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Modified OLSR Protocol for Priority Based Multimedia Traffic Shaping

S. Meenakshi Sundaram[1] and Dr. S. Palani[2]

[1]Department of C.S.E., M.A.M. School of Engineering, Tiruchirappalli, India
[2]Department of E.C.E., Sudharsan Engineering, College, Pudukkottai, India

***Abstract*—Mobile Ad hoc networks (MANET) are a set of wireless devices or nodes that communicate with each other without a central authority or infrastructure controlling the data routing. Routing protocols play a major role in delivery of data packets from source to destination. Optimized Link State Protocol (OLSR), a table driven proactive routing protocol, constantly updates the topology information and routes are readily available. Hello messages are transmitted from a node to seek information about its neighbors and updated in the table. The node assumes that a neighbor is not in the range if the neighboring node fails to respond to the Hello message within the specified hold time. In this paper it is proposed to decrease the control traffic overheads by modifying the existing OLSR routing protocol and traffic shaping based on priority of the packet. Investigations are carried out for multimedia traffic and video streamed traffic. The overall network performance does not degrade and performs well under limited bandwidth conditions.**

***Index Terms*—Ad hoc Network, Optimized Link State Routing and Multimedia Traffic**

I. INTRODUCTION

THE dynamic nature of the ad hoc network requires a different set of network strategies than the wired network for efficient end-to-end communication. The error prone nature of the wireless medium and frequent route changes and packet losses pose many challenges to ad hoc network [1]. As the traffic load increases, the problems such as packet delay and decreased throughput leads to degradation of performance. Routing protocols employed in an ad-hoc network determines the success of the network; as performance of the network is largely dependent on the routing protocol. Routing protocols are researched based on efficient routing of packets hop by hop [2]-[4]. When the traffic load is high, the processing of queued packets has significant effect on overall end-to-end performance and congestion avoidance. Thus, packet scheduling algorithms are used to determine the sequence in which the packets in the queue are forwarded.

The data packets that are to be transmitted from a node are queued in a single line and forwarded using First in First out (FIFO). But the major disadvantage of FIFO is if the head of line is blocked then it prevents other packets from being forwarded. To avoid this block, fair queuing [5] is used to share the link capacity fairly for forwarding of multiple packets. A buffer is formed where the data packets are stored temporarily before transmission, fair queuing forwards packets from the buffer. Usually, the buffer contains multiple queues, with each containing packets of one flow. The finish time of the packets is estimated and packets with earliest finish time are selected to be transmitted first.

A. Weighted Fair Queuing (WFQ)

Weighted fair queuing (WFQ) calculates weights for each packet by multiplying the packet size with the inverse of a weight for the associated queue.

For each arriving packet at node, it is tagged with a start tag $start_{i,n}$ and finish tag $finish_{i,n}$ by the WFQ algorithm [6] as in (1) and (2) respectively:

$$start_{i,n} = \max\left\{v\left(A\left(t_{i,n}\right)\right), finish_{i,n-1}\right\} \quad (1)$$

$$finish_{i,n} = s_{i,n} + P_{i,n} / r_i \quad (2)$$

where n is sequence number of the packet of flow i arriving at time $A\left(t_{i,n}\right)$ $P_{i,n}$ is the packet size and weight r_i. The virtual time $v\left(A\left(t\right)\right)$ is calculated as in (3):

$$\frac{dv(t)}{dt} = \frac{C}{\sum_{i \in B_{FFQ(t)}} r_i} \quad (3)$$

where C is the channel capacity in bits/sec and $B_{FFQ(t)}$ is the set of backlogged flows at time t in error-free fluid service.

The average data rate achieved using WFQ is given by (4):

$$data\ rate = \frac{Rr_i}{\left(r_1 + r_2 + \ldots +_N\right)} \quad (4)$$

R being the link data rate and N active data flows.

B. Optimized Link State Routing (OLSR)

Optimized link state routing (OLSR) is a proactive protocol, where each node maintains routing information to every other node in the network. OLSR [7] is a point-to-point routing protocol based on the traditional link-state algorithm. Link-state messages are periodically exchanged by the nodes to maintain the topology information of the network. The OLSR minimizes the size of each control message and the number of rebroadcasting nodes during each route updates using multipoint replaying (MPR) strategy. This is made possible by retransmitting the packets only to a set of neighboring nodes. This set of nodes is called the multipoint relays of that node. When packets are forwarded to any node which is not in the set, the node can read or process the packet but cannot retransmit it further. The MRP set is selected such that it covers all nodes that are two hops away. Each node from time to time broadcasts a list of its one hop neighbors using hello messages. From the list of nodes in the hello messages, each node selects a subset of one hop neighbors, which covers all of its two hop neighbors as shown in Fig. 1 [8]. For selecting optimal route to a destination, nodes calculate using a "shortest hop path algorithm" based on the topology information in the routing table and stores this information in a routing table. Therefore, routes to every destination are immediately available when data transmission begins. MPR selection is important in OLSR, as smaller the MPR set, less overhead is introduced in the network.

II. RELATED WORKS

El-Khoury et al., [9] presented a framework that has random access mechanism for the delaying transmission by random amount of time to avoid collisions of transmissions of nearby nodes. The time is slotted into fixed time length time frames. A node sending data packet to its neighbor decides with some fixed probability in favor of a transmission attempt. The proposed approach derives expressions for arrival and departure rates and introduces cycle of transmissions where a cycle is number of slots needed to transmit successfully. Simulation results validate the proposed method.

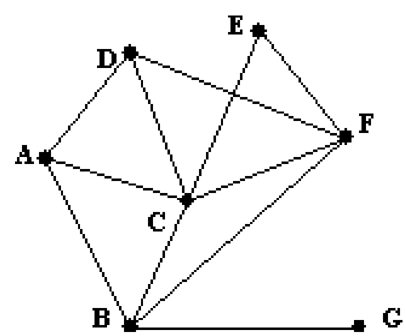
Shakkeera [10] proposed an optimization scheme adapted for OLSR to improve the delivery ratio of the packet and throughput. The traditional OLSR uses greedy algorithm for MPR selection which creates overlap of nodes due to which the performance of the network reduces. In the proposed method, the control packets are transmitted through selected neighbor nodes by augmenting an optimization scheme, thus, reducing the amount of control overhead in the network. The proposed method introduces an algorithm "Necessity First Algorithm (NFA)" for selecting the optimal MRPs.

Benzaid et al., [11] proposed an extension of the OLSR to meet the fast mobility in MANETs. In a high mobility network, the routes to the neighbors are valid only for short duration. And if the data packets are forwarded on an invalid link, it gets dropped. The proposed method, Fast OLSR (F-OLSR) extension accounts for fast nodes in the routing while the routing overhead is maintained as low as possible. A tradeoff is found between the routing overhead and the loss rate. The proposed method differs mainly in the neighbor discovery functionality when compared to the traditional OLSR. The proposed method is adapted to deal with fast mobility. Simulation results show that the proposed F-OLSR performs better than OLSR.

Ying Ge et al., [12] proposed optimizations to OLSR, to limit the amount of control traffic generated and to utilize links efficiently. The proposed scheme is called Hierarchical OLSR (HOLSR), it uses an hierarchical mechanism to OLSR, and greatly reduces the protocol overhead which improves scalability in large size heterogeneous networks. Using OPNET simulations, it was demonstrated that the proposed protocol scales efficiently and overheads are drastically reduced by avoiding frequent route updates.

III. METHODOLOGY

OLSR is an optimization version of link state protocol, where the routes are readily available. Any change in topology of the network results in flooding for updating the topological information to all available nodes. To reduce the overheads due to flooding, multipoint relays (MPR) are used. The MPRs reduce flooding of broadcasts by reducing the same broadcast to some regions in the network. Figure 1 shows the MPR selection in the network. The control messages used by the OLSR are the 'Hello' message and Topology Control (TC) messages. A node sends Hello messages to identify itself to its neighbors and the node also receives information about its immediate neighbors and 2-hop neighbors. With the Hello message the Multipoint Relay (MPR) Selector set is constructed which describes which neighbors has chosen this host to act as MPR and from this information the host can calculate its own set of the MPRs. TC messages originate from the MRPs, it announces the node selection as MRP and is relayed through the entire network. The routing table is calculated using the shortest-path algorithm [13].



Node	1 Hop Neighbor	2 Hop Neighbor	MPR
B	A, C, F, G	D, E	C

Fig. 1: Example for MPR selection

The reactiveness to the topological changes can be adjusted by changing the time interval for broadcasting the Hello messages or increasing the neighborhood holding time. The neighborhood holding time determines whether a link is present between a node and its neighbor. The reliability of the link is not an issue for the control messages, since the messages are sent periodically and the delivery does not have to be sequential. The soft state approach to signaling is used in

OLSR. The routing state times out and is removed unless periodically refreshed by the receipt of routing updates. OLSR depends up on the soft state approach to maintain the consistency of topology information, and the consistency of routing tables amongst network nodes. So, apart from normal periodic messages, the protocol does not generate extra control traffic in response to link failure and node join/leave events.

In OLSR, the soft state timers have two types of usage: message generation and state maintenance. HELLO and TC interval timers are used to send periodic HELLO and TC messages, while state-maintenance timers are to keep updated the state information in OLSR internal tables and remove obsolete state by time-out. By default, OLSR the neighbor state holding time is set to be 3 times the value of the default OLSR HELLO interval; the OLSR TIB holding time is 3 times the default value of the TC interval. TIB and link tuple timers' expiry interval equals the TIB holding time interval. When new nodes join the network, a node detects its new neighbors with a link-sensing process by sending periodic HELLO message. When nodes leave the network, or links between nodes go down, the corresponding link state in the link set and neighbor state in the neighbor set will be removed after the state holding timers expire. In addition, periodic topology control (TC) messages help recover from loss of topology information caused by state corruption or nodes restarting. It is clear that the internal state maintenance in each node is related directly to the refresh intervals and so changing these will impact the protocol as a whole.

Traffic is shaped to represent Pulse Code Modulation (PCM) using G.711 codec.G.711 [14] compresses 16-bit linear PCM data down to eight bits of logarithmic data. The *ITU-T Rec. G.711* presents two PCM audio codecs called A-law and U-law. They both transform linear PCM signal into logarithmic PCM. They both operate on single samples. A-law uses 13-bit linear PCM vector and transforms it into 8-bit logarithmic PCM vector while encoding process. U-law uses 14-bit linear PCM, transforming it into 8-bit. Non-professional sound devices cannot generate either 14-bit sample. In this implementation 16-bit samples are passed to the input of coder. Every sample is converted into 14-bit sample by every sample is converted into 13 or 14-bit sample by cutting off the less significant bits.

For a given input x, the A-law encoding is as in (5):

$$F(x) = \operatorname{sgn}(x)\begin{cases} \dfrac{A|x|}{1+In(A)}, & |x| < \dfrac{1}{A} \\ \dfrac{1+In(A|x|)}{1+In(A)}, & \dfrac{1}{A} \le |x| \le 1 \end{cases} \quad 5 \qquad (5)$$

where A is the compression parameter.

The μ-law algorithm for encoding is as in (6):

$$F(x) = \operatorname{sgn}(x)\frac{In(1+\mu|x|)}{In(1+\mu)} \qquad -1 \le x \le 1 \qquad (6)$$

Where μ=255 (8 bits).

In this paper, it is proposed to investigate a modified OLSR routing protocol wherein traffic is shaped at the network layer based on priority of the packet and an increased Hello interval and Topology control interval to reduce the control packet overhead. The proposed methodology is compared with existing OLSR routing protocol on multimedia traffic and streaming traffic.

IV. EXPERIMENTAL SETUP

The simulation contains a testbed of 20 nodes. Each node runs a multimedia application over UDP. The nodes are distributed 2000 meter by 2000 meter with the trajectory of each node being random. The data rate of each node is 11 Mbps with a transmit power of 0.005 watts. The parameters used in the OLSR routing protocol is shown in Table I.

TABLE I
OLSR PARAMETERS USED IN EXPERIMENTAL SETUP

Hello interval in seconds	3
TC interval in seconds	7
Neighbor hold time in seconds	9
Topology hold time in seconds	21
Duplicate message hold time in seconds	30
Addressing mode	IPV4

Table II gives the network layer packet prioritizing. A weighted queuing approach I is adapted with lowest priority for background traffic and very high traffic for streaming traffic where the QoS becomes an essential parameter.

TABLE II
PACKET SHAPING IN THE NETWORK LAYER

Individual Queue Limit for low priority data	32 Packets
Individual Queue Limit for low priority data	64 Packets
Weights assigned for streaming packet	50
Weights assigned for multimedia packets	30

The average jitter is shown in Fig. 2. It can be seen that the proposed modified protocol provides the same QOS as the existing OLSR. The modified OLSR routing protocol performance is shown in Fig. 3 and Fig. 4.

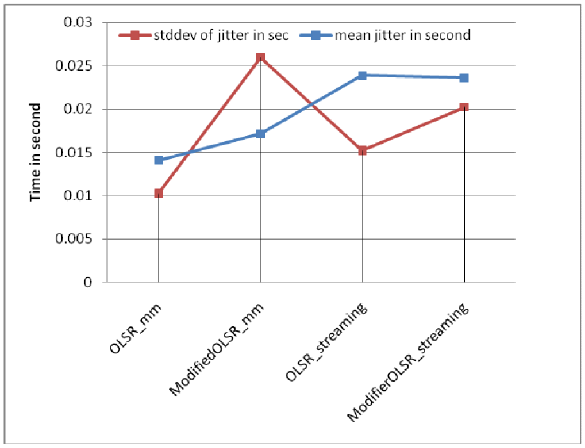


Fig. 2: Average jitter

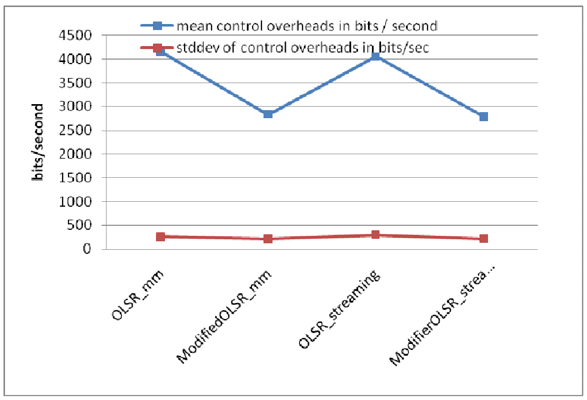


Fig. 3: Mean Control Overheads in bits/sec

Fig. 4: Mean Routing traffic in bits/sec

V. CONCLUSION

In this paper a modified Optimized Link State Routing (OLSR) protocol was proposed. The proposed modification shapes the traffic to be routed based on the priority of the traffic. The priorities of the traffic were based on weights assigned to the traffic type. The Hello interval time and the Topology control interval were modified to decrease the control packet overheads. The proposed technique not only decreases the jitter which is an important QOS parameter for real time streaming data, but also decreases the control packet overhead without loss of QOS parameters.

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