PERFORMANCE ANALYSIS OF DSR & EXTENDED DSR PROTOCOLS

Shakeel Ahmad[1], Bashir Ahmad[2], Irfan Awan[3] and Athar Waqqas[4]

[1,2] *Institute of Computing and Information Technology, Gomal University, Dera Ismail Khan (NWFP) Pakistan*
[3,4] *Mobile Computing, Networks and Security Research Group, Department of Computing, University of Bradford, Bradford, . BD7 1DP, UK*

ABSTRACT

Ad hoc network is group of wireless nodes to establish a network without any fixed infrastructure or centralized supervision/management. In such a network, topology changes dynamically and due to limitations of bandwidth, transmission range and power routing becomes an important issue. A lot of work has been done in field of routing in ad-hoc network since 1990. Dynamic Source Routing protocol (DSR) provides simple and efficient routing for multihop ad-hoc network of mobile nodes. This paper presents a simulation based evaluation and comparison between traditional DSR and extended DSR. It utilises a specially designed framework which builds on the Global Mobile Information System Simulator (GloMoSim). Some optimizations of DSR have already been implemented in GloMoSim. Several different simulation results show that performance got better by traditional (already implemented) DSR.

Keywords

Mobile ad-hoc network, wireless networks, wireless nodes devices, network topology, mobility, proactive, reactive, hybrid, Routing protocols, Dynamic Source Routing Protocol (DSR), routing overheads, route discovery, GloMoSim, Collisions, Throughput, Packets dropped, delay.

INTRODUCTION

In a mobile ad hoc network (Corson and Macker, 1999; Johnson, 1998; Maltze, 1999; Charles, 2000) different nodes (for example mobile phones, laptops, pda, and other wireless devices) communicate with each other without any fixed infrastructure and the media used for communication is wireless.

In a mobile ad hoc network, mobility factor is an important issue due to which mobile nodes are freely allowed to join and leave the network at the same time, and these movements (changing in positions of nodes) are unpredictable. As there is no fixed infrastructure therefore it can operate as a separate network or can be a part of existing /large network. The routes between nodes in mobile ad hoc networks may contain more then one hop e.g. node A wants to communicate with node D then it may be possible that node A have no direct link with node D but it have link with node B who has link with node C and node C has link with node D, so node A will use intermediate nodes to communicate with node D. The nodes in mobile ad hoc network can be a mobile, notebook, computer or any other device.

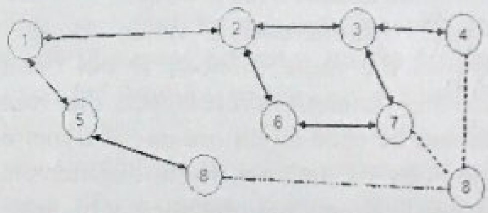


Figure-1 Simple Ad-hoc network of different wireless nodes

The Figure-1 (Broch *et al.*, 2001) shows a simple ad-hoc network of different mobile nodes. In this figure node 8 moves away from node 5 due to which the link will be broken between node 5 and node 8 and where it moves, it establishes new connection with node 7 and node 4.

There are number of protocols for routing in ad-hoc network which can be classified in three main categories: proactive, reactive and hybrid routing protocols. In proactive all nodes established the routes with all other nodes in network and to keep the routes update, these protocols used periodic messages which increase overheads. Unlike proactive, reactive routing protocols will find the route on demand of source node, so it will reduce the overheads created by control messages but in comparison to proactive strategy transmission time will be increased in reactive approach because routes are not available at start so when request came, it has to wait for the time until route become discovered. In Hybrid approach, the properties of reactive and proactive approach are combined to make zone routing protocol. This approach has some benefits but when the zone radius will be reduced, it act as reactive approach and if zone radius will be increased then it perform like proactive approach.

DSR PROTOCOL OVERVIEW

DSR protocol work in two phases: route discovery and route maintenance

- Route Discovery: When a mobile node S wants to send data to any other node D in a network and there is no route known by S to communicate with node D then it will initiate route discovery process to find route so that S will start communication with D node.
- Route Maintenance: When node S knows the route to node D but before starting transmission it detects that route cannot be used any more due to dynamic topology of network route maintenance is used. Route maintenance will detect that source route has been broken due to any reason and node S knows any other route to access node D then that route will be used otherwise it can initiate route discovery to find the route.

The route discovery and route maintenance will be done totally on demand of source node. There is no concept for periodic update messages in DSR so it prevent overheads caused by control message and approaches zero when there not involves mobility factor. In case of mobility DSR will be scaled accordingly for discovering routes. For single route discovery process, a node (who initiated route discovery) may learn more then one routes for a single destination. These multiple routes allow source node to utilize them when one route is not working and also prevent overheads involve for new route discovery. Additional DSR features are:

- Caching Overhead Routing Information
- Replying to Route Requests Using Cached Routes
- Packet Salvaging
- Automatic Route Shortening

PROBLEM DESCRIPTION

In the traditional DSR when source node has no route for destination in its route cache then it generates a route request message for searching route, and this message is then broadcasted to a network till the time to live is expired or the route is found. When the route will be found then the node (which provide the route to destination) will send back the reply in opposite direction (using request message information) towards source node. If the situation when there is one node (having route to destination) involves then there is no problem but when multiple nodes has routes for destination then it can create Route Reply Storms (Royer, 1999) which also result in collisions of control packets and increase congestion at that node where reply is sending. For example if node A send request to find route for destination F to its neighbor node B which then further broadcast it to its neighbors C and D. The route for destination node F is present in route cache of both C and D node then these nodes will send reply at same time to B node so there will be a collision and congestion also increased. If we increase number of nodes then this problem will seriously affect the performance.

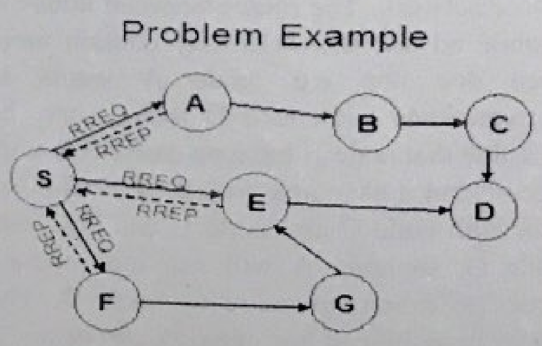


Figure-2 Route Request Reply Storms

For example in the above Figure-2 S is the source node and want to transmit data towards destination node D so it broadcasts route request "RREQ" packet to all it neighbors by flooding technique and the neighbors of node S are node A,E and F. All of these neighbors have the route to destination node in its route cache like node A has the route "BCD", neighbor E has "D" and neighbor F has "GED" so in this case all neighbors will respond imediately (without concerning number of hops it may have) which will cause congestion at node S which will affect the overall performance of DSR protocol.

To solve this problem DSR should prevent Route Reply Storms and the idea is given in (Broch *et al.*, 2001). So We have implemented the idea to prevent route reply storms in traditional DSR (which is already implemented in GLOMOSIM) and when compare the results with traditional DSR the performance got better amd is explained later.

The solution for preventing route reply is introducing delay before sending reply. Due to that delay reply coming at different times so reduce congestion and collisions and overall performance got better then traditional DSR. It is also possible that reply coming of different hop length so reply from short hop length will come first and even in case when hop length is equal the reply will come at different time because there involves random number. The following algorithm is implemented

Delay = H * (h-1+r)

Where delay is time for pausing the reply H is any constant delay introduce per hop H is total number of hops involve to reach destination node R is random number For example in Figure-2, the neighbor nodes of S (source) node will compute there delay depending the number of hops it has to reach destination. Node E will respond immediately because it has direct link with destination node "D" so number of hops is 1 but in case of neighbor "A" and "F" it requires two intermediate nodes so they will respond after that delay. Here is one important factor that neighbor "A"and "F" has equal number of hops to reach destination but due to random number the delay will be different so there is no chance of congestion at node "S" which is a source node.

SIMULATION PARAMETERS AND PERFORMANCE MEASURES

Simulation Parameters

We used GLOMOSIM simulation tool for the evaluation of proposed model. Simulation is based on 100 wireless nodes to create an ad hoc network over the area of 1000 meters * 1000 meters and these 100 wireless nodes are positioned randomly in this area. The mobility is also involved in my simulation so the nodes are allowed to move. The mobility model which we used for simulation is RANDOM-WAYPOINT due to that nodes select any point and move to that point with some constant speed. The minimum mobility speed is 1 meter/sec and maximum speed is 20 meter/sec. After staying there for some pause time it then moves to some other point. We used 6 different pause time: 0, 30, 60, 120, 250 and 500 seconds during my simulation. The CBR (constant bit rate) traffic streams are used for sending 10 packets per second and packet size is 512 bytes. For initial testing of my simulation 10 nodes are communicating with 10 different nodes. The pattern for CRB is as follows

CBR <src> <dest> <items to send> <item size> <interval> <start time> <end time>

Where src is source node and dest is destination node

Performance Measures

To calculate/evaluate the performance of proposed model, the computed Quality of Service (QoS) performance measures are collision, packet delivery ratio, latency time ratio and packet loss during the simulation and then compared collisions, throughput, delay and packet drops of traditional DSR (original/already implemented) with extended model.

- Collision: the channel/resources through which transmission or communication will be progressed. When more then one mobile nodes try to acquire the channel/resources at the same time then there will be collision between them.
- Throughput: Throughput is the rate at which mobile nodes are sending and receiving data packets divided by simulation time. It is measured in bits per second or bits per time slot. It is good measurement of channel capacity of a link/route used for communication
- Latency Rate: When source node sends a data packet towards destination node, it takes some time to deliver and this time is called latency rate/delay or transmission time.
- Packet Loss/Drop: Packet loss describes an error condition in which data packets appear to be transmitted correctly at one end of a connection, but never arrive at the other. There might be different reasons like corrupted packets will be dropped by nodes; the link/route between nodes is not working, insufficient bandwidth, etc.

COMPARISONS & RESULTS

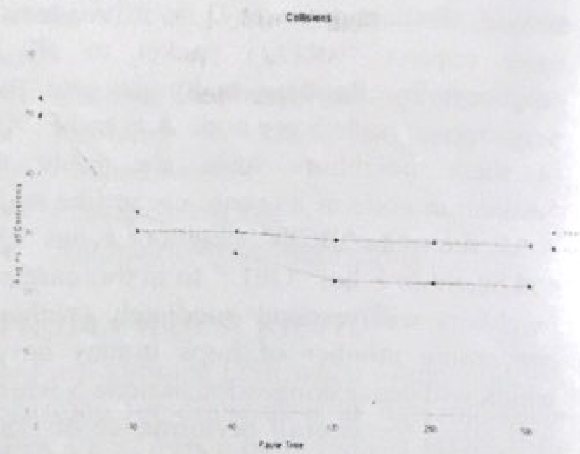
A.

To compute the result and comparison of traditional and extended DSR protocol, following traffic streams are implemented.

CBR 0	79	10	512	5S	0S	0S
CBR 1	78	10	512	5S	70S	100S
CBR 2	77	10	512	2.5S	82.49S	199S
CBR 3	76	10	512	0.8S	91.39S	248S
CBR 4	75	10	512	2.5S	82.49S	199S
CBR 5	74	10	512	0.8S	91.39S	248S
CBR 6	73	10	512	0.8S	91.39S	248S
CBR 7	72	10	512	1.1S	107.8S	274S
CBR 8	71	10	512	0.8S	91.39S	248S
CBR 9	70	10	512	1.1S	107.8S	274S

In the above traffic streams ten different source nodes are sending data towards ten different destination nodes and each source node sending ten data packets at the same time. Each data packet size will be 512 kilo bytes.

Collisions

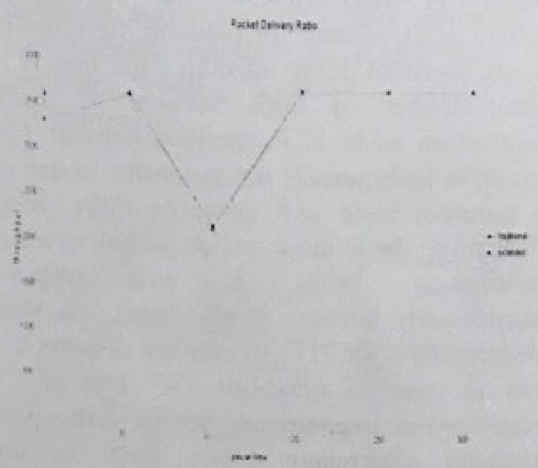


We have calculated the number of collisions at different pause rates: 0, 30, 60, 120, 250 and 500 seconds and then compare the traditional DSR (original/already implemented) with applying my optimization called improved in the above graph. It is clearly viewed that number of collisions is reducing overall in the improved one. The number of collisions is reducing because when more then one neighbors have the route to destination the they delay for dd milliseconds where dd can be calculated as

dd = H * (h-1+r)

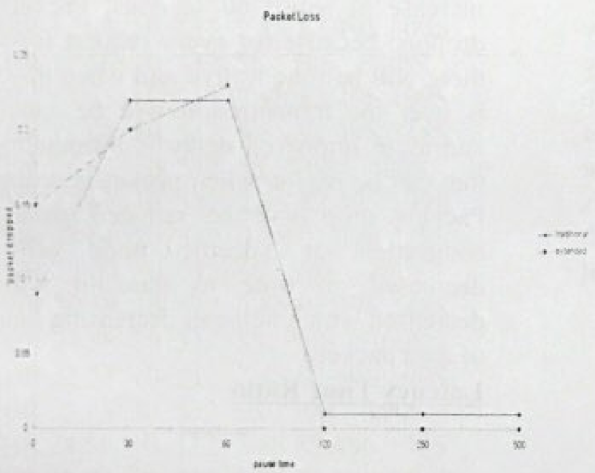
H is defined any constant per hop h is number of hops/intermediate nodes to reach destination r is random number even when number of hops is same the delay will be different so the congestion at that specific node will be reduced and collisions will be reduced due to that reason.

Packet Delivery Ratio



The throughput is also better then the traditional DSR one in most cases. There are number of factors which affect the throughput like delay, collisions, bandwidth, battery/power, etc. If we carefully observe the above graph then it can be easily watched that in one case when mobility pause time is 60 seconds the throughput is decreasing while in case of 0, 30, 120, 250 and 500 pause seconds the throughput is slightly better then traditional DSR one. The throughput is decreasing in pause 60 seconds is might be the case when there involve only one or few number of replies and there is not much traffic/congestion and because of delay, reply will take more time (then usual/traditional DSR) to be delivered to source node which then send the data packet and transmission of data packets will be started.

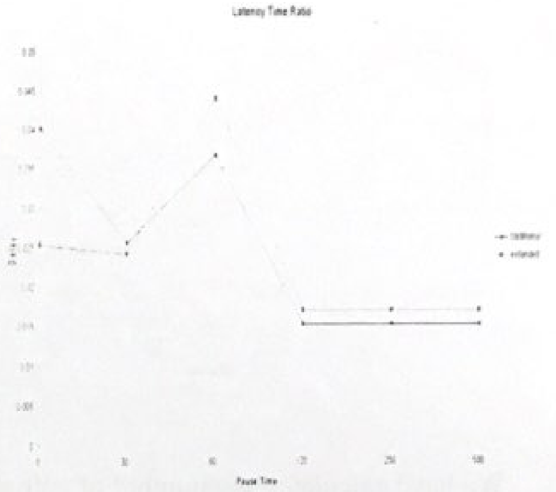
Packet Loss



Packet drops will be reduced in case of pause 30, 120, 250 and 500 seconds but increase in pause 0, and pause 60 seconds. Packets are dropped because for every request for route there will be time to live and when this time is over the transmission will be cancelled and as in improved delay is introducing so that can be reason when packet is dropping. Packets drop will be reduced when the congestion at specific node will be decreased so time to transmit will be decreased which helps in decreasing number of data packets.

Latency Time Ratio

If we observe the above graph then it can be seen that average end to end delay is increasing as delay is introducing for control packets which will result in more delay for data packets so that's why delay is increasing.



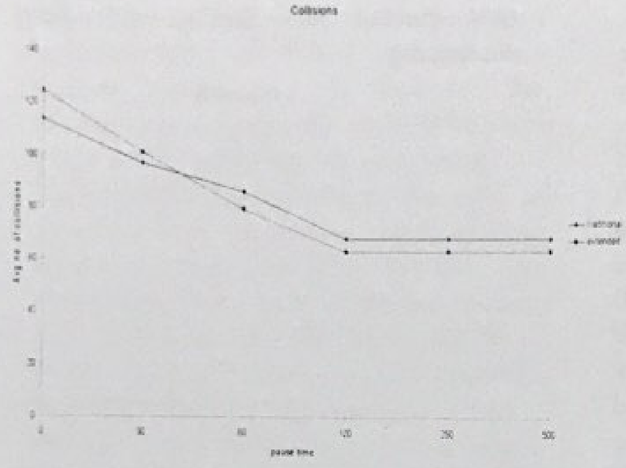
B.

To compute the result and comparison of traditional and extended DSR protocol, following traffic streams are implemented.

CBR 0 79 10 512 5S 0S 0S
CBR 1 78 10 512 5S 70S 100S
CBR 2 77 10 512 2.5S 82.49S 199S
CBR 3 76 10 512 0.8S 91.39S 248S
CBR 4 75 10 512 2.5S 82.49S 199S
CBR 5 74 10 512 0.8S 91.39S 248S
CBR 6 73 10 512 0.8S 91.39S 248S
CBR 7 72 10 512 1.1S 107.8S 274S
CBR 8 71 10 512 0.8S 91.39S 248S
CBR 9 70 10 512 1.1S 107.8S 274S
CBR 10 69 10 512 1.1S 107.8S 274S
CBR 11 68 10 512 0.8S 91.39S 800S
CBR 12 67 10 512 2.5S 82.49S 500S
CBR 13 66 10 512 5S 70S 100S
CBR 14 65 10 512 2.5S 82.49S 199S
CBR 15 64 10 512 0.8S 91.39S 248S
CBR 16 63 10 512 5S 70S 400S
CBR 17 62 10 512 2.5S 82.49S 199S
CBR 18 61 10 512 0.8S 91.39S 248S
CBR 19 60 10 512 5S 70S 700S

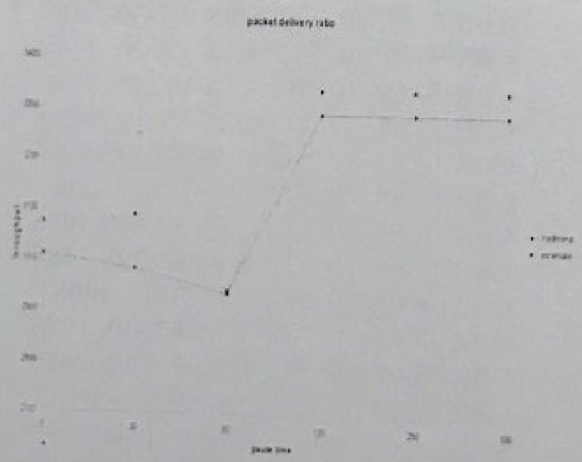
In the above traffic streams twenty different source nodes are sending data towards twenty different destination nodes and each source node sending ten data packets at the same time. Each data packet size will be 512 kilo bytes. In above network 40 nodes take part for sending and receiving data .

Collisions



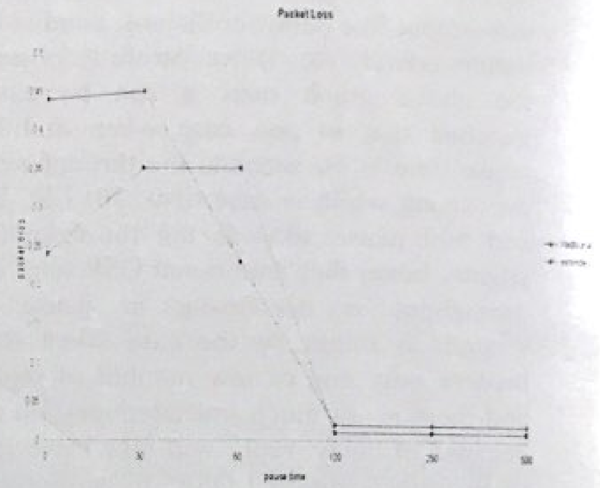
We have calculated the number of collisions at different pause rates: 0, 30, 60, 120, 250 and 500 seconds and then compare the traditional DSR (original/already implemented) with applying my optimization called extended in the above graph. It is clearly viewed that number of collisions is reducing overall in the improved one. The number of collisions is reducing because of less congestion which results in fewer collisions then traditional model of DSR protocol.

Packet Delivery Ratio



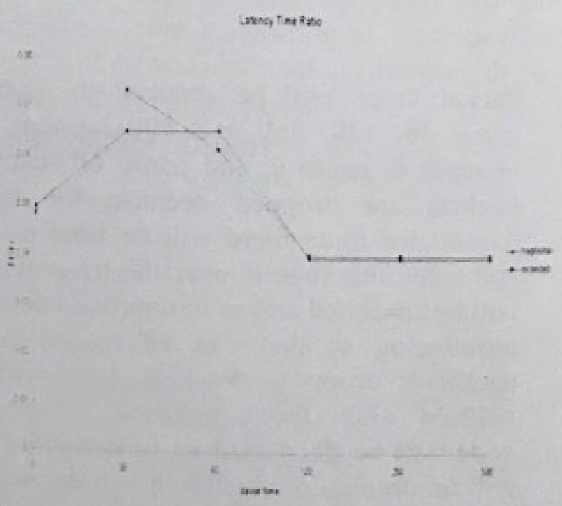
The throughput is also better then the traditional DSR one in mostly all cases.

Packet Loss



Packet drops will be reduced in case of pause 0, 30, 120, 250 and 500 seconds but increase in pause 60 seconds. Packets are dropped because for every request for route there will be time to live and when this time is over the transmission will be cancelled and as in improved delay is introducing so that can be reason when packet is dropping. Packets drop will be reduced when the congestion at specific node will be decreased so time to transmit will be decreased which helps in decreasing number of data packets.

Latency Time Ratio



If we observe the above graph then it can be seen that average end to end delay is increasing as delay is introducing for control packets which will result in more delay for data packets so that's why delay is increasing.

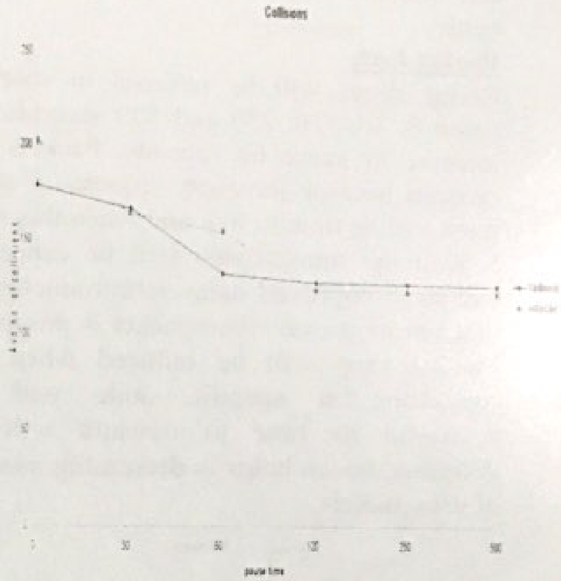
C.

To compute the result and comparison of traditional and extended DSR protocol, following traffic streams are implemented.

CBR	0	79	10	512	5S	0S	0S
CBR	1	78	10	512	5S	70S	100S
CBR	2	77	10	512	2.5S	82.49S	199S
CBR	3	76	10	512	0.8S	91.39S	248S
CBR	4	75	10	512	2.5S	82.49S	199S
CBR	5	74	10	512	0.8S	91.39S	248S
CBR	6	73	10	512	0.8S	91.39S	248S
CBR	7	72	10	512	1.1S	107.8S	274S
CBR	8	71	10	512	0.8S	91.39S	248S
CBR	9	70	10	512	1.1S	107.8S	274S
CBR	10	69	10	512	1.1S	107.8S	274S
CBR	11	68	10	512	0.8S	91.39S	800S
CBR	12	67	10	512	2.5S	82.49S	500S
CBR	13	66	10	512	5S	70S	100S
CBR	14	65	10	512	2.5S	82.49S	199S
CBR	15	64	10	512	0.8S	91.39S	248S
CBR	16	63	10	512	5S	70S	400S
CBR	17	62	10	512	2.5S	82.49S	199S
CBR	18	61	10	512	0.8S	91.39S	248S
CBR	19	60	10	512	5S	70S	700S
CBR	20	59	10	512	0.8S	91.39S	248S
CBR	21	58	10	512	5S	70S	700S
CBR	22	57	10	512	2.5S	82.49S	500S
CBR	23	56	10	512	5S	70S	100S
CBR	24	55	10	512	2.5S	82.49S	199S
CBR	25	54	10	512	0.8S	91.39S	248S
CBR	26	53	10	512	5S	70S	400S
CBR	27	52	10	512	2.5S	82.49S	199S
CBR	28	51	10	512	0.8S	91.39S	248S
CBR	29	50	10	512	5S	70S	700S

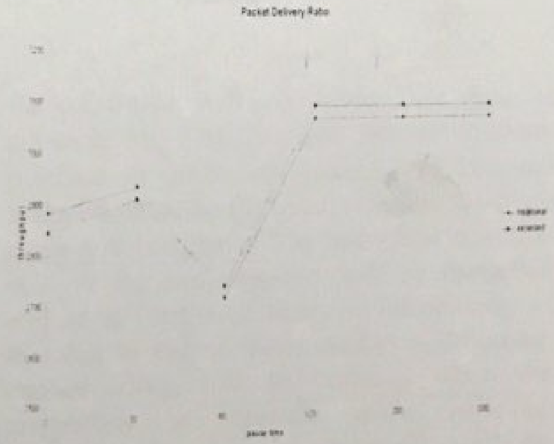
In the above traffic streams thirty different source nodes are sending data towards thirty different destination nodes and each source node sending ten data packets at the same time. Each data packet size will be 512 kilo bytes. In above network 60 nodes take part for sending and receiving data during simulation which runs maximum of 1000 seconds.

Collisions



We have calculated the number of collisions at different pause rates: 0, 30, 60, 120, 250 and 500 seconds and then compare the traditional DSR (original/already implemented) with applying my optimization called extended in the above graph. It is clearly viewed that number of collisions is reducing overall in the improved one. The number of collisions is reducing because of less congestion which results in fewer collisions then traditional model of DSR protocol.

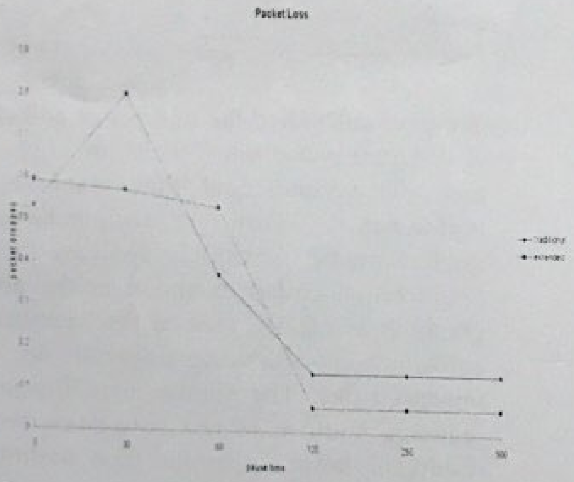
Packet Delivery Ratio



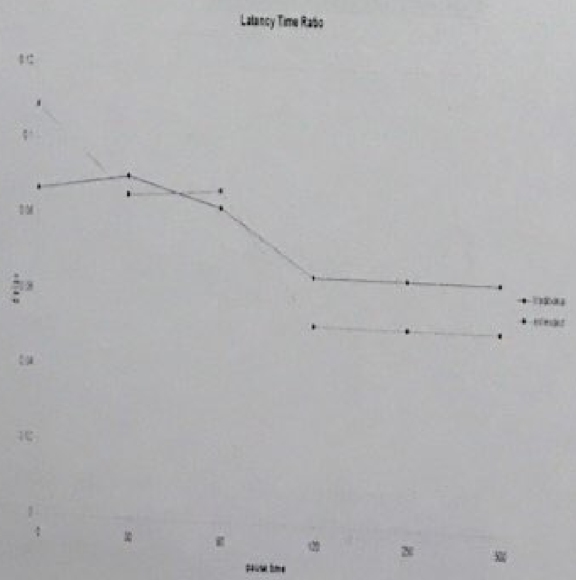
The throughput is also better then the traditional DSR one in mostly all cases due to delay which outcomes in less congestion and therefore packet delivery ratio goes better.

Packet Loss

Packet drops will be reduced in case of pause 0, 30, 120, 250 and 500 seconds but increase in pause 60 seconds. Packets are dropped because for every request for route there will be time to live and when this time is over the transmission will be cancelled and as in improved delay is introducing so that can be reason when packet is dropping. Packets drop will be reduced when the congestion at specific node will be decreased so time to transmit will be decreased which helps in decreasing number of data packets.



Latency Time Ratio



If we observe the above graph then it can be seen that average end to end delay is increasing as delay is introducing for control packets which will result in more delay for data packets so that's why delay is increasing.

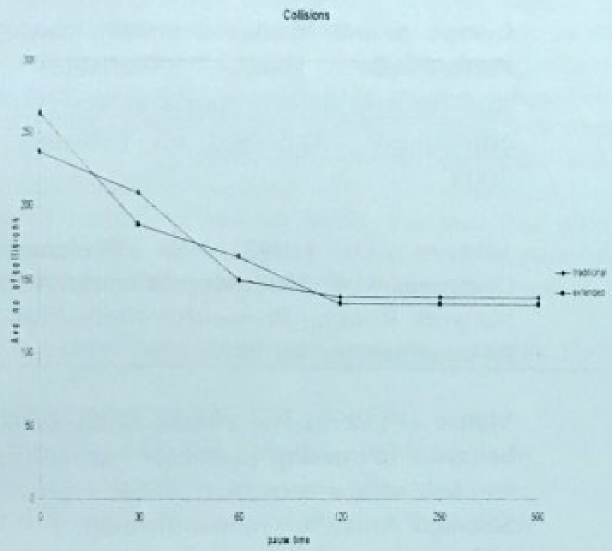
D.

To compute the result and comparison of traditional and extended DSR protocol following traffic streams are implemented.

CBR 0	79	10	512	5S	0S	0S
CBR 1	78	10	512	5S	70S	100S
CBR 2	77	10	512	2.5S	82.49S	199S
CBR 3	76	10	512	0.8S	91.39S	248S
CBR 4	75	10	512	2.5S	82.49S	199S
CBR 5	74	10	512	0.8S	91.39S	248S
CBR 6	73	10	512	0.8S	91.39S	248S
CBR 7	72	10	512	1.1S	107.8S	274S
CBR 8	71	10	512	0.8S	91.39S	248S
CBR 9	70	10	512	1.1S	107.8S	274S
CBR 10	69	10	512	1.1S	107.8S	274S
CBR 11	68	10	512	0.8S	91.39S	800S
CBR 12	67	10	512	2.5S	82.49S	500S
CBR 13	66	10	512	5S	70S	100S
CBR 14	65	10	512	2.5S	82.49S	199S
CBR 15	64	10	512	0.8S	91.39S	248S
CBR 16	63	10	512	5S	70S	400S
CBR 17	62	10	512	2.5S	82.49S	199S
CBR 18	61	10	512	0.8S	91.39S	248S
CBR 19	60	10	512	5S	70S	700S
CBR 20	59	10	512	0.8S	91.39S	248S
CBR 21	58	10	512	5S	70S	700S
CBR 22	57	10	512	2.5S	82.49S	500S
CBR 23	56	10	512	5S	70S	100S
CBR 24	55	10	512	2.5S	82.49S	199S
CBR 25	54	10	512	0.8S	91.39S	248S
CBR 26	53	10	512	5S	70S	400S
CBR 27	52	10	512	2.5S	82.49S	199S
CBR 28	51	10	512	0.8S	91.39S	248S
CBR 29	50	10	512	5S	70S	700S
CBR 30	49	10	512	0.8S	91.39S	248S
CBR 31	48	10	512	5S	70S	700S
CBR 32	47	10	512	2.5S	82.49S	199S
CBR 33	46	10	512	0.8S	91.39S	248S
CBR 34	45	10	512	5S	70S	700S
CBR 35	44	10	512	0.8S	91.39S	248S
CBR 36	43	10	512	5S	70S	700S
CBR 37	42	10	512	5S	70S	700S
CBR 38	41	10	512	0.8S	91.39S	248S
CBR 39	40	10	512	5S	70S	700S

In the above traffic streams forty different source nodes are sending data towards forty different destination nodes and each source node sending ten data packets at the same time. Each data packet size will be 512 kilo bytes. In above network 80 nodes take part for sending and receiving data during simulation which runs maximum of 1000 seconds.

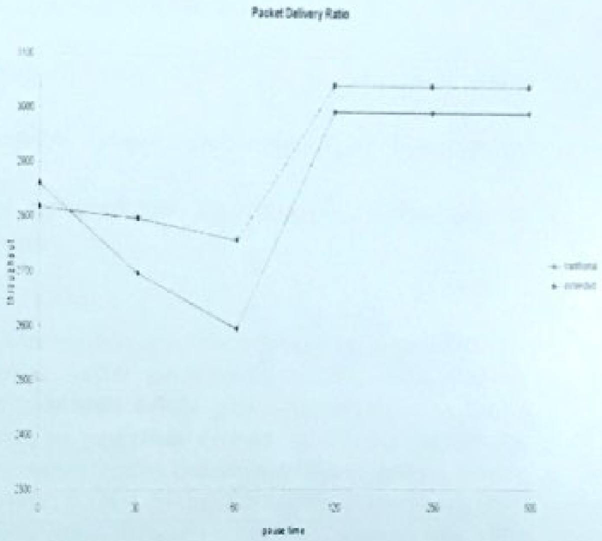
Collisions



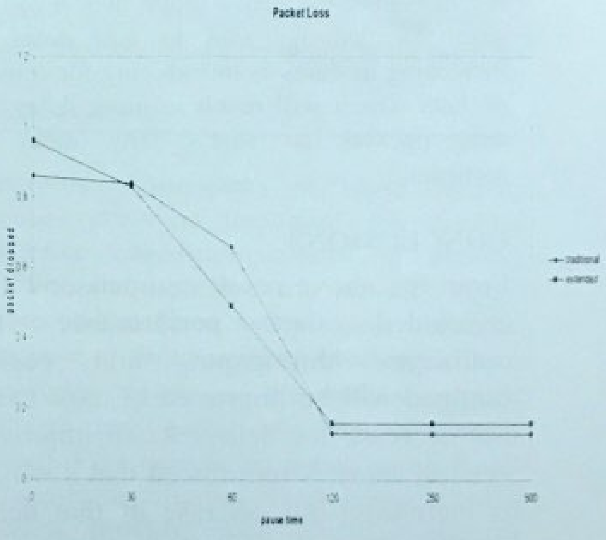
We have calculated the number of collisions at different pause rates: 0, 30, 60, 120, 250 and 500 seconds and then compare the traditional DSR (original/already implemented) with applying my optimization called extended in the above graph. It is clearly viewed that number of collisions is reducing overall in the improved one. The number of collisions is reducing because of less congestion which results in fewer collisions then traditional model of DSR protocol.

Packet Delivery Ratio

Due to delay there will be less congestion and the packets will be transmitted will less chances of dropping which will improve the packet delivery ratio and throughput is also improved due to that reason in case of extended model.

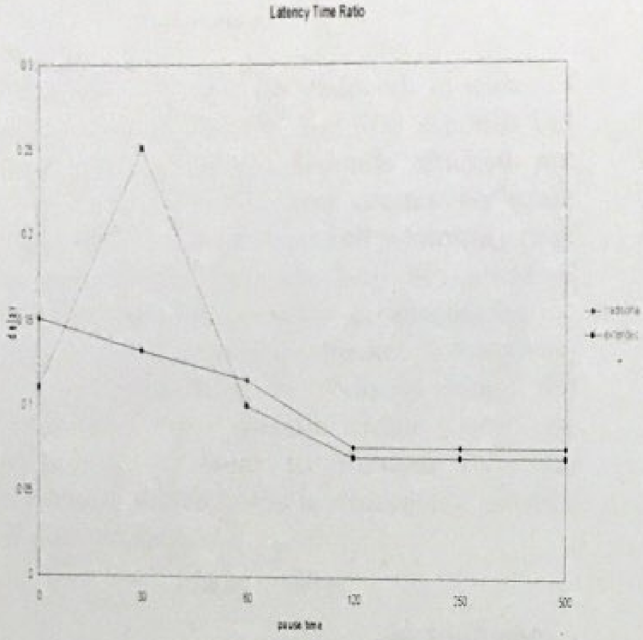


Packet Loss



Packet drops will be reduced in case of pause 0, 30, 120, 250 and 500 seconds but increase in pause 60 seconds. Packets are dropped because for every request for route there will be time to live and when this time is over the transmission will be cancelled and as in improved delay is introducing so that can be reason when packet is dropping. Packets drop will be reduced when the congestion at specific node will be decreased so time to transmit will be decreased which helps in decreasing number of data packets.

Latency Time Ratio



If we observe the above graph then it can be seen that average end to end delay is increasing as delay is introducing for control packets which will result in more delay for data packets so that's why delay is increasing.

CONCLUSIONS

From the above result comparisons it is concluded that performance for collisions, throughput, and packet dropped will be improved in most cases but decrease for delay. As in improved version delay is introduced that's why it is increasing but because of that delay congestion is decreased for one node, collisions and packet drop improve significantly. On the basis of results we can say that there is tradeoff between delay and collisions which results in less packet drops and slightly better throughput then traditional DSR.

REFERENCES

Broch J, David B J and David A M (2001). Dynamic Source Routing Protocol for Mobile Ad hoc Networks , chap: 5 pp.170-201.

Charles E P (2000). Ad-hoc Networking. Addison-Wesley Professional, Chap:3, pp.150-175.

Corson S and Macker J (1999). MANET Performance Issues. Available at: ftp://ftp.irisa.fr/techreports/theses/2003/lemouel.pdf. Accessed on February 2, 2008.

Johnson D (1998). A Performance Comparison of Multi-Hop Wireless AdHoc Network Routing Protocols, Mobi Com 98 Proceedings, pp. 88-101.

Maltzc D (1999).The effects of on-demand behavior in routing protocols for multihop wireless ad hoc networks", IEEE Journal on Selected Areas in Communication, 5 :130-155.

Royer (1999). A review of current routing protocols for Adhoc mobile networks, IEEE Wireless Communications, 6:46-55

Wikipedia (Encyclopedia). Mobile ad-hoc network. Available at: http://en.wikipedia.org/wiki/Mobile_ad-hoc_network. Accessed on January 8, 2008.