A Particle Swarm Optimizied Olsr For Priority Based Multimedia Traffic Shaping

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ABSTRACT: Routing protocols are essential for delivery of data packets from source to destination in Mobile Ad hoc networks (MANET). Optimized Link State Protocol (OLSR) is a table driven proactive routing protocol, with readily available topology information and routes. The efficiency of the OLSR depends on its Multipoint relay (MPR) selection. Various studies have been conducted to reduce the control traffic overheads by adapting the existing OLSR routing protocol. Routing performance is improved by traffic shaping based on priority of the data packet. In this paper, it is proposed to modify OLSR using swarm intelligence, Particle Swarm Optimization (PSO) to reduce end to end delay and improve throughput in the network. Simulation was carried out for multimedia traffic, and video streamed traffic in the network.
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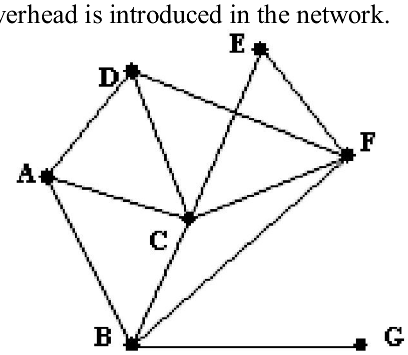
***Index Terms*—**Ad hoc Network, Optimized Link State Routing (OLSR), Particle Swarm Optimization (PSO), Multimedia traffic

I INTRODUCTION

Mobile Ad hoc Network (MANET) have dynamic topology due to user's mobility and due to limited radio range are multihop in nature [1]. Due to the dynamic nature strategies for efficient end-to-end communication is different. Degradation of performance in the network is observed with an increase in traffic load. As performance lowers, problems such as packet delay, decreased throughput crops up. Routing protocols used in the networks, determines the efficiency of the network. Most of the routing protocol researches available in the literature are based on efficient routing of packets hop by hop [2-4] and medium access control [5, 6]. The processing of queued packets using packet scheduling algorithms has a substantial effect on overall end-to-end performance and congestion avoidance.

Most commonly used queuing is the First in First out (FIFO). The data packets to be transmitted from a node are queued in a single line and forwarded using FIFO. But if the head of the line is blocked then it prevents other packets from being forwarded in FIFO. To address this issue, fair queuing [7] is used to share the link capacity fairly for forwarding of multiple packets. Buffers are created where the data packets are stored temporarily before transmission; fair queuing forwards packets from the buffer. The finish time of the packets is estimated, and packets with earliest finish time are selected to be transmitted first.

Optimized link state routing (OLSR) is a proactive protocol, wherein each node maintain routing information to every other node in the network. OLSR [8] is a point-to-point routing protocol based on the traditional link-state algorithm. To update topology information, Link-state messages are periodically exchanged by the nodes. Multipoint replaying (MPR) strategy is used to minimize the flooding during each route updates. This is made possible by retransmitting the packets only to a set of neighboring nodes called the multipoint relays of that node. The MRP set is so selected that it connects to all nodes that are two hops away from it. Hello messages are used to get the one hop neighbors, and each node forms a subset of one hop neighbors, which connects to all of its two hop neighbors as shown in Figure 1 [9]. A "shortest hop path algorithm" is used for selecting optimal route to a destination using topology information in the routing table. The optimal route information is stored in a routing table. Thus, routes to every destination are immediately available during data transmission. MPR selection is important for efficient performance of OLSR, as smaller the MPR set, less overhead is introduced in the network.



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

Fig 1: Example for MPR selection

Various studies have been conducted to reduce the control traffic overheads by adapting the existing OLSR routing protocol. Routing performance are improved by traffic shaping based on priority of the data packet. In this paper, it is proposed to modify OLSR using swarm intelligence, Particle Swarm Optimization (PSO), to reduce end to end delay and improve throughput in the network by traffic shaping at the network layer. The proposed methodology is compared with existing OLSR routing protocol on multimedia traffic and streaming traffic. Rest of the paper is organized as follows: section II deals with literature reviews related to this research; section III introduces all the techniques used in the research; section IV discusses the simulation results and section V concludes the paper.

II RELATED WORKS

Shakkeera [10] proposed mechanism for improving the delivery ratio of the packet and throughput of MANET. The proposed method was based on an optimization scheme adapted for OLSR. The greedy algorithm is used in traditional OLSR for MPR selection. The disadvantage of greedy algorithm is that it forms overlap of nodes which leads to performance degradation. In the proposed method, an optimization scheme is used to select neighbor nodes through which the control packets are transmitted. Thus, reducing the extent of control overhead in the network. “Necessity First Algorithm (NFA)” for selection of the optimal MRPs is introduced in the proposed method.

Ying Ge, et al., [11] proposed optimizations to OLSR, for limiting the amount of control traffic generated and to utilize links efficiently. The proposed scheme uses a hierarchical mechanism to OLSR and is called Hierarchical OLSR (HOLSR). HOLSR greatly reduces the protocol overhead which improves scalability in large size heterogeneous networks. The OPNET simulations demonstrated that the proposed protocol scales efficiently and overheads are drastically reduced by avoiding frequent route updates.

In wireless technologies, the emergence of vehicular *ad hoc* networks (VANETs) is caused due to the current advancements. There are frequent topology changes and network fragmentations in these network produced by the restricted coverage of WiFi and the great mobility. Therefore, the challenging issue is concerned about the above reasons that the central manager entity is not present and routing packets by the network. Hence, it is complicated to deploy VANETs with an effective routing approach. Jamal Toutouh et al., [12] presented an optimal parameter setting of the OLSR, which is a famous mobile *ad hoc* network routing protocol defined by a problem in optimization. For the purpose of determining automatically optimal configurations of this routing protocol, a series of representative metaheuristic algorithms (PSO, DE, GA, and SA) are studied in this manner. Additionally, for accurate evaluation of the performance of the network under the proposed automatically optimized OLSR, a collection of realistic VANET scenarios (based in the city of Málaga) has been defined. Compared to the standard (RFC 3626) and many human experts, the proposed tuned OLSR configurations outperform when experimented making its utilization in VANETs configurations acquiescent.

Reza Firsandaya Malik et al., [13] proposed a novel algorithm for MPRs selection in order to improve the OLSR using particle swarm optimization sigmoid increasing inertia weight (PSOSIIW)’s performance. The enhancement of the particle swarm optimization (PSO) in terms of simplicity and quick convergence towards optimum solution is accomplished significantly by the sigmoid increasing inertia weight. In order to sustain MPRs selection in OLSR, degree of willingness, the packet delay of each node and the novel fitness function of PSOSIIW are introduced. The network simulator 2 (ns2) is implemented to investigate the end-to end delay, packet loss and throughput of the proposed approach. The results obtained reveal the better performance of the proposed OLSR-PSOSIIW over the standard OLSR and OLSR-PSO specifically by means of end-to-end delay and throughput. The benefits of employing PSO for optimizing routing paths in the MPRs selection algorithm are revealed by the proposed OLSR-PSOSIIW.

III METHODOLOGY

A. Weighted Fair Queuing (WFQ)

Weighted fair queuing (WFQ) computes the weights for each data packet. It is obtained by multiplying the packet size with the inverse of a weight for the associated queue and each packet is tagged with a start tag $start_{i,n}$ and finish tag $finish_{i,n}$ by the WFQ algorithm [14] 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 the 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 [15]. The virtual time $v\left(A(t)\right)$ 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):

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

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

B. Pulse Code Modulation (PCM)

Traffic is shaped to characterize Pulse Code Modulation (PCM) using G.711 codec [16]. It compresses 16-bit linear PCM to 8-bits logarithmic data. The ITU-T Rec. G.711 presents two PCM audio codecs called A-law and U-law. In this implementation, 16-bit samples are passed to the input of coder. For a given input x, the A-law encoding is as in (5):

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

where A is the compression parameter.

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

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

Where μ=255 (8 bits).

C. Particle Swarm Optimization (PSO)

Particle Swarm Optimization (PSO) is a technique for maximizing objectives to find parameters by exploring the search space of given problem. This technique, originated from swarm intelligence and evolutionary computation [16]. The swarm intelligence based on the observation of swarming habits of birds and fish, and the evolutionary computation to find a local or global maximum. The PSO algorithm represents each solution is a 'bird' in the search space and is referred to as 'particle'. It uses the objective function to evaluate its candidate solutions, and operates on the resultant fitness values. Candidate solution and its estimated fitness, and velocity give the position of the particle. It also remembers the best fitness value it achieved till then during the algorithm's operation which is usually referred to as the individual best fitness, and the candidate solution that achieved this fitness, is the individual best position 'pbest'. The best fitness value attained among all particles in the swarm which is called global best fitness, and the candidate solution that attained this fitness, which is called the global best position or global best candidate solution 'gbest'. The PSO algorithm includes three steps that are reiterated until some stopping criteria is met [17]:

1. Fitness of each particle is evaluated.
2. Individual and global best fitness and positions are updated
3. Velocity and position of each particle is updated.

If a directed graph G = (V, E) defines a communication graph, where V is a set of n nodes and E set of m edges. Each edge has the parameters of link quality, jitter and packet dropped. These functions can be formulated for a path as follows:

$$link\ \text{quality}(p_i) \ge L \qquad i = 1,....,k$$
$$jitter(p_i) \le J \qquad i = 1,....,k$$
$$Packet\_dropped(p_i) \le PD \qquad i = 1,....,k$$

IV EXPERIMENTAL SETUP AND RESULTS

The simulation setup consists of 20 nodes. The nodes are spread over 2000 meter by 2000 meter with the trajectory of each node being random. Each node runs a multimedia application over UDP. The data rate of each node is 11 Mbps with a transmit power of 0.005 watts. The simulations are run for 400 sec. The parameters used in the OLSR routing protocol is shown in table 1.

Table 1: 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 2 gives details of the network layer packet prioritizing. A weighted queuing approach is adapted with the lowest priority for background traffic and very high priority for streaming traffic, to maintain the QoS of the network.

Table 2. 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 Figure 2 for OLSR and modified OLSR. It can be seen that the proposed modified protocol reduces the jitter when compared to the existing OLSR. The jitter is reduces in the range of 25% to 32% when compared the classic OLSR. Though, the proposed optimization has very less impact on the jitter.

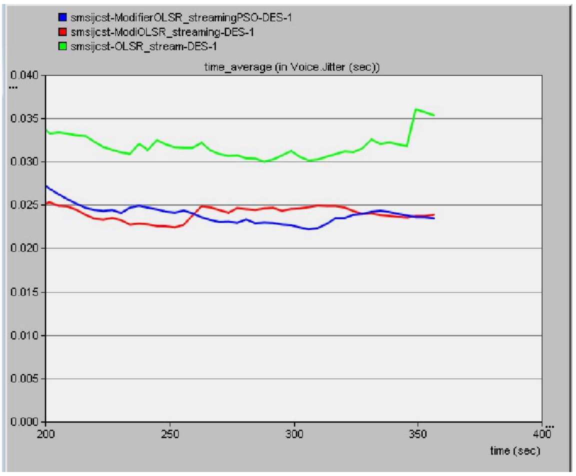


Fig 2: Average jitter for the proposed OLSR and classic OLSR

The modified OLSR routing protocol performance of data dropped and end to end delay is shown in Figure 3 and Figure 4 respectively.

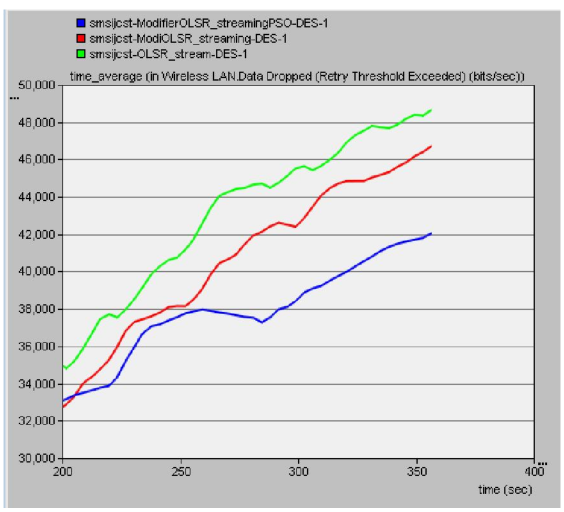


Fig 3: Data dropped

The performance in terms of packet data dropped improves considerably with the use of proposed optimized OLSR. It is evident from the graph that with the increase in time the proposed optimized OLSR drastically reduces the number of packets dropped when compared to both OLSR and modified OLSR.

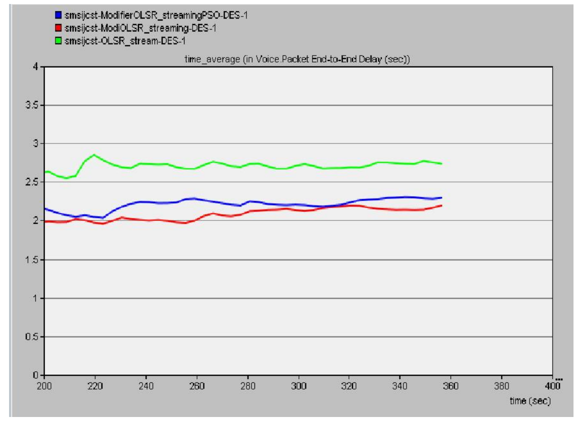


Fig 4: End to end delay

Though the proposed optimized OLSR performs better than the OLSR in terms of end to end delay, modified OLSR performs the best as seen in Figure 4. Figure 5 shows the throughput, and it is seen that the proposed OLSR achieves better throughput when compared to the traditional OLSR and modified OLSR. It is also noticed that the proposed optimization performs better with time, improving the throughput by more 3% w.r.t OLSR and modified OLSR.

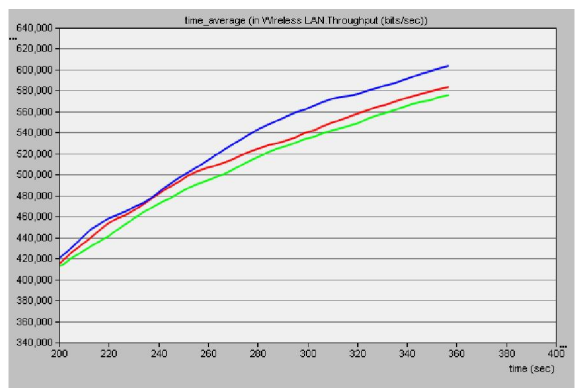


Fig 5: Throughput for various OLSR

V CONCLUSION

Various studies have been conducted to decrease the control traffic overheads by modifying the existing OLSR routing protocol and traffic shaping based on priority of the packet. In this paper, it is proposed to modify OLSR using swarm intelligence, Particle Swarm Optimization (PSO) to reduce end to end delay and improve throughput in the network. Simulation was carried out for multimedia traffic and video streamed traffic in the network. Results demonstrate that the proposed modified OLSR using PSO is effective in improving the throughput, reducing the packet data dropped. Jitter and end to end delay is also effectively decreases when compared with the traditional OLSR.

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