IJCTA, 9(33), 2016, pp. 79-87

L2R : Multicast Routing Protocol for Effective Localized Route Recovery in Backbone Networks

Deepika Vodnala* S. Phani Kumar and Srinivas Aluvala*****

Abstract : Multicast routing is a crucial task in mobile ad-hoc networks due to the dynamic adaption of network topology. Currently plenty of protocols in existence for routing, still the route maintenance is challenging because of the high mobility of nodes causing frequent link failures. To overcome the problems of route maintenance, various mechanisms were proposed, but none of the protocol provides better solution to find an alternate path from the point of link failure. So there is a dire need of a protocol that generates an alternate path in case of a link failure over the network. In this paper, a Localized Route Recovery (L2R) protocol is initiated to generate an alternate path for link failures in backbone networks. To ensure link failure recovery L2R is implemented, the upstream node initiates local route discovery to generate an alternate path to the destination. The simulation results of L2R yielded the better results in comparison with the existing link failure recovery protocols, increasing packet delivery ratio, throughput, minimizing overhead and delay of transmission.

Keywords : Mobile Ad-hoc Network, Multicast Routing, Backbone, Link Failure, Localized Route Recovery.

1. INTRODUCTION

A set of nodes in mobility connected to one another through wireless links forming an autonomous system is referred as mobile ad-hoc network (MANET) [1]. The nodes in the network are self-organizing and highly dynamic, making the topological changes rapidly and unpredictable. In large area MANETs multicasting [2] of packets is a major challenging job, currently many of the wireless network applications require a set of nodes to work as a group to carry out data transmission. To optimize the resource usage, communications in ad-hoc networks and the topology control techniques, lies in the backbone formation. Backbone structure is set to be a virtual link as it is not a physically dedicated network link. It's a hierarchical organization replica used in MANETs to exert the inherent issues of scalability in ad-hoc networks.

Due to many reasons like faint environment, signal inference, high mobility of nodes and data collisions the occurrence of link failures [3] in source route is very high which significantly increase the routing overhead, end-to-end delay, dropping ratio of packets, and in turn it degrades the performance of MANET. Currently many link failure recovery mechanisms were in existence but none of these protocols giving effective results.

In this paper a new multicast routing protocol, L2R is proposed to provide quick recovery during link failures by generating an alternate path (P_a) through localization. The major contributions of this protocol

* Research Scholar, Dept of CSE, GITAM University, Hyderabad, India deepuvodnala19@gmail.com.
** Professor & Head, Dept of CSE GITAM University, Hyderabad, India phanikumar.s@gmail.com.
*** Asst. Professor, Dept of CSE SR Engineering College, Warangal, India srinu.aluvala@gmail.com.

are: constructing a virtual backbone, multicast routing and link failure recovery. L2R minimizes end to end delay, routing overhead, control packet overhead on every node, improving packet delivery ratio, and throughput and adoptable in any of the MANET environment.

2. LINK FAILURE RECOVERY TECHNIQUES

A. Dynamic Source Routing - Link Failure Localization (DSR-LFL)

DSR-LFL algorithm (Praveen Yadav et al., 2013) [4] provides link failure recovery based on location of link failure in source route. Initially source route is divided into three regions: equal sized source and destination regions and a larger sized middle region compared to other regions. During packet transmission if any link failure occurs, DSR-LFL checks for the location of upstream node (US_n). If upstream node belongs to source region, error message is sent to source and the source take decisions. If upstream node belongs to destination region, upstream node finds a new route to destination by collecting the information from downstream nodes (DS_n). If upstream node belongs to middle region, local link recovery is implemented using one hop or two hop request with in the region. After the successful link recovery a packet is sent to source to inform about the new route. This technique results in stale route entries and increased packet loss.

B. Quick Recovery On-Demand Multicast Routing Protocol (QRODMRP)

QRODMRP (S. Muthumari Lakshmi et al., 2015) [5] adopts the implementation of Enhanced ODMR Protocol (EODMRP). It recovers link failures with hop to hop communication within the mesh. Recovery can be done in two ways: initiating a new route discovery from source or from upstream node.

C. Trustworthy Link Failure Recovery (TLFR)

TLFR algorithm (Y. Harold Robinson et al., 2015) [6] works based on the best forwarder selection opportunistic routing protocol providing continuity in packet forwarding at times of compound link failures. A black list, a minimum set of link failure nodes along its path is carried by each packet to forward the information to the other nodes, apart from the links blacklisted are chosen to select the next hop. The node which makes positive progress towards destination with the maximum power of reception gets highest priority to become the best forwarder. It caches packets to be delivered during the transmission. At times, within the scope of duration if best forwarder fails the next candidature node with high priority transmit the packets.

3. LLFR MODEL

Local Link Failure Recovery algorithm (LLFR) [7] was proposed to perform route recovery in mobile ad-hoc networks. The LLFR deployed on each node, maintains RREP Buffer Table (RBT) stack [8] which collects Route Replies (RREPs) from neighboring nodes in ascending order of signal strength. RSSI (Received Signal Strength Indication) is used for determining the stability of the link. When a link fails, upstream node selects the top most entry (RREP) having highest signal strength for generating an alternate path to transmit the packets to destination. Once alternate path is generated, upstream node updates the route caches and intimates the source. If no alternate path found in RBT, upstream node clears the RBT and generates route error and initiates route discovery again.

Algorithm: LLFR

----

init_route_discovery ($\overrightarrow{SD}$)

if ($\exists$ S: $\overrightarrow{SD}$ && $\exists$ x, y: $\in$ $\overrightarrow{SD}$)

{if $(\overset{\varnothing}{\overrightarrow{xy}})$

LLFR (x, D)

else

send_queued_pkts $(\overrightarrow{\mathrm{SD}})$

}

LLFR(x, D)

if($\forall\ P_a \in x$: RBT)

{ P_a = Best_RSSI_Path (RxPr (n) $\forall\ n_i..n_j$)

send_queued_pkts $(\overrightarrow{x\mathrm{D}})$

}

else

{ RBT = = $\varnothing$

generate_route_err $(\overrightarrow{x\mathrm{S}})$

init_route_discovery $(\overrightarrow{\mathrm{SD}})$

}

Best_RSSI_Path (RxPr (n) $\forall n_i\ldots\ldots n_j$)

RxPr ($n_{\max}$) = n_i

for($c = n_{i+1}$; $c < n_j$; c ++)

{ if (n_c > RxPr($n_{\max}$))

RxPr ($n_{\max}$) = n_c

}

hi_RSSI= RxPr ($n_{\max}$)

P_{Bst_RSSI} = hi_RSSI

return (P_{Bst_RSSI})

4. PROPOSED WORK

A. Overview: Localized Route Recovery Protocol

Localized Route Recovery (L2R) protocol is a hybrid routing protocol for route recovery. In backbone networks route discovery process works as follows: when a source needs to forward a data packet to the destination, route discovery process is initiated by sending a Route Request (RREQ) packet to the core node and it is flooded on the entire network. The route cache's of the intermediate nodes are updated with the routing information on receiving RREQ packets and continues broadcasting. On receiving RREQ packets, destination sends back RREP to source on receiving RREP by the source. Data is transmitted to the destination, upon the reception of RREP packet by the source. During the transmission of data packets if any link failure occur in the source route, upstream node implements L2R to find an alternate path to the destination. Initially in L2R, upstream node broadcasts RREQ packet to its 1-hop neighboring nodes (1_hop_nb_n) and forward it towards the destination. Upon receiving RREQ packet, destination sends RREP packet back to upstream node along the path RREQ packet is arrived and it is considered as an alternate path. Then upstream node forwards data packets to destination through the alternate path. If multiple alternate paths found, upstream node selects the path having minimum hop count (minhpct) as an optimal alternate path (P_{oa}).

Algorithm: L2R

----

init_route_discovery $(\overrightarrow{SD})$

if (∃ S: $\overrightarrow{SD}$ && ∃ x,y: ∈ $\overrightarrow{SD}$)

{ if $(\overset{\otimes}{xy})$

L2R(x, D)

else

send_queued_pkts $(\overrightarrow{SD})$

}

L2R(x, D)

∃ 1_hop_nb_n : $\overrightarrow{xD}$

send_RREQ[x, 1_hop_nb_1…..1_hop_nb_{n-1}, D]

receive_RREP[D, 1_hop_nb_{n-1}…..1_hop_nb_1, x])

∀ xD ∃ $\overrightarrow{P_a}$

if(n($P_{a(x \to D)}$) > 1)

{ for($P_a = P_1$; $P_a \le P_n$; P_a++)

{ for(hp = 0; hp ≤ 1_hop_nb_{n-1}; hp ++);

{ hca = hp

P_{min} = hc(P_i)

} }

minhpct = 0

for(Pc = P_{1+1}; Pc ≤ P_n; Pc ++)

{ if(Pc == P_{min})

{ minhpct ++

}}

if(minhpct == 1)

$P_{oa} = P_{min}$

return P_{oa}

else

{ for(Pc = P_{1+1}; Pc ≤ P_n; Pc ++)

{ if(Pc == P_{min})

{ Pc_{sum} = 0

for(t = x; t < = D; t =1_hop_nb)

Pc_{sum}+ = d(1_hop_nb_i, 1_hop_nb_{i+1})

}}}

P_{oa} = min(Pc_{sum})

return P_{oa}

At the time of transmitting data packets from source S to destination D a route found *i.e.* S-1-2-3-4-D and a link failure is identified between the nodes '3' and '4' as shown in figure 1 (*a*). According to L2R, in figure 1 (*b*) upstream node '3' send RREQ to its 1-hop neighboring nodes '*a*' and 'd'. Figure 1(*c*) 1-hop neighboring nodes on receiving RREQ packet; forward it to the next neighboring nodes until it reaches to the destination. Figure 1 (*d*) RREP packet is sent back to node '3' through the path RREQ packet is received. In this scenario, there exist two alternate paths: P_1: 3-*a*-*b*-*c*-D; P_2: 3-*d*-*e*-D. Figure 1 (*e*) node '3' opt P_2 as an optimal alternate path with less number of hops in comparison to P_1.

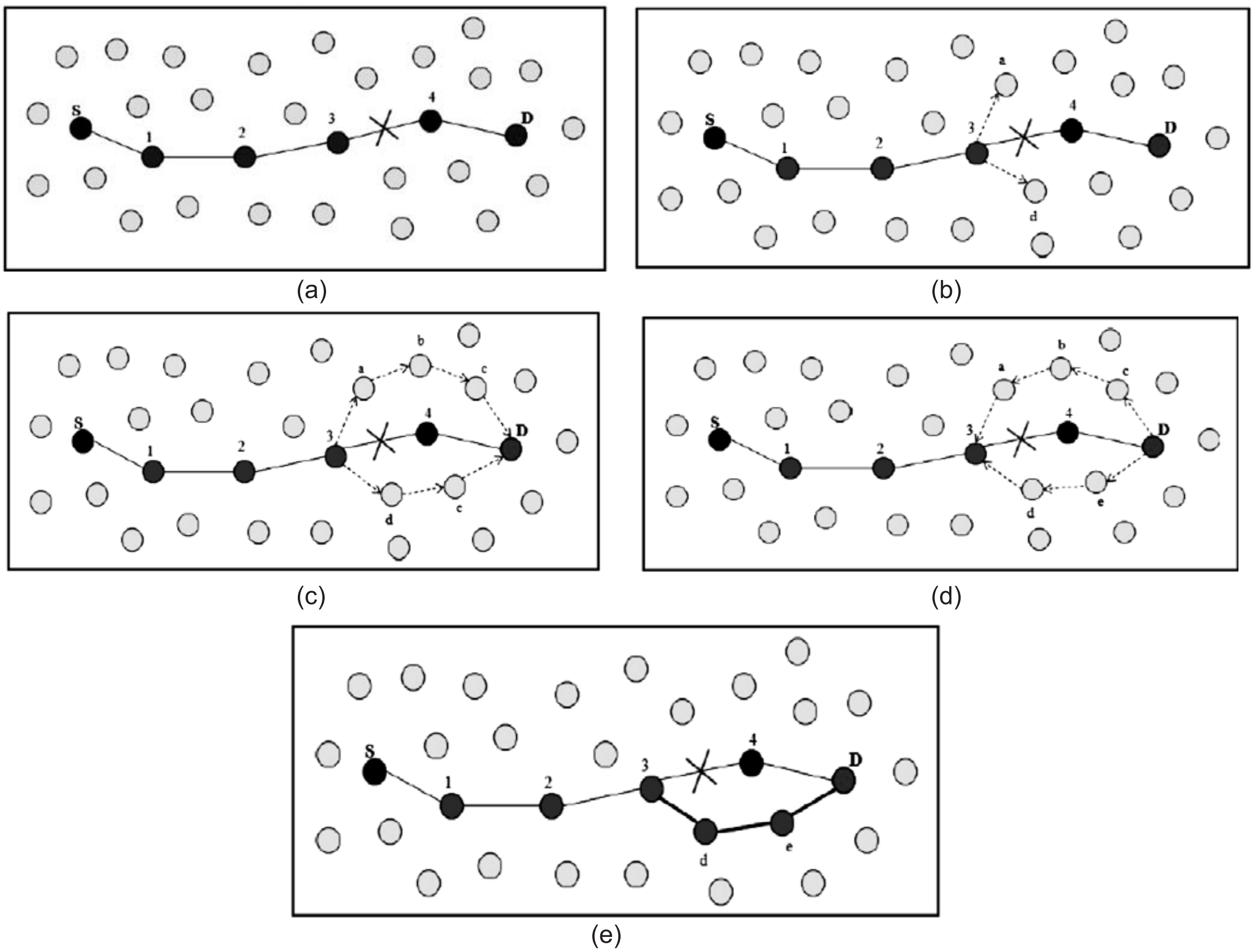


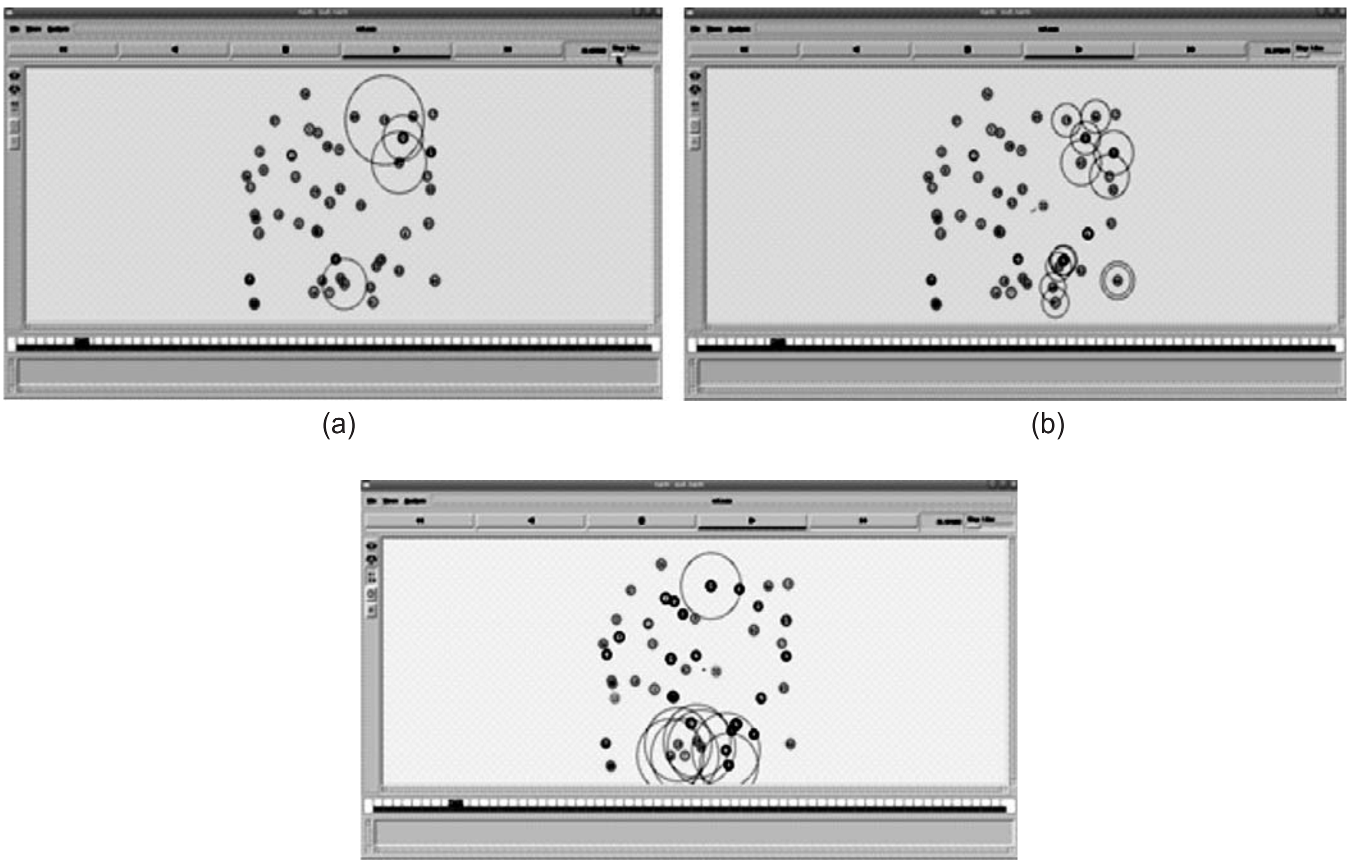
Figure 1: Schematic representation of L2R (*a*) Occurrence of route failure, (*b*) Upstream node sending RREQ to 1-hop neighboring nodes, (c) RREQs towards destination, (*d*) RREPs to source, (*e*) Alternate path generation

5. RESULTS

This section shows the performance of L2R in comparison with LLFR using Network Simulator (NS2) tool. The simulation parameters are summarized in Table I. and in figure 2 experimental scenario of L2R is shown. Figure 2 (*a*) the network of 50 nodes (green color) are configured in the simulation area of 1000m x 1000m where the nodes 1, 25, 27, 36, 49 (red color) are initialized as core nodes to form a virtual backbone. Figure 2 (*b*) source and destinations are initiated as node 6 (blue color) and node 20 (yellow color), through the discovered path 6-2-38-4-20 multicast packet transmission takes place, during the transmission a link failure at node 2 (black color) is identified. Figure 2 (*c*) on link failure, L2R finds an optimal alternate path 6-30-40-19-48-28-1-42-20 from a set of available alternate paths.

Table 1
Simulation Environment.

Parameter	*Value*
Simulation Tool	NS2 (2.34)
Simulation Area	1000m x 1000m
No. of Nodes	50
MAC Type	IEEE 802.11
Simulation Time	200s
Antenna Model	Omni Antenna
Channel Type	Wireless Channel
Mobility Model	Random Way Point
Traffic Type	UDP



(a) (b) (c)

Figure 2: L2R experimental scenario (*a*) Initialization of core nodes in backbone network, (*b*) Multicast packet transmission and identification of link failure, (*c*) Packet transmission through alternate path

A. Graph Analysis

The simulation of L2R protocol in comparison with LLFR protocol produces effective results by considering various parameters like packet delivery ratio (PDR), throughput and normalized overhead with increasing traffic.

Figure 3 shows the comparison of Packet Delivery Ratio between L2R and LLFR. We can observe that the packet delivery ratio keeps increasing as the traffic gradually increases, at some instances it keeps fluctuating but it's always more when compared with the LLFR. Table II, Shows the packet delivery ratio of L2R and LLFR.

Table 2

Packet Delivery Ratio

Traffic	*L2R*	*LLFR*
4	85.807	51.6377
5	69.8818	44.5626
6	75.8911	28.9463
7	65.4052	23.9618
8	52.4367	26.4745

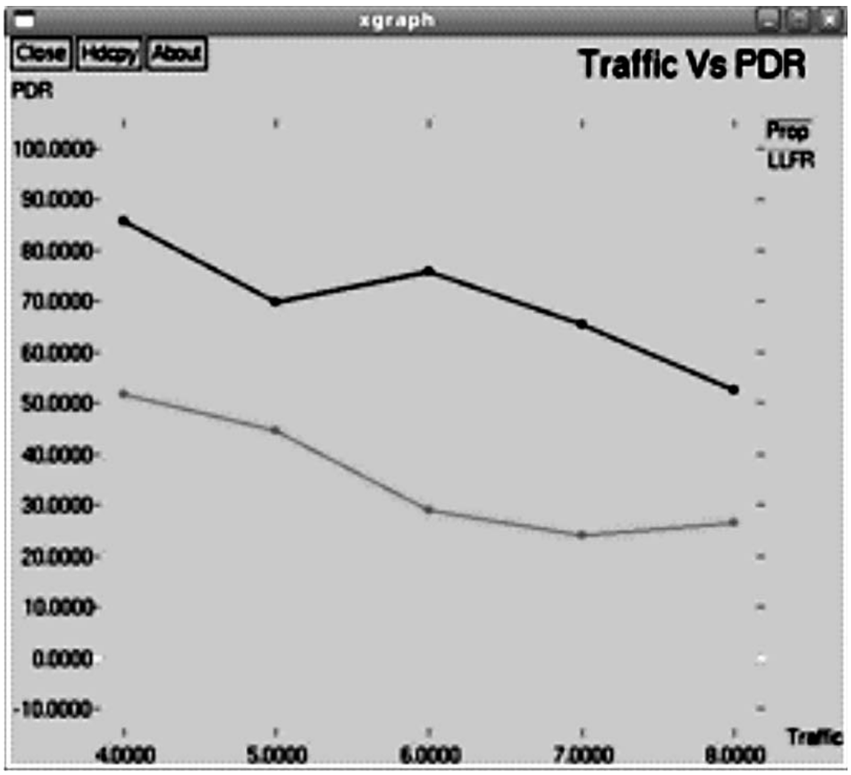


Figure 3: Traffic Vs Packet Delivery Ratio

Figure 4 shows the comparison of Throughput between L2R and LLFR. Results show that the throughput of L2R is better than the LLFR. Table III shows the throughput of L2R and LLFR.

Table 3

Throughput

Traffic	*L2R*	*LLFR*
4	268948	161850
5	273387	174335
6	354286	135131
7	357120	130834
8	327589	165394

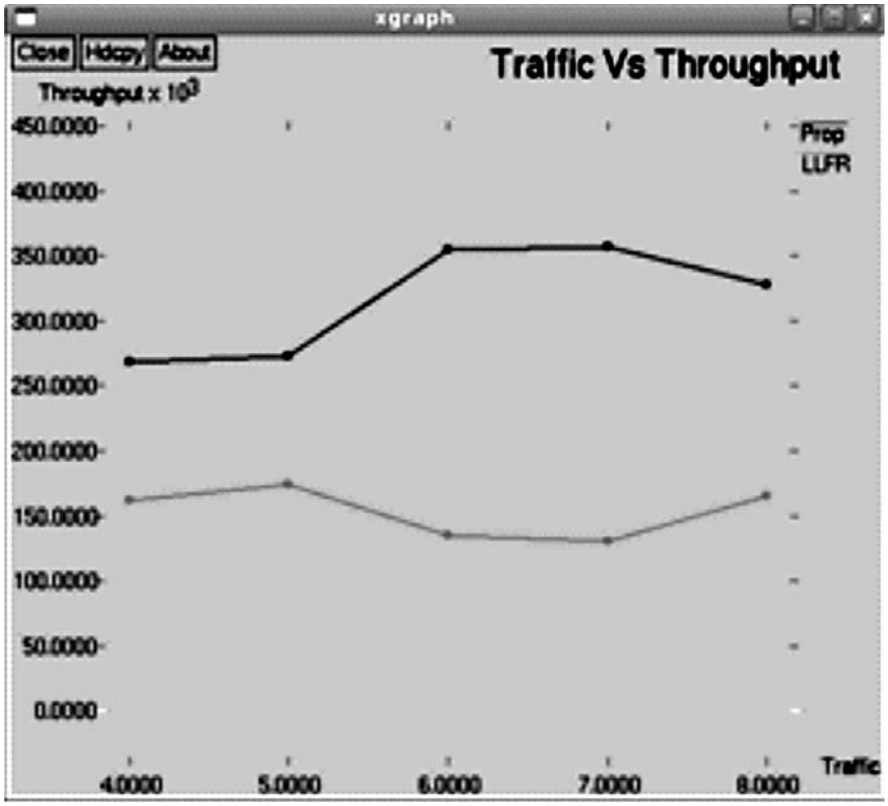


Figure 4: Traffic Vs Throughput

Figure 5 shows the comparison of normalized overhead between L2R and LLFR. Results shows that as the traffic increases the overhead increases in LLFR but in contrast as the traffic increases the overhead gradually decreased in L2R, as a result the network performance increases. Table IV shows the normalized overhead of L2R and LLFR.

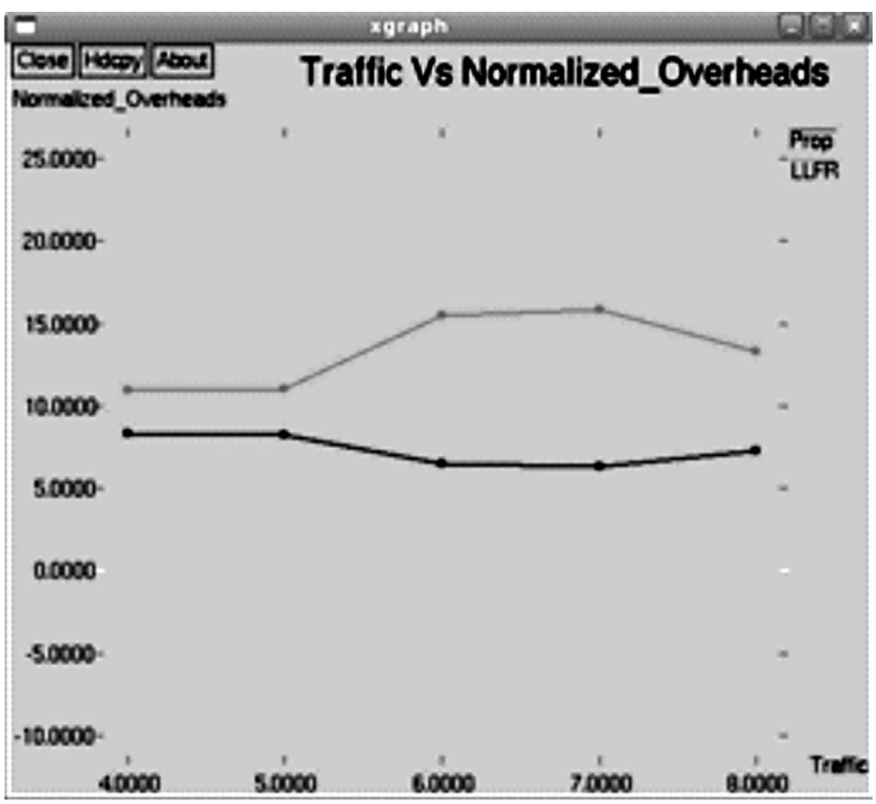


Figure 5: Traffic Vs Normalized Overhead

Table 3

Normalized Overhead

Traffic	*L2R*	*LLFR*
4	8.37105	10.9886
5	8.21313	11.0324
6	6.46787	15.4459
7	6.31208	15.7959
8	7.24449	13.3112

6. CONCLUSION

In this paper, Localized Route Recovery protocol has been proposed which effectively recovers the link failures in backbone based mobile ad-hoc networks. The proposed algorithm locally discovers and generates an optimal alternate path from among the set of available alternate paths in case of a link failure. The simulation results show that the L2R protocol provides better performance in comparison with LLFR technique even in highly dynamic and large area networks.

7. REFERENCES

1. Parul Vashist, K.Hema, "New Multicast Routing Protocol in Ad-Hoc Network, International" Journal of Innovations in Engineering and Technology, vol. 2, pp. 103-119, April 2013
2. R.Janakavi,V. Keerthana, S. Ramya, S. Gayathri Devi, "A Survey of Multicast Routing Protocols", International Journal of Scientific Engineering and Technology, vol. 3, pp. 418-421, April 2014
3. M Ravi Kumar, N Ramesh Babu, N Geethanjali, "A Review on Multicast Routing Protocols for Mobile Ad-Hoc Networks", International Journal of Advanced Research in Computer Science and Software Engineering, vol. 3, pp. 856-862, September 2013
4. Praveen Yadav, Joy Bhattacharjee, Dr. K S Rahguwanshi, "A Novel Routing Algorithm Based on Link Failure Localization for MANET", International Journal of Engineering Research and Applications, vol. 3, pp. 1133-1139, Jul-Aug 2013
5. S. Muthumari Lakshmi, K. Thirunadana Sikamani, "Quick Recovery from Link Failures using Enhanced On-demand Multicast Routing Protocol", Research Journal of Applied Sciences, Engineering and Technology, vol. 9, pp. 526-530, 2015
6. Y. Harold Robinson, M. Rajaram, "Trustworthy Link Failure Recovery Algorithm for Highly Dynamic Mobile Ad-hoc Networks", International Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering, vol. 9, pp. 233-236, 2015
7. P.R. Jasmine Jeni, A. Vimala Julie, A. Messiah Bose, "An Enhanced Route Failure Recovery Model for Mobile Ad-hoc Networks", Journal of Computer Science, vol. 10, pp. 1561-1568, 2014
8. P. R. Jasmine Jeni, A. Vimala Juliet, A. Messiah Bose, "An Efficient Quantum Based Routing Protocol with Local Link Failure Recovery Algorithm for MANET", International Journal of Engineering & Technology, vol. 3, pp: 237-244, 2014
9. Emily M. Craparo, Jonathan P. How, Eytan Modiano, "Throughput Optimization in Mobile Backbone Networks", IEEE Transactions on Mobile Computing, vol. 10, pp. 560-572, April 2011
10. Zifen Yang, Deqian Fu, Lihua Han, Seong Tae Jhang, "Improved Route Discovery Based on Constructing Connected Dominating Set in MANET", International Journal of Distributed Sensor Networks, 2015.