Performance Review of Optimized Link State Routing Protocol

Swati, Yogesh Chaba

***Abstract*- A mobile ad hoc network is a decentralized system in which each node participates in the routing tasks by forwarding data for other nodes and dynamically self-organizes the network. In such networks every node acts as a server and as a client at the same time. MANET is an autonomous system of mobile routers (and associated hosts) connected by wireless links- the union of which forms an arbitrary graph. The main issue in MANET is routing. Basically two important routing in MANET are reactive and proactive routing and in this paper optimized link state routing is the area of interest. Various papers have been studied and it is found that there are some obstacles like memory overhead, bandwidth consumption and long delay which degrade its performance so, some modification can be done in the existing OLSR protocol.**

Keywords: MANET, OLSR, MPR, LSA etc.

I. Introduction

According to Internet Engineering Task Force, a MANET is "An autonomous system of mobile routers (and associated hosts) connected by wireless links- the union of which forms an arbitrary graph. The routers are free to move randomly and organize themselves arbitrarily; thus the network's wireless topology may change rapidly and unpredictably" [1]. A mobile ad hoc network (MANET) is a type of self-configuring wireless ad hoc network based on mobile devices. Each device in a MANET is free to move and the wireless links between them change frequently. Following figure shows centralized network and ad-hoc network. This kind of networks are suitable for remote area applications where there is no need for a central node.

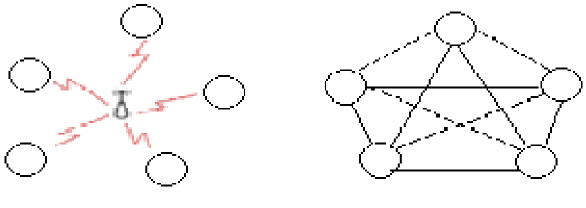

Figure 1. Centralized network (left) versus ad hoc network (right)

Within MANET there are usually several different paths to reach the destination. Routing is needed to find a path between source and destination. Each node is responsible for storing, maintaining and forwarding data packets. Conventional route discovery for Adhoc routing protocols extensively use simple flooding, which could potentially lead to high channel contention, causing redundant retransmissions and thus excessive packet collisions in the network [14]. MANET routing protocols are typically subdivided into two main categories: proactive routing protocols and reactive (on-demand) routing protocols. Here the main focus is on OLSR which is proactive routing.

II. Optimized Link State Routing (OLSR)

Optimized Link State Routing protocol (OLSR) is an optimization of a pure link state proactive routing protocol, designed for mobile ad-hoc networks. It uses a new network element: the Multi Point Relay or MPR. Here every node has information about all the routes and the shortest path to every destination. This is done by periodically broadcasting the routing information to all nodes in the network. OLSR introduces three main improvements [1]:

- OLSR reduces the message overhead by forwarding broadcast messages only through a subset of nodes selected as multipoint relays (MPR), instead of sending control packets by all the links in the network.
- Link state information is generated only by the multipoint relays, minimizing then the control messages flooded in the network.
- Multipoint relays may choose to report only information about the links between itself and its selectors (nodes who have selected it as their multipoint relay). Hence, only partial link state information is flooded in the network.

OLSR protocol functioning is based on two basic control messages: HELLO and Topology Control (TC) messages. HELLO messages are sent periodically by all nodes of the network and are used for link sensing, neighbor detection and MPR selection signaling. On the other hand, TC messages are sent by the MPRs and

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contain topology information used by nodes to calculate their routing tables. All OLSR traffic (included HELLO and TC messages) are sent in packets. OLSR uses 'sequence number' to distinguish between different messages [2].

Figure 2 shows the difference between regular flooding of messages by every node, as each one of them forward messages; and with use of MPRs (blue nodes), showing the reduced number of messages used, where only MPRs are re-transmitters to 2-hop neighbors.

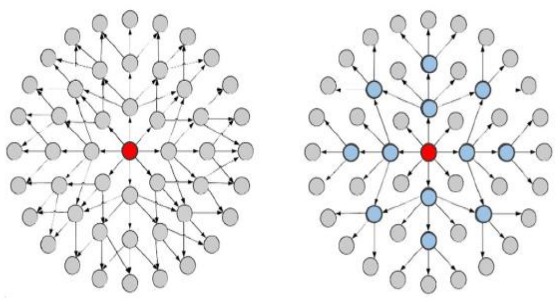

Figure 2: Broadcasted network, and the network with MPRs in OLSR.

OLSR functioning:-

1. MPR Selection

In OLSR, broadcast messages should be diffused over the entire network. 1-hop neighbor is the directly connected node, 2-hop neighbor is the node which can be reached through 1-hop neighbor (figure 3). Each node selects 1-hop neighbor within symmetric (bidirectional) link as its MPR. One node can have multiple interfaces, thus can have multiple MPRs. More 2-hop neighbors can increase the number of MPRs. A collection of MPRs for a given node is called MPR set. Those nodes who selected a router as its MPR are called MPR Selectors. For a given MPR, MPR selectors are called MPR selector set. MPR set needs to cover given node's all possible 2-hop neighbors [2].

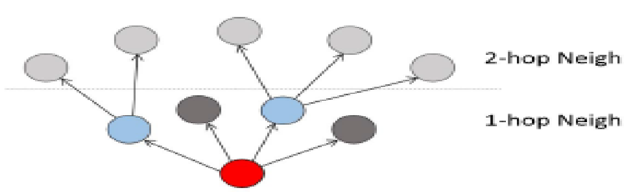

Figure 3: The 1-hop and 2-hop neighbors' relation with the source and MPR.

Here two blue nodes (MPRs) can be called MPR set for the source node (the red one, which can be called the MPR selector).Only MPR can forward messages, other nodes, can receive and process broadcast messages but cannot forward them.

2. Link Sensing

Link sensing is the process of exchanging information about links between neighbors. It is transmitted using Hello messages, which are periodically broadcasted between each OLSR connected interfaces. The purpose of this process is to update the local link information at every node. Each node should be able to detect a link to its neighbor and the type of link like symmetric (bidirectional) or asymmetric [1]. When node receive Hello message, it can update or create its Link Set.

3. Neighbor Discovery

A node can have multiple OLSR interfaces, each with different IP address. A link between nodes, connects one interface of one node, with one interface of the other node. In this situation the first node assume the neighbor's connected interface address as the address of the neighbor [1].

4. Topology Control and Route Calculation

Each node is informed about link-state information by the Topology Control message (TC). MPRs relationships and routing tables for route calculation are analyzed by these TC messages. Routes are constructed from Link Sensing and Neighbor detection messages. When a node receives a Hello message, it updates or create its Link Set. Every node sends TC messages with advertised links set (with links to all nodes of its MPR selector set with the sequence number).

Each node maintains its routing table, which is created based on local link information and topology set information. Routing table contain (for each reachable destination): destination address, next hop address, number of hop to reach the destination and local interface address from which that destination can be reached. If the routing table changes entries (adding/removing/updating) the node does not sent any additional message. Routing calculation is done based on the information from routing table, using shortest path algorithm, guaranteeing the path to the destination (if it is reachable) almost immediately [1].

OLSR Advantages:

- Low latency (less average end-to-end delay) and high data delivery ratio.
- Reduced control messages overhead,
- good performance
- Suitable for large and dense networks
- Independent on central element.

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OLSR Disadvantages:

- Routing delays and bandwidth overhead at MPRs
- Requires more processing power when discovering an alternate route.

III. Literature review

OLSR protocol for mobile ad-hoc networks proposed by P. Jacquet et al, [1], [4] is proactive & table-driven approach. It is optimization of pure link state protocol as it reduces the number of retransmissions in the entire network by using Multi-point relay technique. It provides optimal routes to destination in terms of number of hops.

Analysis of routing protocols for MANETS was proposed by K. Vyas et al, [3] concludes that at low mobility table-driven protocols perform better as they have very high throughput.

Another analysis by R. Desai[5] showed that OLSR has minimum end-to-end delay and high overhead with more number of nodes than AODV and DSR protocols which are on-demand.

G. Adam et al. [6] showed that OLSR performed the worst, comparing to AODV and DSR, in terms of the packet delivery ratio and jitter. OLSR cannot be a proper choice for delay-sensitive applications.

To compare the performance in terms of loss packets and energy packets for routing protocols in MANET, Fihri. M et al, [7] showed that in small networks AODV, OLSR, ZRP behaves same in terms of energy with high loss packets for OLSR, whereas in large networks with more number of nodes OLSR shows more stability and flexibility in terms of energy and mobility than other two protocols with acceptable packet loss.

Comparison of OLSR and TORA is done by Pankaj Palta and Sonia Goyal [8] demonstrated that OLSR is better in those scenarios where bandwidth is large.

The performance comparison of various routing protocols over MANET done by Gagangeet singh aujla and Sandeep singh kang [9] on the basis of throughput, delay, load and data dropped performance metrics. They concluded that results for ftp give the clear picture about the OLSR protocol's best performance in all scenarios whereas the results for http application give the mixed picture. OLSR has highest throughput, least data dropped.

A comparison of Link State, AODV and DSR protocols for two different traffic classes, in a selected environment by F. Bertocchi et al. [10] claimed that AODV and DSR perform well when the network load is moderate and if the traffic load is heavy then simple Link State outperforms the reactive protocols.

S. Shelja et al [11], analyzes the routing table construction in OLSR and found that the construction of routing tables is difficult and time consuming process with time complexity of the order of O(n2), where n represents number of nodes in network. Also it requires more bandwidth and memory space for route maintenance.

Simulation results by M. Goto et al [12] showed that OLSR with packet restoration has high performance in packet delivery ratio in high mobility and high loaded environment.

Under consideration of 50 mobile nodes at data rate of 1Mbps simulation R. Malekian et al, [13] demonstrated that OLSR enhances end-to-end delay at least 22% in comparison with AODV and reduces the overhead of flooding by using MPRs, but needs more bandwidth for maintaining routing tables.

IV. Findings OF review of literature

From literature review it is concluded that, OLSR reduces the overhead of flooding and the amount of information to be exchanged in the network by making use of network element- MPR (Multi-point Relay). It broadcasts the routing information only through multi point relays. At low load & low mobility proactive protocols like OLSR results in high throughput, hence it is better than other protocols. It shows minimum end-to-end delay and high overhead with more number of nodes than reactive protocols. Around 22% end-to-end delay can be enhanced by OLSR as compare to other pro-active protocols. But with high mobility it shows long delays. It is not so good for delay-sensitive applications as it need some time to maintain its routing tables. In large networks with more nodes this protocol shows more flexibility and stability in terms of energy than on demand protocols, whereas in small networks OLSR, AODV and ZRP behave same in terms of energy. The drawback of OLSR is its higher bandwidth consumption and memory overhead. As OLSR needs to store maximum number of tables for route maintenance so it requires more space to store them, resulting high memory overhead.

V. Conclusion

Overall the performance of existing OLSR protocol can be enhanced by doing some modifications. More bandwidth consumption, high memory overhead and long delay are some of the obstacles that somehow degrade its performance. These occur because OLSR is the only protocol which uses maximum number of tables. So for maintenance of these tables it consumes more space & therefore degrades its performance. By working over these issues performance can be increased up to some extent.

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