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**Research Article**

# Efficient Link Based Route Selection for Multicasting in Mobile Ad Hoc Networks

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**Abstract:** Mobile Ad hoc networks have invaded some of the most traditional technologies due to the portability that comes handy with efficient communication using the 'temporary links' created between the nodes. One of the major issues face, however, is the link failure issue during the movement of nodes. In this study, we provide a solution to perform efficient multicasting in MANETs called Link Based Route Selection for Multicasting (LBRSM) with the link conditions considered as well. $\bar{\varphi}$ is a novel link factor proposed that aids in choosing the best next node to reach the destinations while multicasting. The efficiency of the proposed method is evaluated by the simulations in network simulator. To prove the efficiency, we compare the simulations results of LBRSM and LSMRP to show that the LBRSM is efficient.

**Keywords**: Ad hoc network, link factor, multicasting, mobility, network simulator, route selection

## INTRODUCTION

Mobile ad hoc networks are extensively used for on-the-move applications and remain as a promising technology. The network is formed using autonomous nodes used over links that are bandwidth constrained. The network topology may change rapidly and unpredictably over time because of the node mobility. All nodes are autonomous, who can take decisions regarding the operations among the nodes individually and in a decentralized manner. Owing to the advantages, MANETs are preferred for applications like: Personal area networking, in military environments, in civilian environments and emergency operations.
The main challenges involved with MANETs are listed:

- Limitations of the Wireless Network: packet loss due to transmission errors; variable capacity links; frequent disconnections/partitions; limited communication bandwidth; and Broadcast nature of the communications.
- Limitations Imposed by Mobility: dynamically changing topologies/routes; and lack of mobility awareness by system/applications.
- Limitations of the Mobile Computer: short battery lifetime and limited capacities.

The main issue among these challenges is that the mobility of nodes that has a great impact on the quality of service and quality of links in the network. Figure 1 shows that the nodes within the range of each other than can form a communication path.

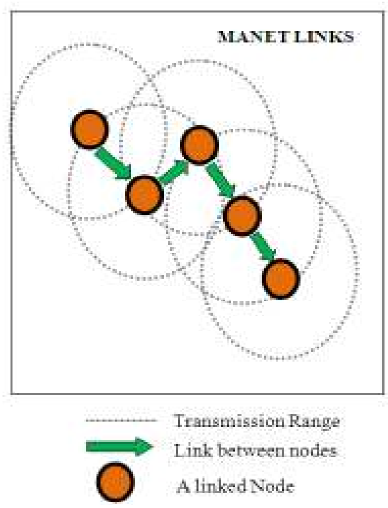


Fig. 1: Links in a MANET

When mobility is introduced, the communication can be disturbed as in Fig. 2. The nodes move out of each other's range and hence the links between the nodes are broken. Although there are a few works related to providing reliability while transmission in the network, there is always a need for the most efficient ideally reliable communication protocol for a MANET. The work proposed in this study is one such effort to reduce link failures in the MANET increasing the QoS. The organization of the paper is this: related works, proposed Link Based Route Selection for Multicasting (LBRSM) and simulation analysis using the network simulator.

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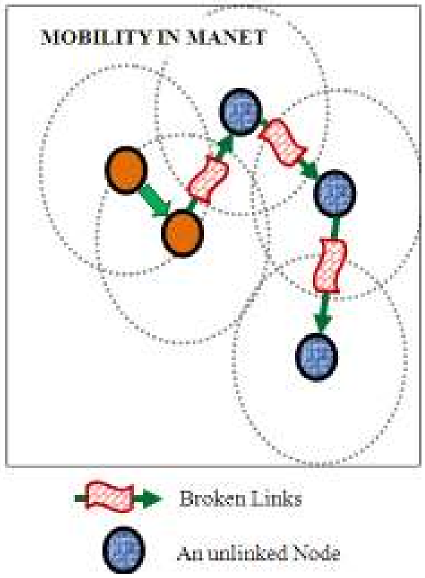


Fig. 2: Link breakages in a MANET

## LITERATURE REVIEW

There are many works related to the reliable route selection in MANET. Ad hoc On-demand Distance vector routing is the first known efficient routing protocol designed by Royer and Perkins (1999) for MANETs.

Multicast mode of the Ad hoc On-demand Distance Vector (MAODV) routing was one f the earliest proposed multicast routing protocols by Perkins and Royer (1999). MAODV is a shared tree based multicasting scheme. This scheme picks a sole sender to construct the multicast tree and then shred the constructed tree with other sender. The MOAODV constructs an efficient multicast tree using the unicast routes of AODV. Hello messages are flooded to be able to check the link connectivity while forming the multicast routes. Even though the multicast trees can be efficiently constructed, in the absence of a receiver, continuous flooding of the hello messages takes place which is a big drawback of MAODV.

Forwarding Group Multicast Protocol (FGMP) by Ching-Chuan *et al*. (1998) is a new multicast protocol for multihop mobile wireless networks. Here, a group of nodes in charge of forwarding multicast packets is designated according to the requests of the members instead of forming multicast trees. Multicast is then carried out via “scoped” flooding over such set of nodes. Every forwarding group is dynamically refreshed to bear with the changes. Wireless broadcast transmissions are exploited by the forwarding group to reduce the channel and storage overhead, thus improving the performance and scalability.

A weighted multicast routing algorithm for MANET, ‘A link stability-based multicast routing protocol for wireless mobile ad hoc networks’ was proposed in Torkestani and Meybodi (2011). In that method, the probability distribution of the mobility is unknown and the multicast routing problem is first transformed into an equivalent stochastic Steiner tree. The algorithm used here is based on learning-automata. The main objective of Torkestani and Meybodi (2011) is to find out the most stable routes in high mobility conditions. The major disadvantage is the computational complexity of the probabilistic method proposed here. Other related works can also be found in Mauve *et al*. (2003), Shen and Jaikaeo (2005) and Baker and Akcayol (2011). Some of the disadvantages present in these protocols are overcome by the routing scheme proposed in this study.

## PROPOSED WORK

The work proposed in this study ensures QoS enhancement during the communication in MANETS using the link factor estimation mechanism. Link residual life is the main metric utilized for route selection mechanism using which the link factor $\bar{\varphi}$is determined.

**Evaluation metrics:** Link Factor ($\bar{\varphi}$) is the Link Residual Life (LRL) of the current link between the two nodes along with the link considerations of the nodes during previous mechanisms:

$$\bar{\varphi} = LRL + \frac{1}{k}\ Redundant\ LRL \tag{1}$$

where, k is the redundancy of a node being used for communication and Redundant LRL is the average of the entire link residual life values of the node n since the beginning of the network operations.

The link residual life is given by the expression in Eq. (2):

$$LRL = \frac{D_R}{V_R} \tag{2}$$

where, $D_R$ is the distance remaining to move out-of-range of the node with which a link is formed and $V_R$ is the relative velocity of the nodes. Each node thus estimates dynamically the redundant LRL value of itself with the nodes it comes across while moving around in the network. The redundant LRL value is stored in each and every node during communication using the algorithm below:

**Algorithm:**

```
While (1)
{
k = 1
for (i = 0; i<nn; i++) //where i and j are the nodes in the MANET
```

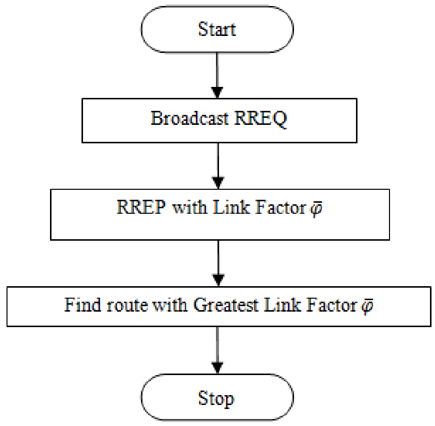


Fig. 3: Working of the LBRSM scheme

```
{
   for (j = 0; j<nn; j++)
   {
        While (i ! = j)
        {
          DR←distance to move out of range of j's range
            VR← relative velocity of I with respect to j
            If (LRL(i) ! = 0) //if LRL for i exists
            {
               k++; // increment k for the node i
            }
            LRL(i) = DR/VR
         Calculate the link factor φ̄ //store the φ̄ in each node's database
        }
    }
}
}
```

**Working of the proposed LBRSM scheme:** The evaluation metrics for every node have been presented and now the link factor $\bar{\varphi}$ is calculated and stored by every node dynamically.

When a source initiates a route request message requesting for a path through which it can send data to the destination, the reply carries the link factor concerning the sender (i) and the receiver (j). Depending on the highest $\bar{\varphi}$, the route to the destination is selected by each node from its neighbors successively. This is performed as shown in the flowchart in Fig. 3.

## SIMULATION ANALYSIS

The simulation analysis is performed by the use of network simulator tool (NS-2) that is used extensively for research in many areas of networking. Since it is possible to discreetly analyze the events in a network scenario, we use the NS-2 tool for the simulation of the LBRSM scheme in a MANET. The simulation parameters used are listed in Table 1.

Table 1: Simulation parameters

| Parameter | Value |
|---|---|
| Simulation time | 80 ms |
| Number of nodes | 31 |
| Routing protocol | AODV |
| Traffic model | CBR |
| Simulation area | 1000×1000 |
| Transmission range | 250 m |
| Antenna type | Omni antenna |
| Network interface type | WirelessPhy |
| Channel type | Wireless channel |
| Mobility model | Random way point |

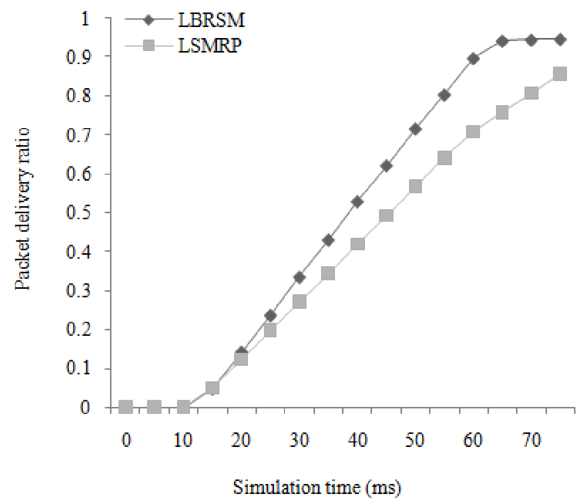


Fig. 4: Packet delivery rate of LBRSM and LSMRP

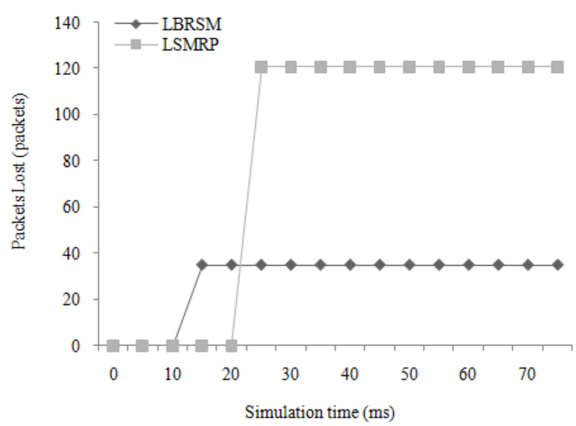


Fig. 5: Packet losses of LBRSM and LSMRP

The performance comparison of LBRSM with the LSMRP is performed in this section by comparing the packet delivery rate, loss and delay.

**Packet delivery rate:** The Packet Delivery Rate (PDR) is the ratio of the number of packets delivered to the total packets sent. It is measured by the Eq. (3):

$$PDR = \frac{Total\ Packets\ Delivered}{Total\ Packets\ Sent} \quad (3)$$

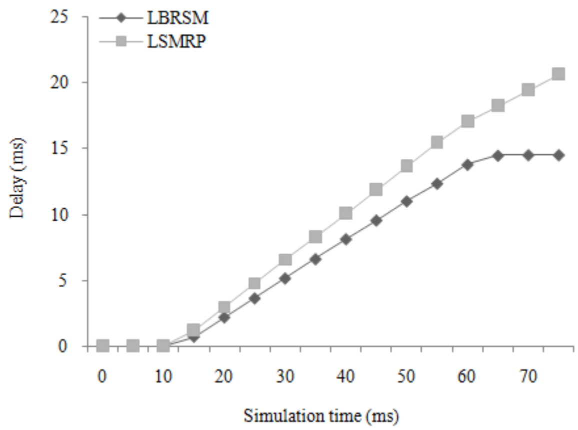


Fig. 6: Delays of LBRSM and LSMRP

Figure 4 shows that the PDR value of the LBRSM scheme is greater than that of the LSMRP.

**Packet loss:** The total number of packets lost over the simulation time is plotted in the Fig. 5. The plots indicate that the losses are minimized in the proposed LBSRM scheme when compared to the LSMRP. The packet loss is minimized because the number of link failures has been reduced while routing in the network due to the link factor estimation parameter$\bar{\varphi}$.

**Delay:** The delay analysis of the LBRSM scheme is shown in the Fig. 6.

The time delay occurred during data transmission of the LBRSM and LSMRP simulations show that the proposed LBSRM scheme is greater than the existing scheme.

## CONCLUSION

In this study, we proposed, designed and simulated the Link Based Route Selection for Multicasting (LBRSM) scheme for mobile ad hoc networks. We have introduced the link factor $\bar{\varphi}$ that only uses the current link residual life factor but also the previous and redundant link residual life values to estimate the reliable route to reach the destination. Comparing with the simulation results of LSMRP, the LBRSM has proved better performance in terms of packet delivery rate, loss and delay during data transmission. This scheme can be applied in the areas of military operations, emergency and disaster management in order to ensure reliable data delivery on-the-move.

Future work aims at analysis of energy consumption also as a factor of reliability and efficiency along with the incorporation of security schemes in the network.

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