AN IMPROVED OLSR PROTOCOL USING MULTIPOINT RELAY SELECTION IN MANET

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Abstract-**Flooding is an important communication primitive in mobile ad hoc networks. And also serves as a building block for more complex protocol such as routing protocol. In any flooding mechanism one must balance reliability against message overhead. On the one hand, increasing reliability generally involves sending a greater number of redundant messages and thus increases message overhead. Redundant messages are needed to reach all nodes and to recover from packet loss, hence reducing the overhead will generally decrease reliability. Selective broadcast of that packet improves the reliability as well as packet drop. These compensation packets are constructed from dropped data packets, based on techniques from AODV, AOMDV. The OLSR protocol (Multi-relay selection) inherits these stability of the link state algorithm, due to this proactive nature it has an advantage of having the route immediately available when needed. OLSR protocol is an optimization of a pure link state protocol for mobile ad hoc networks. The OLSR minimizes flooding of this control traffic by using only the selective nodes called multipoint relay, to diffuse this messages in networks. Only the multipoint relay of nodes transmits its broadcast messages.**

Index Terms-AODV; AOMDV; OLSR; Multi-relay selection

I. INTRODUCTION

An Ad hoc network is a collection of mobile nodes, which forms a temporary network without the aid of centralized administration or standard support devices regularly available as conventional networks. These nodes generally have a limited transmission range and, each node seeks the assistance of its neighbouring nodes in forwarding packets and hence the nodes in an Ad hoc network can act as both routers and hosts. Thus a node may forward packets between other nodes as well as run user applications. By nature these types of networks are suitable for situations where either no fixed infrastructure exists or deploying network is not possible. Ad hoc mobile networks have found many applications in various fields like military, emergency, conferencing and sensor networks. Each of these application areas has their specific requirements for routing protocols.

II. RELATED WORK

Royer, et al[1], An analysis of the optimum node density for ad hoc mobile networks. This work explores the nature of this transmission power tradeoff in mobile networks to determine the optimum node density for delivering the maximum number of data packets. It is shown that there does not exists a global optimum density, but rather that, to achieve this maximum, the node density should increase as the rate of node movement increases.

Das, et al[2], Performance comparison of two on-demand routing protocols for ad hoc networks In this work they compare the performance of DSR and AODV, two prominent on-demand routing protocols for ad hoc networks. DSR and AODV both use on demand route discovery, but with different routing mechanics. DSR exploits caching aggressively and maintains multiple routes per destination. AODV, on the other hand uses routing tables, one route per destination and destination sequence numbers, a mechanism to prevent loops and to determine freshness of routes.

Ni, S, et al[3], The broadcast storm problem in a mobile ad-hoc network In this work states broadcast activities in MANETs are both unreliable and spontaneous. For on-demand MANETs routing protocols the problems caused by unmanaged

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broadcast activities. Broadcast based Route Discovery is performed for every unknown route in the network. The study also pointed out that flooding based broadcast creates redundant broadcasts, network contention and frequent packet collisions. Several schemes were proposed to alleviate the problem. The schemes were counter-based schemes, probabilistic schemes, location aided, distance schemes and location aided schemes.

W. Lou et al[4], Forward-node-set-based broadcast in clustered mobile ad hoc networks. In the study analyze MANET performance with adjusted probability for flooding. The analysis looked into issues such as saved rebroadcasts, reach ability, mobility and node density. Saved rebroadcasts are the number of redundant broadcasts activities that are prevented or stopped. The observation from these studies found that low mobility contributes to more saved rebroadcasts. The different probability values used in different types of speed and node density affects the reachability and saved rebroadcasts. The object prompts for a dynamic probabilistic scheme to be introduced to cope with the varying types of MANETs' environments.

Siddique, A., et al[5], Performance evaluation of dynamic probabilistic flooding using local density information in MANET The main objective of the work is utilizing the neighbor cache information for the AODV protocol that periodically updates it "active" neighbors for its node. The scheme introduced in the study utilizes a dynamic probabilistic broadcast coupled with the neighbor information. Thus the broadcast probability is based on the number of nodes that is kept in the neighbor cache. The scheme however does not determine whether if the neighbors in the network is proportion to the size of the network and it is does not tell of the algorithms performance against an inconsistent topology in terms of neighbor size and mobility.

Zhang, Q., et al[6], Dynamic probabilistic broadcasting in MANET In this work they introduced to reduce the amount of flooding performed on MANETs by performing flooding via a probabilistic based broadcast based on the packet ID information. The packet ID is stored in an array list, where each redundant broadcast packet ID is incremented, while the more redundant packet is received the less probable that a broadcast is to be performed. The introduced scheme managed to reduced the amount of latency and generate fewer rebroadcasts compared to the fixed probability approach and counter based approach.

III. OLSR PROTOCOL

The OLSR routing protocol inherits the stability of the link state algorithm. Due to its proactive nature, it has an advantage of having the routes immediately available when needed. OLSR protocol is an optimization of a pure link state protocol for mobile ad hoc networks. First, it reduces the size of control packets; instead of all links, it declares only a subset of links with its neighbours who are its multipoint relay selectors. Secondly, it minimizes flooding of this control traffic by using only the selected nodes, called multipoint relays, to diffuse its messages in the network. Only the multipoint relays of a node retransmit its broadcast messages. This technique significantly reduces the number of retransmissions in a flooding or broadcast procedure.

Apart from normal periodic control messages, the protocol does not generate extra control traffic in response to link failures and additions. The protocol keeps the routes for all the destinations in the network, hence it is beneficial for the traffic patterns where a large subset of nodes are communicating with each other, and the pairs are also changing with time. The protocol is particularly suitable for large and dense networks, as the optimization done using the multipoint relays works well in this context. More dense and large a network is, more optimization is achieved as compared to the normal link state algorithm.

The protocol is designed to work in a completely distributed manner and thus does not depend upon any central entity. The protocol does not require a reliable transmission for its control messages: each node sends its control messages periodically, and can therefore sustain a loss of some packets from time to time, which happens very often in radio networks due to collision or other transmission problems. The protocol also does not need an in-order delivery of its messages: each

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control message contains a sequence number of most recent information, therefore the re-ordering at the receiving end cannot make the old information interpreted as the recent one.

OLSR protocol performs hop by hop routing, i.e. each node uses its most recent information to route a packet. Therefore, when a node is moving, its packets can be successfully delivered to it, if its speed is such that its movement could be followed in its neighbourhood, at least. The protocol thus supports a nodal mobility that can be traced through its local control messages, which depends upon the frequency of these messages.

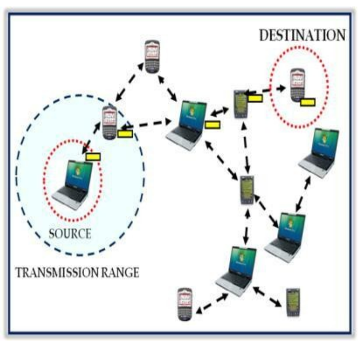

Fig. 1 A Route Request and Reply path for OLSR protocol

A. *Multipoint Relays*

The idea of multipoint relays is to minimize the flooding of broadcast packets in the network by reducing duplicate retransmissions in the same region. Each node in the network selects a set of nodes in its neighbourhood, which retransmits its packets. This set of selected neighbour node is called the multipoint relays (MRPs) of that node. The neighbours of any node N which are not in its MPR set, read and process the packet but do not retransmit the broadcast packet received from node N. For this purpose, each node maintains a set of its neighbours which are called the MPR Selectors of the node. Every broadcast message coming from these MPR Selectors of a node is assumed to be retransmitted by that node. This set can change over time, which is indicated by the selector nodes in their Hello messages.

OLSR protocol relies on the selection of multipoint relays, and calculates its routes to all known destinations through these nodes, i.e. MRP nodes are selected as intermediate nodes in the path. To implement this scheme, each node in the network periodically broadcast the information about its one-hop neighbours which have selected it as a multipoint relay. Upon receipt of this MRP Selectors information, each node calculates and updates its routes to each known destination. Therefore, the route is a sequence of hops through the multipoint relays from source to destination.

Multipoint relays are selected among the one hop neighbours with a bi-directional link. Therefore, selecting the route through multipoint relays automatically avoids the problems associated with data packet transfer on uni-directional links. Such problems may consist of getting an acknowledgment for data packets at each hop which cannot be received if there is a uni-directional link in the selected route.

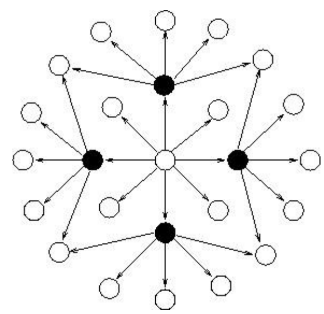

Fig. 2 Multipoint Relay

IV. IMPROVED OLSR USING MULTIPOINT RELAY SELECTION

The proposed routing scheme assumes that the receiver based channel allocation scheme is used where each node is assigned a dedicated non-interfering channel for receiving data. The nodes are assumed to be equipped with multiple communication interfaces. At least one radio is utilized for incoming data on a dedicated channel, and another radio for outgoing data which switches between channels according to the receiving channel

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of the next hop node. The following definitions are needed before we proceed:

• N - Set of nodes in the network

• s - Source node

• d - Destination node

• N(s) - Set of one-hop neighbors of node s

• N2 (s) - Set of two-hop neighbors of node s

• MPR(s) - Set of multipoint relays (MPR) of node s

The proposed MMCR scheme is contrasted with proactive routing scheme m-OLSR. The m-OLSR protocol is a multi-channel version of the standard OLSR scheme. It calculates routes to every node in the network. In order to minimize complexity of routing scheme, the OLSR selects a minimized subset of one-hop neighbors to become multipoint relays (MPRs) that provide full connectivity toward all its two hop neighbors. Only the MPR nodes will forward the data thus minimizing number of alternative paths (MPRs) for route selection. Consequently, the complexity of the routing decision is reduced for the same network size. However, the m-OLSR limits the capacity of a network by minimizing number of MPRs since each MPR adds more capacity in terms of additional, non-overlapping channel.

A. MPR Mechanisms

Neighbors Discovery:

Each node in the network transmits HELLO packets to its neighbors. The HELLO packet is modified version of the one used in the implementation of OLSR. The header of the HELLO packet is modified to include the transmission time. The node receiving the HELLO packet can calculate the delay by using the timestamp from the HELLO packet header; however, this requires time synchronization between the nodes. The HELLO packets contain the list of its neighbors and the energy utilization for each of these neighbors. The HELLO packets also contain information about the node's receiving channel including the available bandwidth. This information is used by the receiving node to calculate the bandwidth factor of the corresponding link.

Multipoint Relay Selection:

Each node in the network uses its 'neighbor table' to select multipoint relay (MPR) nodes from the one-hop neighbors to reach all the two-hop neighbors with minimum cost. The optimal set of MPRs varies with traffic and network congestion.

Pseudo code for OLSR MPR Selection Algorithm

```
# 1_hop_set is a set of one-hop neighbors of source

# 2_hop_set is a set of two-hop neighbors of

source mpr_set = {}; # empty set

foreach dest_node IN 2_hop_set DO

foreach mpr_candidate IN 1_hop_set

if mpr_candidate connects source and dest_node

then cost(mpr_candidate) = INFINITY;

else cost(mpr_condidate) = COST (source TO mpr_candidate) +

COST (mpr_candidate TO dest_node);

end foreach;

mpr_node = mpr_candidate with lowest cost;

add mpr_node TO mpr_set;

add to a routing table the mpr_node as a next hop

node toward dest_node;

end foreach;

# mpr_set holds the selected MPR nodes for the source
```

Implementation in MMCR:

The bandwidth available for each receiving channel at each node is sent via HELLO packets to its neighbor nodes. The neighbor node receiving these HELLO packets stores the available bandwidth

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information for each of these channels. The available bandwidth at each node is the sum of the available channel bandwidths over all the channels. This information is used during MPR selection and routing process. Once the link is utilized by the traffic, the load balancing is performed on per packet basis using the criteria presented earlier. This approach will maximize utilization of the link when compared to a per flow load balancing where the packets of a particular flow have to be routed via the selected channel/interface. In contrast, the proposed scheme will transmit all packets over any of the available channels. Hence, even if the flow data rate exceeds the capacity of a single channel it can be transmitted over the multiple channels while meeting the performance criteria.

B. Simulation Settings

The TABLE I gives the simulation setup for simulation of results. The area used for 100 nodes is 800m X 800m.The Bandwidth used for connection is 2Mbps. The packet size is 1000 Bytes. The traffic model used is CBR. The transmission range used is 50m.

Number of nodes	100
Transmission Range	150m
Packet size	512 Bytes
Time To Live	1ms(millisecond)
Traffic ModeL	VBR
Area Size	1000 * 1000m
MAC Protocol	802.11
Routing Protocol	OLSR
Frequency	5MHZ
Bandwidth	1mbps
Queue Length	150m
Packet Interval	0.05 seconds
Antenna	Omni
Initial Energy	100 joules

TABLE I. SIMULATION SETTINGS

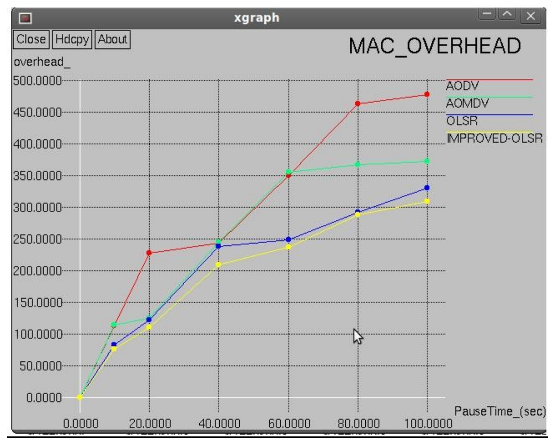
A. Performance Metrics

There is various performance metrics used for evaluating Broadcasting OLSR multipoint relay selection is given below

Overhead:

The time taken to transmit data on a packet-switched network. It is calculated by Units (Bytes).

$$\text{Overhead} = \frac{\text{No of route request packet + route reply packet}}{\text{Total control packet send}}$$



Throughput:

The system throughput or aggregate throughput is the sum of the data rates that are delivered to all terminals in a network. It is calculated by units (Hertz).

$$\text{Throughput} = \frac{\text{Number of data packet received}}{\text{Time in second}}$$

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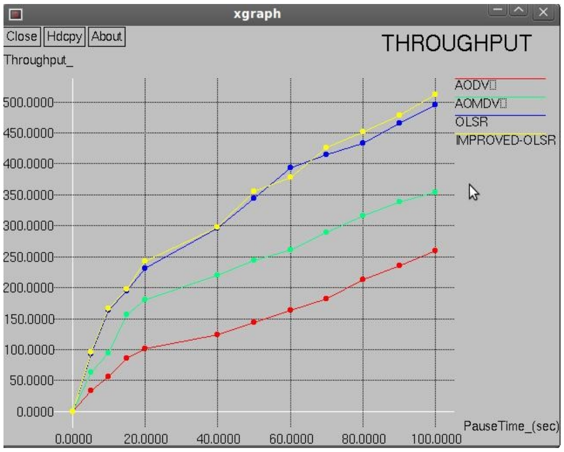
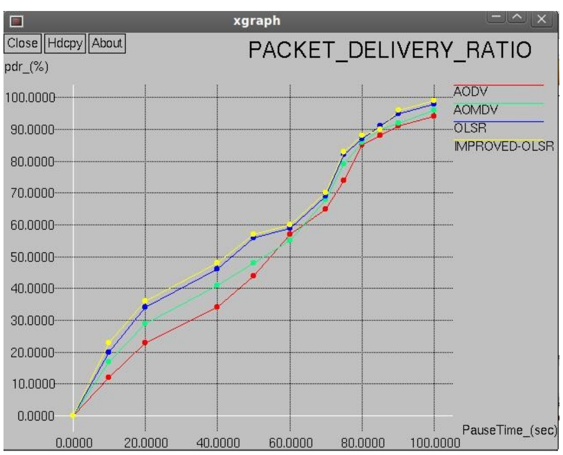


Packet Delivery Ratio:

Packet Delivery Ratio is defined as the average of the ratio of the number of data packets received by each receiver over the number of data packets sent by the source. It is calculated by units percentage.



V. CONCLUSION AND FUTURE ENHANCEMENT

The proposed scheme uses OLSR protocol (Multipoint Relay Selection). In this OLSR protocol is mainly used to broadcast efficiently by selecting the shortest path between source and destination node and avoid number of unnecessary transmissions that occurs during broadcasting. The simulation results shows that proposed OLSR protocol achieves good packet delivery ratio, Overhead, Throughput than the existing AODV, AOMDV, OLSR (Multipoint). The simulation results shows that the proposed OLSR protocol (Multipoint Relay Selection) performs better than the existing AODV, AOMDV, OLSR protocol (Multipoint) in terms of Packet delivery ratio, Throughput and Overhead. The proposed scheme reduces the number of transmissions that occurs during broadcasting by selecting the shortest path between source and destination node by using OLSR (Multi Relay Selection). The future work can be extended by decreasing the energy consumption and time delay.

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