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An Performance improved Revised Optimal Link State Routing (ROLSR) Algorithm for MANETs.

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ABSTRACT

As MANETs are often set up in challenging environments with high mobility, the selection of an appropriate routing protocol is very important to maintain good Quality of Service. Communication vacuums or the unreachability problem has been one of the main issues in mobile ad hoc networks. With highly mobile and unreliable nodes, they can occur very often and may lead to loss of data packets in the network. Most of the existing methods that are available to handle this issue try to find out a route around the communication void. Due to this the data packets may have to travel more number of hops in reaching the destination and thus causing more delay in data delivery in the network. The aim of this research paper is to explore the various features of exisiting routing algorithms. Specifically it analyzes the existing two routing protocols such as link state routing (LSR) and Optimal Link State Routing (OLSR) and formulate a new algorithm which overcome the shortcomings present in these algorithms. The performance of the newly created algorithm Revised Optimal Link State Routing (ROLSR) was examined with simulation environment. The analysis and simulations show that using this method a data packet takes less number of hops to reach the destination compared to the existing methods with low error rate, fewer message overhead and minimum delay. Thus, with the new ROLSR routing can be achieved with better QoS. But, the result vary depends on the various applications. Hense it is an application specific one.

INTRODUCTION

A MANET or Mobile Ad hoc Network is a self configuring network with the properties like frequent host movement, frequent topology change, no cellular infrastructure, easy to deploy and multi-hop wireless links. Most importantly data must be routed via intermediate nodes (M. Tarique, *et al*. 2009). Here every node in the network should be able to act as a router to locate the optimal path to forward a data packet. Some of the major applications are Personal area networking such as cell phone, laptop, ear phone and wrist watch, Military environments such as soldiers, tanks and planes, Civilian environments such as taxi cab network, meeting rooms, sports stadiums, boats and small aircraft, Emergency operations such as search-and-rescue, policing and fire fighting (E. M. Royer and C.-K. Toh, 2003).

Due to this ever increasing demand of MANETs, over the past years a lot of research has been carried out to move different applications from traditional infrastructure environment into the ad hoc based environment, so that several new services will be created for the new environment. But the MANETs have some limitations too(D. Bhattacharyya, *et al*., 2010). Some of the challenges in mobile environments are as follows. In wireless networks, there is a high possibility of packet loss due to transmission errors, frequent disconnections/partitions,

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limited communication bandwidth, variable capacity links and broadcast nature of the communications. Further, limitations imposed by mobility are dynamically changing topologies/routes and lack of mobility awareness by system/applications. Moreover in terms of mobile devices limitations are short battery lifetime and limited capacities (C. E. Perkins and P. Bhagwat, 2004).

Even though MANETs have brought so many advantages to set up new applications, some of the issues are still remain to be addressed. One of the most important issues is routing of data packets in MANETs. Whenever, nodes entering or leaving the networks, the network topology keep on changing, so it becomes very hard to select a forwarding node to route the packets. Selection of an optimal path from the source to the destination also remains a big challenge. The nonexistence of a centralized control also adds to this issue (J.-H. Cho, *et al*., 2011).

Guaranteeing the Quality of service (QoS) is also a challenge in these networks as the topology change dynamically and network state details are generally inaccurate. Reliability in data delivery and security of the network needs to be maintained (V. Sharma and B. Alam, 2012). MANETs are more exposed than wired networks due to the threats from compromised nodes, nodes mobility, lack of physical security, scalability, dynamic topology, and decentralized management. Because of these vulnerabilities, MANETs are more prone to malicious attacks and this elevates the need for appropriate security in these types of networks (L. J. G. Villalba, *et al*., 2009).

Manets Routing Protocols:

In this section, we will discuss about the various existing MANETs routing protocols. Dynamic routing protocols are categorized depending on what the routers tell each other and how they use the information to form their required routing tables so that they can forward the nodes effectively. They are proactive (table driven) and reactive (source initiated).

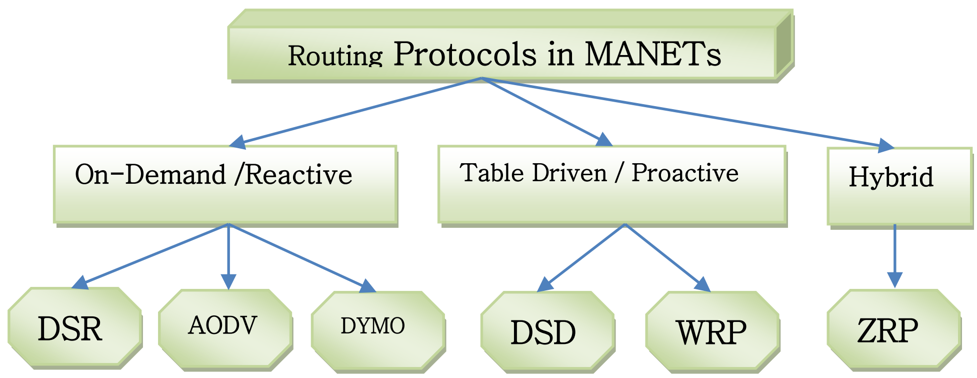

Fig. 1: Routing protocols in MANETs

Figure 1 shows the various routing protocols available for MANETs. Proactive routing mechanism requires every nodes to maintain one or more routing tables to store routing related information. But in reactive mechanism create routes only when desired by the source node. It has a separate route maintenance procedure. The comparisons between various routing mechanism is listed in Table 1.

Table 1: Comparison of various routing protocols

Properties	Reactive	Proactive	Hybrid
Route Availability	Determined when necessary	Always available	Based on the location of the destination node
Route Structure	Mostly flat except Cluster based routing protocols(CBRP)	Both flat and Hierarchical	Mostly Hierarchical
Storage Requirements	Low	High	Depends on the size of the cluster.
Traffic Control Volume	Low	High	Lower than proactive and reactive
Mobility Handling Effects	ABR has LBQ, AODV uses local route discovery	Updates happen at fixed intervals	Usually more than one path may be available
Scalability	Few 100 nodes	Upto 100 nodes	Upto 1000 or more
Delay	High	Low	High
Distributed	Yes	Yes	Yes
Routing Overhead	Proportional to the number of communicating nodes and increases with increased node mobility	Proportional to the size of the networks regardless of network traffic	Reduced routing overhead when compared with others.

Desirable Factors For Designing And Selecting Routing Protocols For Manets:

The routing protocol must be designed in such a way that it should support the highly dynamic nature of the mobile ad hoc networks. The desired protocol must take care of continuously moving nodes and must be able to make proper routing decisions for the data packets.

A. Decentralized Control:

Design and selection of the protocol must be done considering the truth that the ad hoc network does not have any centralized control. Every node can join or leave the network at any time and can move freely throughout the network ie. Free movement (L. Abusalah, *et al*., 2008).

B. Forwarding of Packets:

Packets forwarding must be made by the protocol in an efficient way considering many factors like traffic in the link, nodes transmission range, etc (M. Nikolov and Z. J. Haas, 2015).

C. Free of Loops:

The chosen routing protocol must ensure that the data send across the network is not circulated around the networks on the same paths or between the same nodes. If proper consideration is not taken care, performance degradation in the network can occur (V. G. Menon and P. M. Joe Prathap, 2016).

D. Memory:

As the ad hoc network has mobility, routing algorithms with additional memory requirements may face some severe problem. Maintaining current accurate location information subject to topological changes causes high traffic volume, long queues, severe congestion, overhead, latency and high energy expenditure. Therefore, it is desirable to avoid solutions which involve large memory requirements at node level itself(V. G. Menon and P. M. Joe Prathap, 2013).

E. Delay:

The chosen routing protocol must make sure that the delay experienced by the data packets in the ad hoc network is low and provide a good performance is guaranteed always.

F. Guaranteed Message Delivery:

The chosen routing protocols must make sure that all the data transferred by the source has been delivered properly to the destination. This is one of the most important required feature for every routing protocols used in MANETs.

G. Selection of Optimal Path:

Optimal path selection to send the data packet is a very important factor with any routing protocol. The algorithm has to be chosen in such a way that it should select the most optimal path to the destination for transferring the data packets.

H. Overhead:

Usually whenever we add additional features and characteristics with the existing one, overhead will occur. The desired routing protocol must make sure that the additional overhead required is kept minimum and it does not affect the performance of the current network significantly. Both the routing and control overhead should be kept minimum to provide a better performance for the routing protocol in the MANETs (Tamilarasan and Santhamurthy, 2011).

Optimized Link State Routing Algorithm:

In generic link state routing protocol, every node monitors neighbors/local links and advertises them to the network. In this protocol, usually state of local links is sent periodically and it must be re-sent because of non-reliable delivery and possible joins/merges. Moreover each node maintains the full graph by collecting the updates from all other nodes; The set of all links forms the complete graph; Routing is performed using shortest path computations on the graph. Neighbor discovery is done using basic Hello protocol. For periodic link advertisement, normal flooding will be done. But this method is very inefficient in case of high mobility. So the revised optimized routing mechanism is a mandatory one (Y. Zhen, *et al*., 2010).

To achieve the optimized link state routing algorithm we can add enhancement in the following levels.

- Hello protocol enhancement (differential)
- Flooding protocol enhancement
- Reduces the cost of flooding by using knowledge of topology
- Multi-Point Relay (OLSR)

- Topology Based Reverse Path Forwarding (TBRPF)
- Reduce the number of advertised links to less than the complete graph (Topology Filtering)
- Nearsighted Updates (Fisheye & HSLS) i.e. Scoped flooding for advertisements and Update nearby nodes quickly & far nodes more slowly.

By using the above considerations we can achieve the optimized routing protocols. Several enhancements and versions are developed in this optimal link state routing protocol. In this paper too we provide a revised optimized routing protocol with add on features.

Revised Optimized Link State Routing (Rolsr) Algorithm:

Performance analysis of the most important opportunistic routing protocols from each category is carried out in highly mobile and dynamic ad hoc networks and a comparative analysis is done. The performance is analyzed based on various Quality of Service (QoS) performance metrics. The major issues that lead to transmission inefficiency of opportunistic protocols in highly mobile and dynamic ad hoc networks are identified. This new protocol would ensure reliable and continuous communication between the wireless devices in highly mobile and dynamic ad hoc networks.

A. Optimal Neighbor Sensing:

A node X is said to be a neighbor of another node Y if there exists a direct connection between the two nodes X and Y, allowing data to be transmitted in either (asymmetric) or both directions (symmetric) of the link. The proposed ROLSR aims at being entirely independent of the underlying link-layer being used. In ROLSR, a node releases a HELLO-messages from time to time. Changes in the neighborhood is identified from the information in these messages. Upon receiving a HELLO-message, a node can thus gather information describing its neighborhood and two-hop neighborhood, along with it detect the “quality” of the links in its neighborhood. Every node should maintains an information set, unfolding the neighbors and the two-hop neighbors. Such information is considered suitable for a limited period of time, and must be refreshed periodically to remain valid. Expired information is purged from the neighbor- and two-hop neighbor sets.

B. Generic Message Flooding:

Since, MANETs can be of arbitrary size, instead of Hello messages, a method for flooding topological information into a network of any size is very much necessary. A node to emit a control message, which will be flooded into the entire network in an “effective” (no duplication) way. Every node can perform some “local duplicate elimination” (avoiding the receiving of same message again). Moreover we should ensures that all reachable nodes receive a message at least once.

In ROLSR, the problem of duplicate transmissions of a message within a sector is easily avoided through the notion of multipoint relays (MPRs). A node can selects a set of symmetric neighbor nodes as MPRs, implying that each node has a (possibly empty) set of nodes, which have selected it as multipoint relays. This set is called the MPR selector set. A node, then, has the accountability of relaying messages, emitted from its MPR selectors, while not relaying messages from any other nodes. This add on restriction majorly used to avoid collisions.

C. Topology Information:

The additional task required for the optimized routing algorithm is to diffuse a enough set of topological information to all nodes in the networks.

In ROLSR, a topology control message (TC-message), is generated by all the nodes periodically. It contains the address of the node generating the TC-message, as well as the addresses of all the MPR selectors of that node. Thus via a TC-message, a node effectively proclaims reachability to all its MPR selectors. Since every nodes have choose an MPR set, reachability to all nodes will be proclaimed through the network. The result is that every nodes will receive a partial topology graph of the network, constructed by all reachable nodes in the network and the set of links between MPR selectors and its nodes. Using this partial topology graph, it is possible to apply a any optimal shortest path algorithm for computing optimal routes from a node to any reachable destination in the network.

Experimental Results:

A hand on experiments were performed on a model test network of desktop systems and laptops, equipped with IEEE 802.11 wireless interfaces. Our test setup range from 7 to 30 nodes, and a variety of different experiments were conducted. The main aim of the experiments were to provide partially as a “concept proof”, particularly as a way to indicate areas for potential optimizations and further investigations via simulations of larger setup networks.

a. Routing Overhead:

The following figure 2. provide the normalized routing overhead for the three routing protocols. from the graph we can clearly understands ROLSR provide better results when compared with OLSR. Moreover the network pass time increases the overhead reduces considerably.

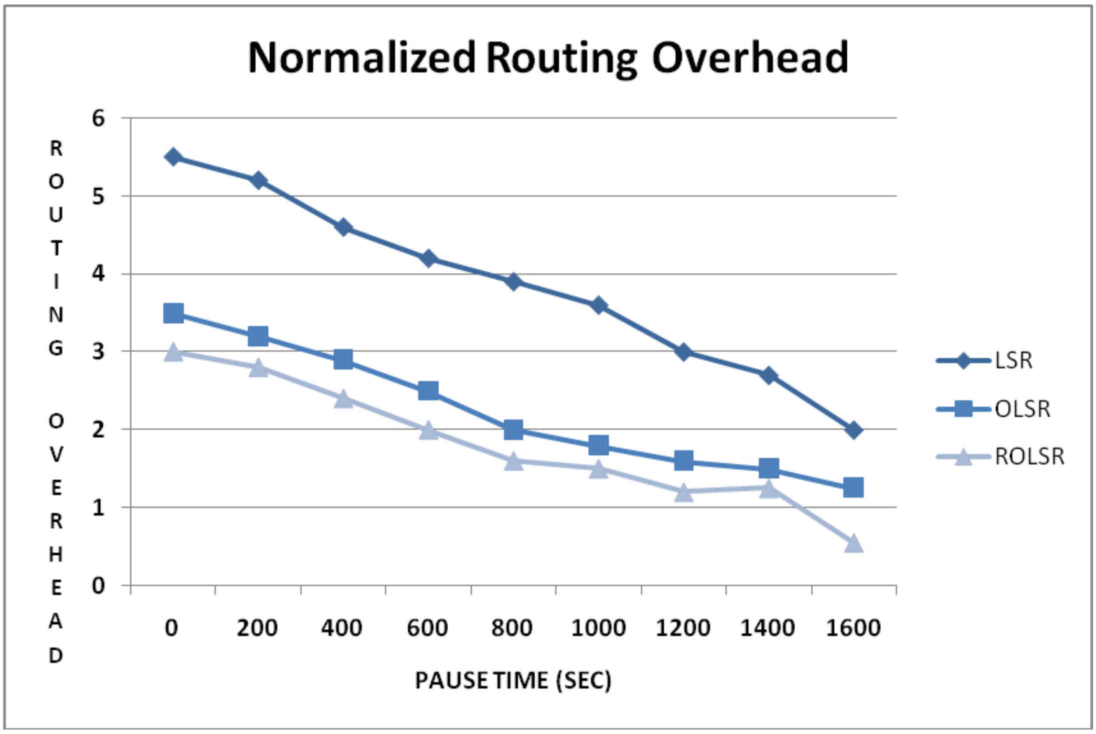

Fig. 2: Routing Overhead

b. Optimal Neighbor Sensing:

The follwing figure 3 depicts the simulation result for error rate in optimal neighbour sensing methodology for the three protocols. the graph clearly specify that our enhanced optimal link state routing algorithm provide low error rate.

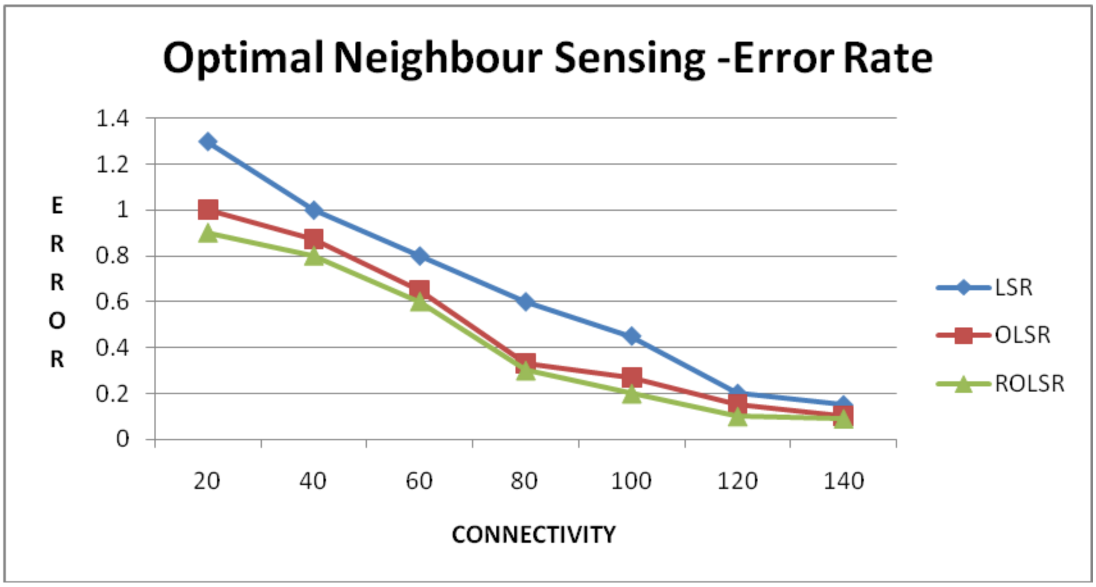

Fig. 3: Error Rate

C.***Optimal Neighbour Sensing:***

Figure 4 specify the message overhead details for the three protocols.when the node density increases, automatically messsage flooding too increses, which inturn increse the message overhead.

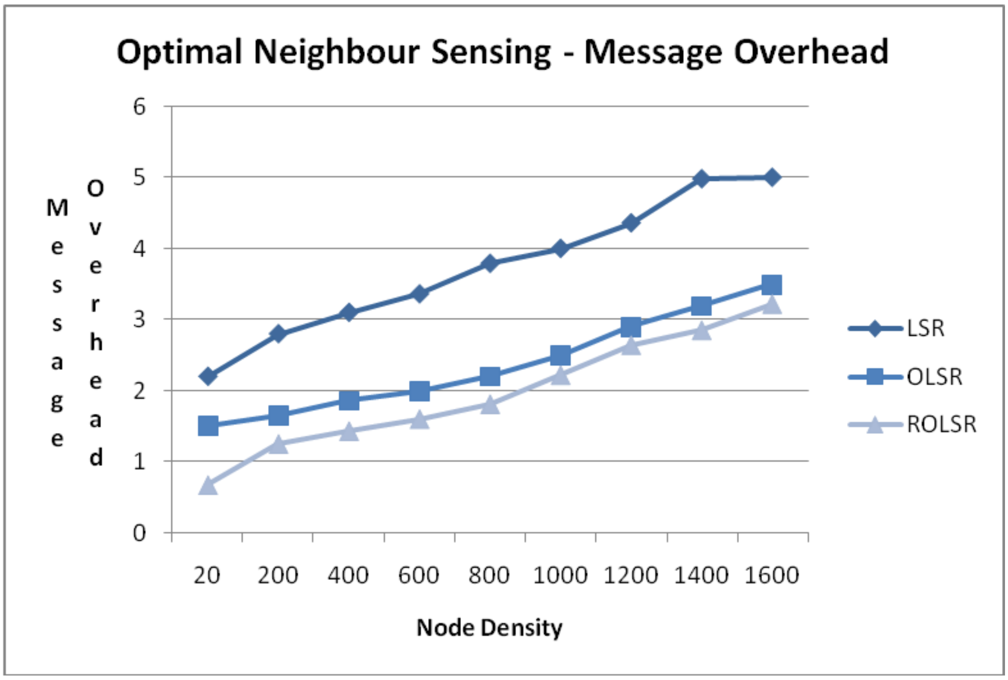

Fig. 4: Message Overhead

Conclusion And Future Work:

Due to the mobility, MANET has the dynamic, continuously changing network topology. For MANETs the performance of the routing protocols is merged with many reasons like the choice if the physical technology, behavior of the link layer, etc,. The overall behavior of the protocols based on the working domain only. This paper initially explores the existing various routing protocols and its features. Further the article explain the newly created algorithm ROLSR. Moreover, a simulation environment is created and the performance of the two major algorithms LSR and OLSR are compared with ROLSR. This ROLSR is table driven (proactive) in nature. Like other routing algorithms, this ROLSR performance is also application specific only. Applications which requires frequent node changes, frequent route changes, dense networks with frequent communication and no long delay in transmissions can easily adopt this proposed ROLSR.

In future, the algorithm can be applied to any real time environment and the results should be tested in different QoS features. Further, by including some security mechanism like authentication verification and integrity checking, we can improve the overall performance.

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