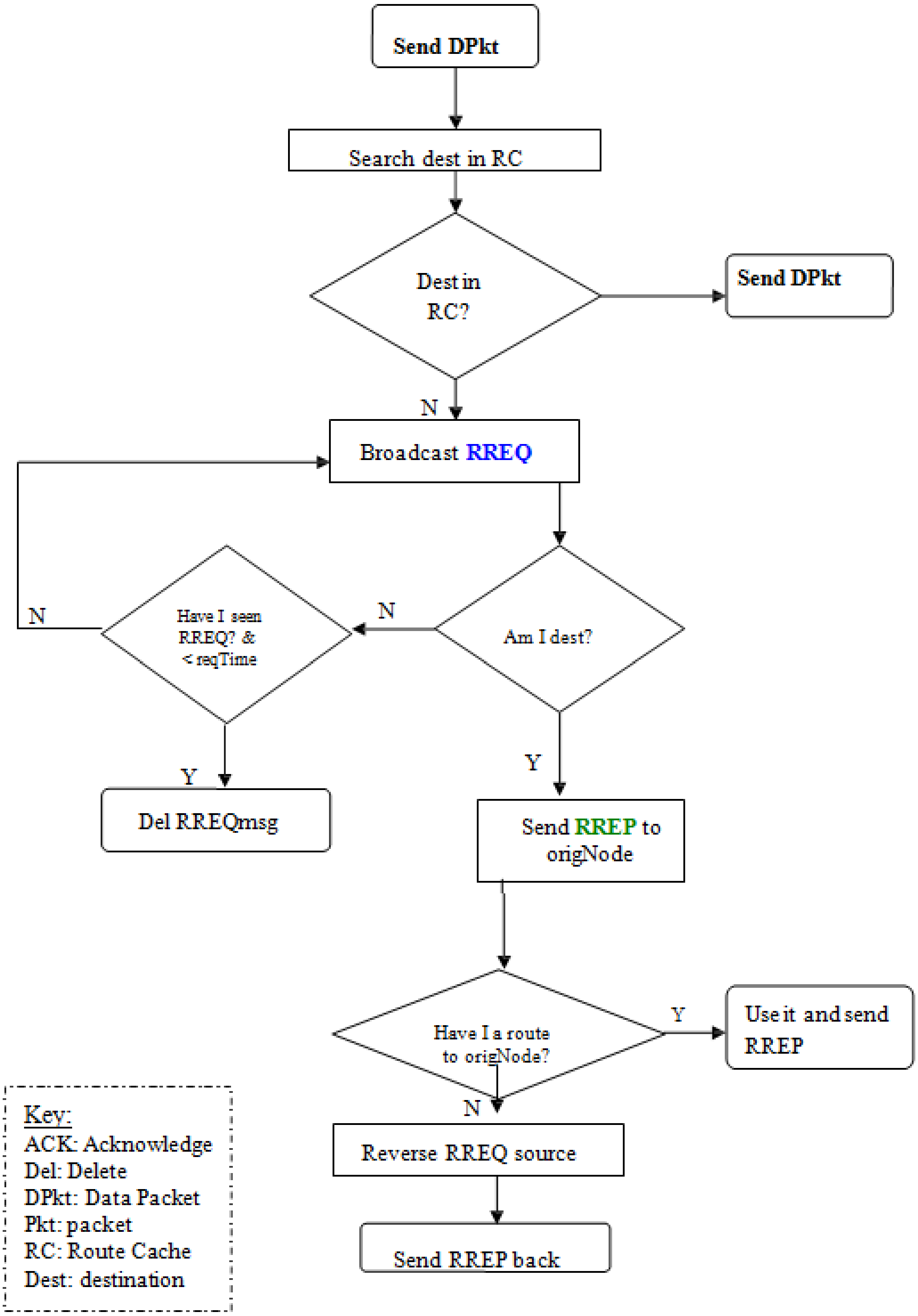


Figure 7: DSR route discovery "RREQ & RREP"

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DSR Transmission of a Data Packet:

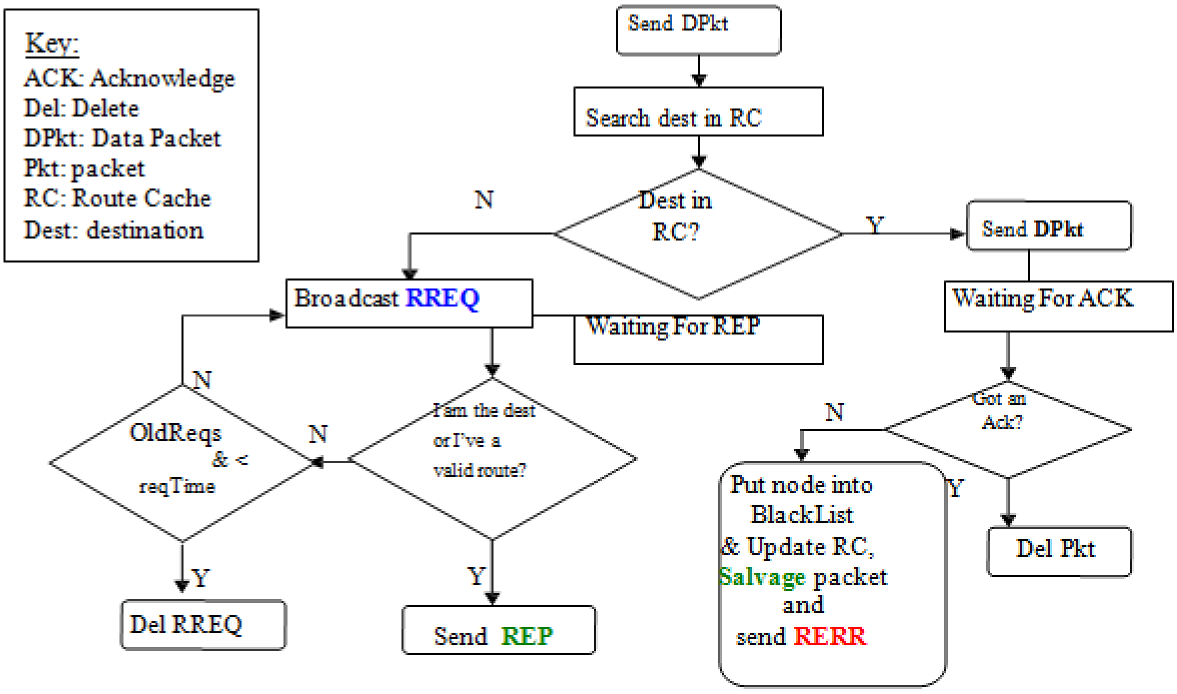

Figure 8: Send Data Packet using DSR protocol

DSR Route Maintenance

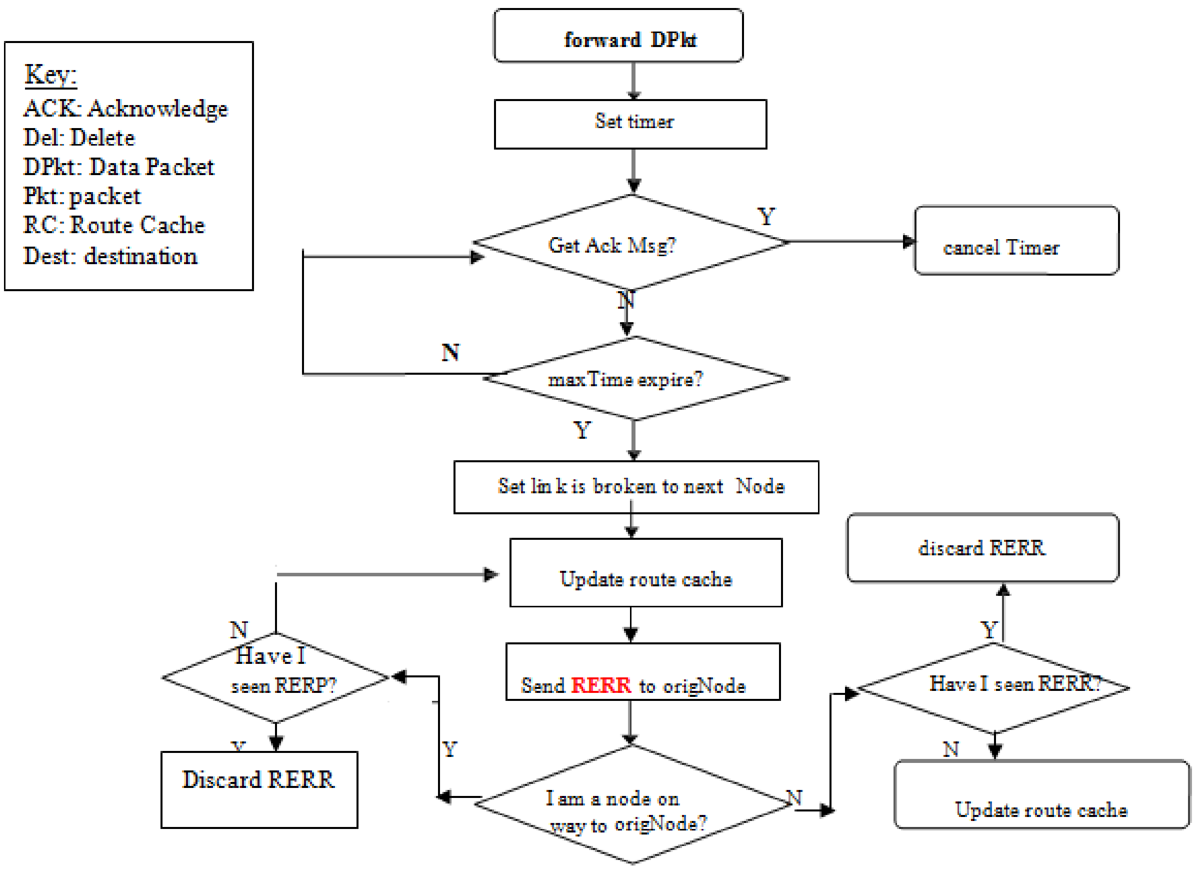

Figure 9: Basic DSR Route Maintenance

3. Performance Metric & Network Parameters

For network simulation, there are several performance metrics which is used to evaluate the performance. In simulation purpose we have used three performance metrics.

3.1 Packet Delivery Ratio

Packet delivery ratio is the ratio of number of packets received at the destination to the number of packets sent from the source. The performance is better when packet delivery ratio is high.

3.2 Average End-to-End Delay

This is the average time delay for data packets from the source node to the destination node. To find out the end-to-end delay the difference of packet sent and received time was stored and then dividing the total time difference over the total number of packet received gave the average end-to-end delay for the received packets. The performance is better when packet end-to-end delay is low.

3.3 Normalized Routing Load

Number of routing packets "transmitted" per data packet "delivered" at destination. Each hop-wise transmission of a routing is counted as one transmission. It is the sum of all control packet sent by all node in network to discover and maintain route.

NRL = Routing Packet/Received Packets

3.4 Average Throughput

It is defined as the ratio of total packets received to the simulation time. [6]

The simulations were performed using Network Simulator Ns-2 (www.isi.edu/nsnam/ns), popular in the ad- hoc networking community. The mobility model used is Random Way point Model. The traffic sources are CBR (continuous bit –rate), number of data connections is 10, data packet size is 512 byte and data sending rate is 4 packet/second. The source-destination pairs are spread randomly over the network in a rectangular filed of 700 m X 500 m. During the simulation, each node starts its journey from a random spot to a random chosen destination. Once the destination is reached, the node takes a rest period of time in second and another random destination is chosen after that pause time. This process repeats throughout the simulation, causing continuous changes in the topology of the underlying network. The simulation time is 500 seconds and maximum speed of nodes is 10 m/s. The interface queue is 150- packet drop-tail priority queue. Three types of network scenario for different number of nodes are generated [7].

1. Wireless scenario with fixed position of nodes.
2. Wireless scenario with movable nodes (traffic generated by cbrgen and setdest.
3. Wireless scenario with movable nodes giving time slices for communication.

4. Result and Discussion

4.1 Average End-to-End Delay

Average end–end delay of DSR is low with fixed position of ad-hoc nodes (Scenario-1) as compared to movable nodes/ large number of nodes particularly (Scenario-2). (Figure 10)

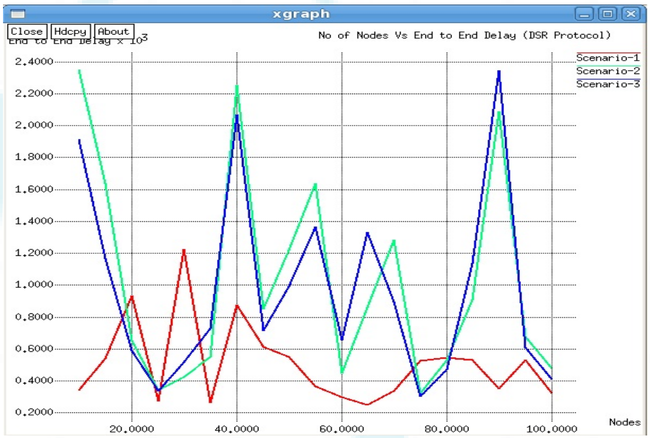

Figure 10: Number of Nodes V/S End to end Delay

4.2 Normalized Routing Load

With low number of sources/nodes and no mobility (10) DSR performs better. But as mobility and large number of nodes/sources, performance of DSR concerned to normalized routing load degrades (Figure 11).

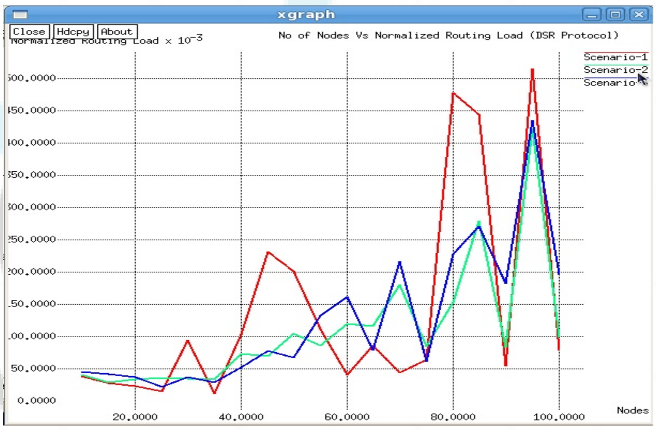

Figure 11: Number of Nodes V/S Normalized Routing Load

4.3 Packet Delivery Ratio

In case of fixed nodes (wireless), a DSR protocol delivers 90+% of data packets (around 94-97% with less number of nodes). However, with the fixed position of nodes, DSR maintains 80-95% of delivery of data packets (Figure 12, scenario-1). But the packet delivery fraction starts degrading gradually when there is increase in number of sources (Figure 12, scenario-2 & 3). DSR perform better when number of sources is low, but when network load increases, packet delivery ratio decreasing.

Figure 12: Number of Nodes V/S Packet Delivery Ratio

4.4 Throughput

DSR gives better throughput for less number of source/nodes under mobility (Figure 13).

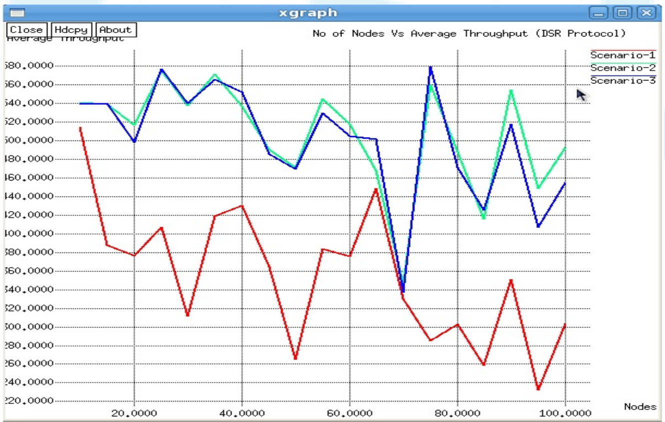

Figure 13: Number of Nodes V/S Throughput

5. Conclusion

DSR is a flat reactive (or on-demand) protocol, set up a path between the sender and the receiver only if a communication is waiting. An advantage of a reactive protocol is its scalability as long as there is only light traffic and low mobility. The disadvantages are: (a) the initial search latency may degrade the performance of the interactive applications, (b) the quality of the path is unknown in advance, and (c) route caching mechanism is useless in high mobility networks as routes change frequently.

6. Future Work

Considering same network parameters and scenarios compare the performance metrics like throughput, end to end delay, packet delivery ratio and normalized routing load with other routing protocols like AODV, DSDV.

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