Research Journal of Applied Sciences, Engineering and Technology 7(17): 3616-3622, 2014
DOI:10.19026/rjaset.7.714
ISSN: 2040-7459; e-ISSN: 2040-7467

Submitted: November 13, 2013 Accepted: November 29, 2013 Published: May 05, 2014

Research Article

Enhanced Optimized Link State Routing for Multimedia Traffic using Genetic Algorithm

[1]S. Meenakshi Sundaram, [2]S. Palani and [3]A. Ramesh Babu
[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
[3]Department of Computer Applications, Saranathan College of Engineering, Tiruchirappalli, India

Abstract: The aim of this research is to modify OLSR using GA to reduce the end to end delay and to improve the network throughput. Simulation was carried out for multimedia traffic and video streamed network traffic using OPNET Simulator. Routing is a primary MANET function where each node forms routes between nodes not directly in each others range for communication. Major challenges in MANET are routing protocol design while maintaining quality of service in the network. Optimized Link State Routing (OLSR) protocol is a Table driven Proactive Routing Protocol having topology information and routes which are used for routing. OLSR's efficiency depends on Multi Point Relay (MPR) selection. Many studies are conducted to decrease control traffic overheads by modifying existing OLSR routing protocol and traffic shaping based on packet priority.

Keywords: Ad hoc network, Genetic Algorithm (GA), multimedia traffic, Optimized Link State Routing (OLSR)

INTRODUCTION

MANET is a collection of autonomous wireless links connected system of mobile routers. Routers move randomly organizing themselves arbitrarily; hence, network's wireless topology changes rapidly and unpredictably. Such networks operate either as stand-alone or are connected to the internet. MANETs have no infrastructure and operate either alone or have gateways to interface with fixed networks. There might be multiple hosts per router leading to rapid network wireless topology changes.

Generally, ad hoc wireless networks are self-creating, self-organizing and self-administrating networks with unique benefits and flexibility for various situations/applications. Hence they are used where wired network and mobile access are either unproductive or unfeasible. Examples include: earthquake hit areas, when infrastructure is destroyed, soldiers in a destructive environment; space exploration, virtual classrooms, tracking of rare animals, biological detection and undersea operations (Ahmed and Ramani, 2007). MANET is exploited globally, as a familiar wireless communication network which enabled communication companies and R and D Institutes to introduce developments in MANET to enhance performance and add features to this service (Ameen and Ibrahimi, 2011). Ad hoc networks traffic is different from those of infrastructure wireless network, including:

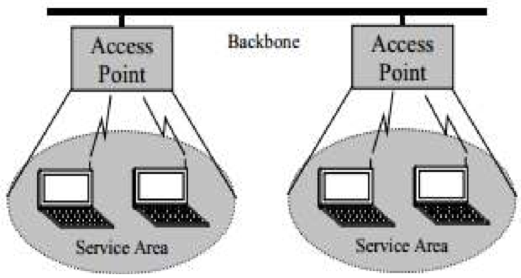
- **Peer-to-peer:** Communication between two nodes in one hop. Network traffic (Bps) is consistent.
- **Remote-to-remote:** Communication between two nodes beyond a single hop which maintains a stable route between themselves resulting in many nodes staying in each other's communication range in a single area or moving as a group. Traffic is similar to standard networks.
- **Dynamic traffic:** Occurs when nodes are dynamic and move around. Routes must be reconstructed resulting in poor connectivity and short burst network activity (Fig. 1).

For wireless ad hoc networks, there are numerous kinds of routing protocols. These routing protocols are categorized as reactive or proactive routing protocols (Ali and Ali, 2009). The ad hoc routing protocols having both proactive and reactive advantages is called hybrid routing protocols. Reactive protocol is also called on-demand routing protocol.

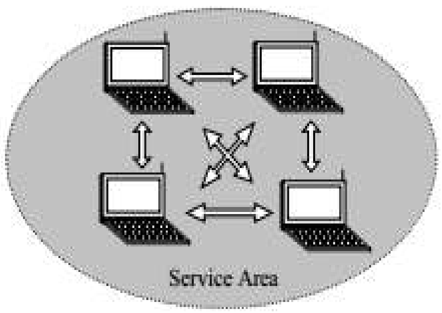
The second kind of protocol is proactive or table driven routing protocol. The first kind of protocol is called Reactive MANET Protocol (RMP). Proactive protocol is also called Proactive MANET Protocol (PMP). OLSR is a proactive MANET routing protocol which inherits stability of a link state algorithm and has routes available when required due to its proactive nature. OLSR is optimized over MANET based on classical link state protocol.

OLSR minimizes control traffic flooding overhead using only chosen nodes called MPRs, to retransmit

Corresponding Author: S. Meenakshi Sundaram, Department of C.S.E., M.A.M. School of Engineering, Tiruchirappalli, India



(a) Infrastructure-based wireless network



(b) Ad hoc wireless network

Fig. 1: Infrastructure and infrastructure less wireless networks

control messages. This reduces retransmissions needed to flood a message to all network nodes. Secondly, OLSR needs partial link state to be flooded to provide shortest path routes. OLSR is designed for completely distributed network not depending on any central entity. The protocol needs no reliable control messages transmission: each node forwards control messages and so sustains a reasonable message loss which occurs frequently in radio networks due to collisions or transmission problems.

Benefits of OLSR:

- As it is a proactive protocol, destination routes in a network are known and maintained prior to use. Available routes in a standard routing table are beneficial for some systems and network applications for there is no route discovery delay linked to a new route location.
- Routing overhead generated while greater than a reactive protocol is the same with a number of routes.
- Default and network routes are injected into the system by HNA messages permitting links to the internet or other networks in OLSR MANET cloud (Mohan and Saroja Devi, 2012).

Traffic in networks is modeled as follows: block traffic, transaction traffic and streaming traffic. To define a block traffic source, the modeler needs to specify the distribution functions and corresponding parameters for each of the following modeling variables:

- Number of blocks per session
- Block size
- Inter-arrival time of blocks

Transaction traffic consists of alternate ON and OFF periods. During the ON periods, packets are generated intermittently. Based on this definition, the following modeling variables are needed to define a transaction traffic session:

- Session time
- ON period
- OFF period
- Packet size
- Inter-arrival time of packets during ON period

For each variable, the distribution function to be used and corresponding parameters for these distributions must be specified. In this case also, all modeling variables can assume constant values.

Streaming traffic sources emit data units with no significant silence periods in between the data units. Video traffic falls under this category. For streaming traffic, significant correlation can exist between these units and this has to be taken into account when modeling. Moreover, the traffic is likely to remain bursty on different time scales. This also has to be considered in modeling the streaming traffic. Auto-regressive models produce traffic with an exponentially decaying auto-correlation function. The characteristics of the video traffic streaming also depend on the compression standard adopted. MPEG4 and H.263 standards are potential candidate coders for providing multimedia over that mimic the characteristics of data generated by these types of coders into the framework.

In this framework streaming traffic can be modeled as follows:

- A constant bit rate source by specifying the bit rate
- A variable bit rate source using the autoregressive model
- A variable bit rate source using the Fractional ARIMA model (F-ARIMA)
- A variable bit rate source using the wavelet model

This study proposes to modify OLSR using GA to reduce the end to end delay and to improve the network throughput. Simulation is undertaken for multimedia traffic and network video streamed traffic using OPNET Simulator. The end to end delay, jitter time average, time average and throughput of the proposed GA based OLSR are compared with the conventional OLSR Protocol.

LITERATURE REVIEW

Multi objective GA algorithm based adaptive QoS MANET routing was proposed by Kotecha and Popat (2007) who applied Multi Objective GA to optimize four QoS parameters (bandwidth constraints, delay and other nodes traffic and hop number) to provide adaptive MANET route. The simulations were conducted on Network Simulator NS-2.28 with results revealing that GA based approach was an improvement over the traditional method.

An efficient multicast routing in MANETs where a GA approach considerably reduced solutions to be evaluated was proposed by Dilip Kumar and Vijaya Kumar (2009). The proposed method chooses one path from a path set between each node-pair. Routes were computed through on-demand source routing principle considering node reliability. Simulations were undertaken on computed routes to evaluate the proposed algorithm's performance.

A GA based on Demand Multicast Routing Protocol (GA-ODMRP) to improve routing messages performance for MANETs was proposed by Baburaj and Vasudevan (2008). GA-ODMRP suited MANETs where topology changed frequently and suffered power constraints. GA-ODMRP performance was evaluated through various realistic scenarios and was demonstrated to be efficient.

QoS Parameter Optimization Using Multi-Objective GA in MANETs was proposed by Asraf *et al*. (2010) to locate optimal multicast tree. Simulation studies revealed that GA was robust and scaled well for many nodes. Routing Optimization using GA in Ad Hoc Networks was proposed by Al-Ghazal *et al*. (2007). The proposed algorithm improves routing using clustering algorithm based on cluster head gateway switching protocol and GA mechanisms. The proposed algorithm also showed that GA's could locate if not the shortest, at least a good path between source and destination in ad-hoc network nodes.

GA with Immigrants and Memory Schemes for Dynamic Shortest Path Routing Problems in MANETs was proposed by Yang *et al*. (2010) to solve MANET's dynamic SP routing problem. It considered MANETs target systems as they represented new-generation wireless networks. Experimental results revealed that immigrants and memory-based GAs quickly adapted to environmental changes (network topology changes) producing high quality solutions after every change.

GA-based QoS Route Selection Algorithm for MANETs was proposed by Abdullah *et al*. (2008). The work described GA operation including fitness calculation, population initialization, mutation process, crossover process and GA parameters selection. Simulation was performed for 20 mobile nodes to predict basic QoS routing algorithm performance regarding the effect of mobility. The result showed that QoS routing could successfully use GA to locate optimal routes.

Abdullah and Parish (2007) proposed QoS Routing using GA (QOSRGA) could select QoS route based on QoS metrics like bandwidth delay and node connectivity index. This paper outlined GA process and how related parameters were selected. It specifically depicted mobility effect on QOSRGA protocol performance.

A survey of QoS routing solutions for MANETs was proposed by Hanzo and Tafazolli (2007) that described their interactions with medium access control protocol when applicable, providing users with insight into differences allowing highlighting of trends in protocol design and to identify areas for further research.

A mechanism to improve delivery ratio of MANET packets and throughput was proposed by Shakkeera (2010) based on an OLSR adapted optimization scheme. Greedy algorithm is used in traditional OLSR for MPR selection creating nodes overlap resulting in reduced network performance. In the proposed method, an optimization scheme selects neighbor nodes for control packets transmission reducing network control overhead amounts. This introduced "Necessity First Algorithm (NFA)" to select optimal MRPs.

Gowrishankar *et al*. (2007) examine scenario based performance analysis of AODV and OLSR in MANET and compared the performance of the two routing protocols: The performance differentials are analyzed using various metrics like packet delivery ratio, end to end delay and number of nodes and are simulated using NS2.

METHODOLOGY

This study proposes to modify OLSR using GA to reduce end to end delay and improve network throughput. Simulation is tried out for multimedia traffic and network video streamed traffic.

Weighted Fair Queuing (WFQ): Weighted Fair Queuing (WFQ) computes each data packets weights which is obtained through multiplying packet size with inverse of a weight for associated queue and each packet is tagged with a start tag and finish tag by WFQ algorithm as given below 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 packet of flow i arriving at time is packet size and weight. The virtual time is calculated as given below in (3):

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

where, C is channel capacity in bits/sec and is the set of backlogged flows at time t in error-free fluid service.

The average data rate achieved through use of WFQ is seen below in (4):

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

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

Pulse Code Modulation (PCM): Traffic is shaped to represent Pulse Code Modulation (PCM) using G.711 codec.G.711 (Meenakshi Sundaram and Palani, 2012) which compresses 16-bit linear PCM data to 8 bits of logarithmic data. A-law and U-law two PCM audio codes are presented by the ITU-T Rec. G.711. In the implementation 16-bit samples are passed to coder input. For given input x, A-law encoding is given below in (5):

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

where, A is compression parameter.

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

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

where µ = 255 (8 bits).

Genetic algorithm: Genetic Algorithm (GA) Karegowda *et al*. (2011) is natural selection and natural genetics inspired optimization technique. Unlike many search algorithms performing local, greedy search, GA is a stochastic general search method that explores large search spaces. GA is composed of three operators: reproduction, crossover and mutation. As the first step in GA, an initial individual's population is generated randomly/heuristically. Individuals in genetic space are called chromosome which is a collection of genes where genes are generally represented by varied methods like binary value, permutation and tree encodings.

GA tries to optimize fitness/objective function denoted as f (p). An N individuals population is tested using f (p). Typically, f (p) is property type determined by numerical solver analyzing a specific design. In this project, antenna code NEC2, calculates properties of fitness function antenna.

All parameters are assigned Darwinian terms. Input, p, is DNA strand or chromosome which consists of a set of genes, denoted as:

$$p = \{gi \mid i = 1, 2, .. Ng\}$$

where, Ng is number of genes making up the chromosome, each gene is a problem parameter. A gene is made up of a string of alleles.

This section explains selection, recombination and mutation operators in GA.

Selection methods: Selection procedures are classified into two classes as follows. Fitness Proportionate Selection which includes methods like roulette-wheel selection and stochastic universal selection. In the former, each individual in a population is assigned a roulette wheel slot size in proportion to its fitness. That is, in a biased roulette wheel, good solutions have larger slot size than less fit solutions. Roulette wheel is spun to get a reproduction candidate. Roulette wheel selection is implemented as follows:

- Evaluate the fitness, f_i of each individual in the population
- Compute the probability (slot size), p_i, of selecting each member of the population: $p_i = fi/\sum_{j=1}^{n} f_j$, where n is the population size
- Calculate the cumulative probability, for each individual: q_i = i, j = 1 p_j
- Generate a uniform random number r ∈ (0, 1)
- If $r<q_1$ then select the first chromosome, x1, else select the individual x_i such that q_i-1<r ≤q_i
- Repeat steps 4-5 n times to create n candidates in the mating pool

Crossover: Crossover is a matter of replacing some of the genes in a parent by corresponding genes of another as shown in Fig. 2. Suppose there are 2 strings a and b, each having 6 variables, i.e., $(a_1, a_2, a_3, a_4, a_5)$ and $(b_1, b_2, b_3, b_4, b_5)$.

Two cross points are randomly selected from numbers and a new solution produced through combining pieces of original 'parents'. For instance, if cross points were 2 and 4, 'offspring' solutions would be:

$(a_1, a_2, b_3, b_4, a_5)$ and $(b_1, b_2, a_3, a_4, b_5)$

A similar prescription is provided for m-point crossover where m>1(Sivanandam and Deepa, 2007).

Mutation operator: Mutation is a unary variation operator applied to one genotype delivering a modified

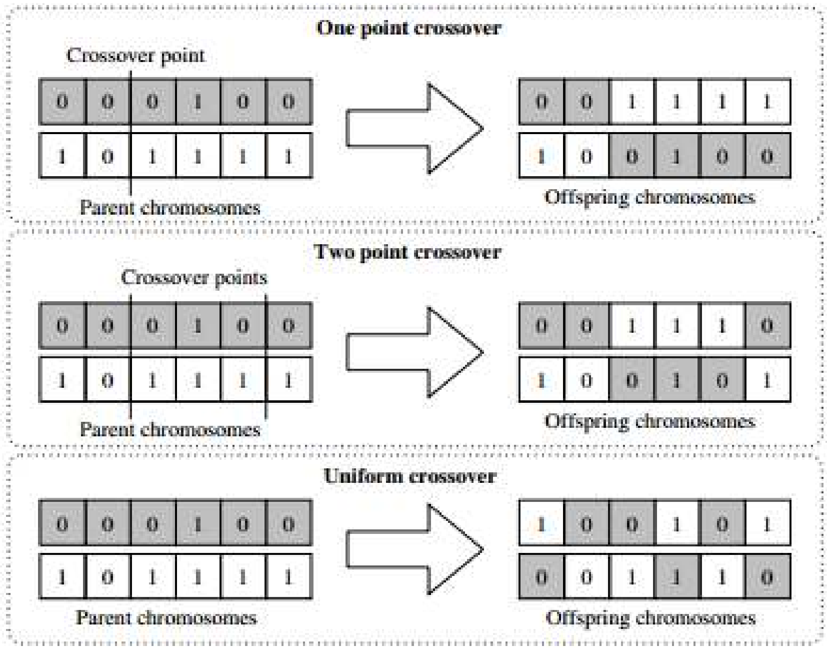


Fig. 2: Examples of crossover

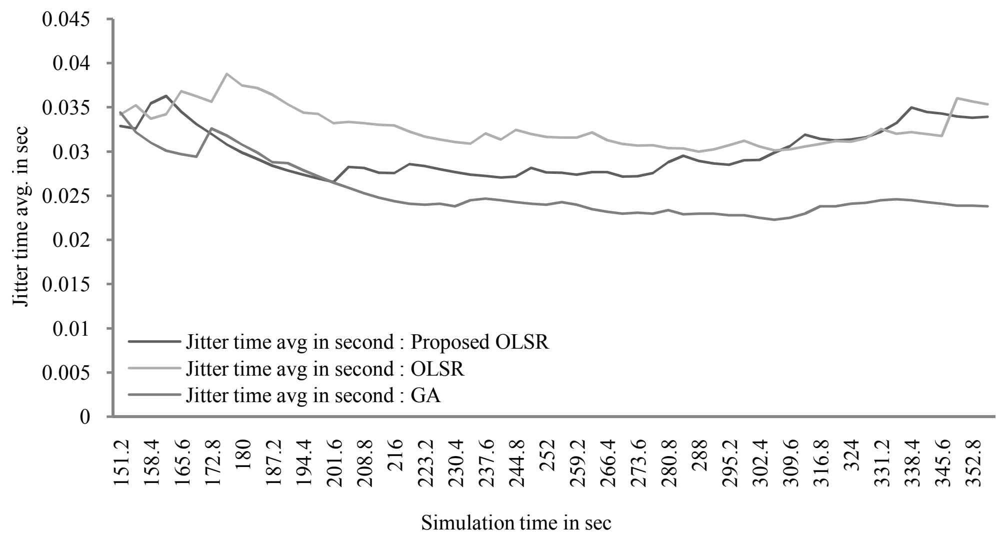


Fig. 3: Jitter time average in second

mutant, the child or its offspring. Generally, mutation causes a random unbiased change and also has a theoretical role: it guarantees that space is connected.

SIMULATION STUDY AND RESULTS

In this study, it is proposed to modify OLSR using Genetic Algorithm using OPNET Simulator, to reduce the end to end delay and improve throughput in the network. Simulation is carried out for multimedia traffic and video streamed traffic in the network. The results obtained are as shown in Fig. 3 to 6.

Figure 3 shows that the jitter time average of the proposed GA based OLSR Protocol is decreased by 15.11% when compared to the conventional OLSR Protocol which has 22.28% jitter time average.

Figure 4 shows that the time average of the proposed GA based OLSR Protocol is decreased by 13.26% when compared to the conventional OLSR Protocol which has 10.78% time average.

Figure 5 shows that the proposed GA has low end to end delay compared to other methods. It decreases by 18.1% for the proposed OLSR method and by 16.16% as compared to the OLSR method.

Figure 6 shows that the proposed GA has high average throughput of 486690.2896 compared to other methods.

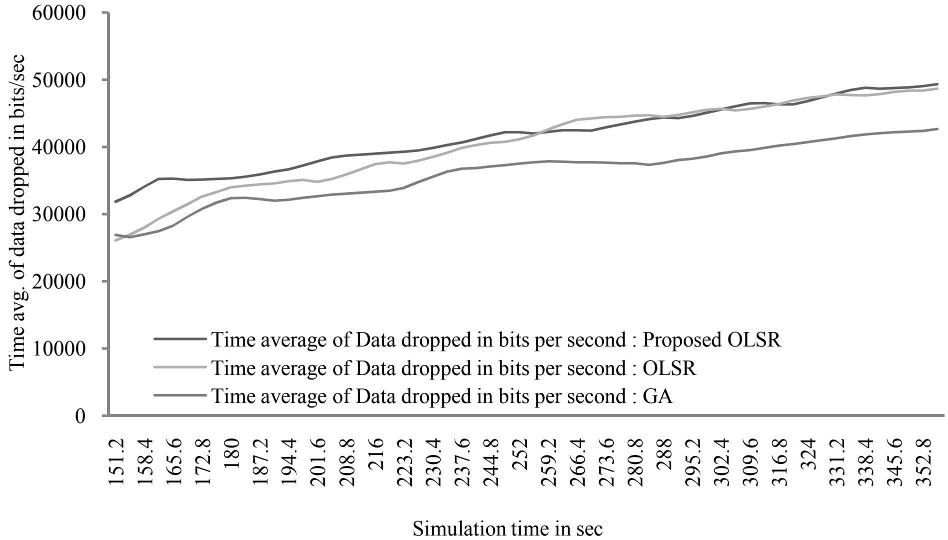


Fig. 4: Time average of data dropped in bits per second

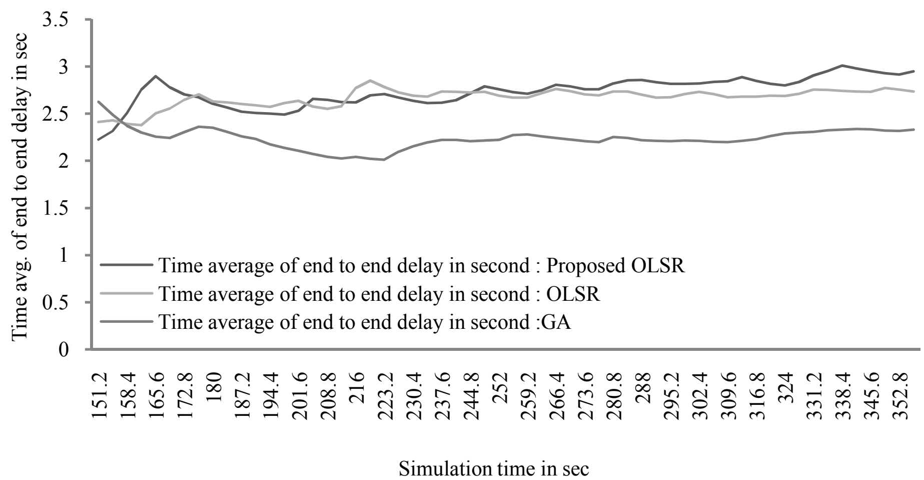


Fig. 5: Time average of end to end delay in bits per second

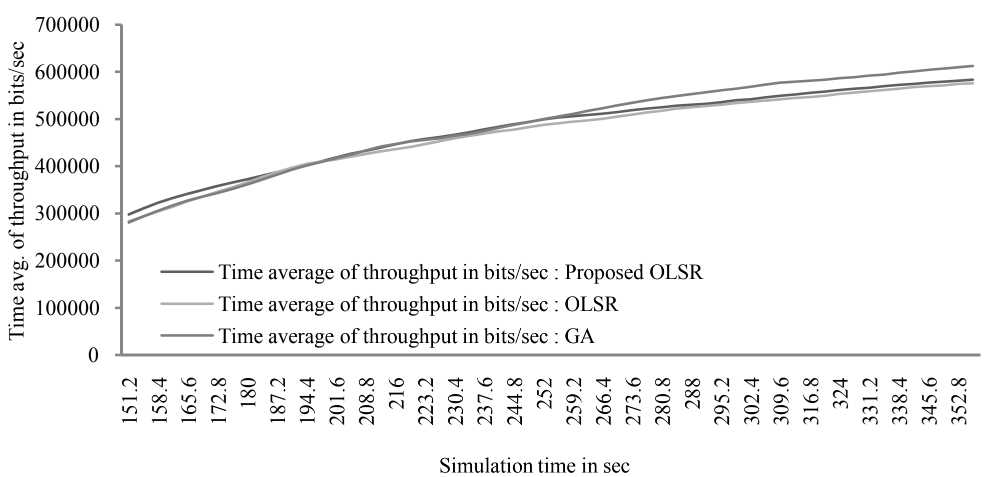


Fig. 6: Time average of throughput in bits per second

CONCLUSION

This study proposes to modify OLSR using GA to reduce the end to end delay and to improve the network throughput. Simulation is undertaken for multimedia traffic and network video streamed traffic. Routing protocols in MANET can be categorized as Reactive protocols and Proactive protocols. In Proactive Routing Protocols, all nodes need to maintain a consistent view of the network topology. In Reactive Protocols a node which wants to initiate communication with a node to which it has no route, the routing protocol will try to establish such a route. The end to end delay of the proposed GA based OLSR is decreased by 18.1% when compared to the conventional OLSR Protocol which has 16.16% end to end delay. The decrease in end to end delay enables the delivery of the packets in the network quicker. The jitter time average of the proposed GA based OLSR Protocol is decreased by 15.11% when compared to the conventional OLSR Protocol which has 22.28% jitter time average. The time average of the proposed GA based OLSR Protocol is decreased by 13.26% when compared to the conventional OLSR Protocol which has 10.78% time average. The throughput of the proposed GA based OLSR Protocol is enhanced by 1.73% when compared to the conventional OLSR Protocol which has 3.57% throughput. This improves the packet delivery in the network. Thus the throughput is increased the proposed GA has high average throughput of 486690.2896 as compared to other methods.

REFERENCES

Abdullah, J. and D. Parish, 2007. Effect of mobility on the performance of GA-based QoS routing in mobile Ad Hoc networks. Proceeding of IEEE International Conference on Intelligent and Advanced Systems (ICIAS, 2007), pp: 352-357.

Abdullah, J., M.Y. Ismail, N.A. Cholan and S.A. Hamzah, 2008. GA-based QoS route selection algorithm for mobile ad-hoc networks. Proceeding of 6th IEEE National Conference on Telecommunication Technologies, 2008 and 2008 2nd Malaysia Conference on Photonics (NCTT-MCP, 2008), pp: 339-343.

Ahmed, S. and A.K. Ramani, 2007. Exploring the requirements for QoS in mobile ad hoc networks. J. Inform. Commun. Technol., 1(2): 01-09.

Al-Ghazal, M., A. El-Sayed and H. Kelash, 2007. Routing optimization using genetic algorithm in Ad Hoc networks. Proceeding of IEEE International Symposium on Signal Processing and Information Technology, pp: 497-503.

Ali, S. and A. Ali, 2009. Performance analysis of AODV, DSR and OLSR in MANET. Proceedings of 7th International Conference on Wireless Systems, pp: 34.

Ameen, S.Y. and I.A. Ibrahimi, 2011. MANET routing protocols performance evaluation with TCP Taho, Reno and new-Reno. Int. J. u e-Serv. Sci. Technol., 4(1): 37-49.

Asraf, N.M., R.N. Ainon and P.K. Keong, 2010. QoS parameter optimization using multi-objective genetic algorithm in MANETs. Proceeding of 4th IEEE Asia International Conference on Mathematical/Analytical Modeling and Computer Simulation (AMS), pp: 138-143.

Baburaj, E. and V. Vasudevan, 2008. An intelligent mesh based multicast routing algorithm for MANETs using particle swarm optimization. Int. J. Comput. Sci. Network Secur., 8(5): 214-218.

Dilip Kumar, S.M. and B.V. Vijaya Kumar, 2009. EAAC: Energy-aware admission control scheme for ad hoc networks. Int. J. Wirel. Netw. Commun., 1(2): 201-219.

Gowrishankar, S., T.G. Basavaraju, M. Singh and S.K. Sarkar, 2007. Scenario based performance analysis of AODV and OLSR in mobile Ad hoc networks. Proceedings of the 24th South East Asia Regional Computer Conference, pp: 18-19.

Hanzo, L. and R. Tafazolli, 2007. A survey of QoS routing solutions for mobile ad hoc networks. IEEE Commun. Surv. Tutorials, 9(2): 50-70.

Karegowda, A.G., A.S. Manjunath and M.A. Jayaram, 2011. Application of genetic algorithm optimized neural network connection weights for medical diagnosis of Pima Indians diabetes. Int. J. Soft Comput., 2(2): 15-23.

Kotecha, K. and S. Popat, 2007. Multiobjective genetic algorithm based adaptive QoS routing in MANET. Proceedings of IEEE Congress on Evolutionary Computation, pp: 1423-1428.

Meenakshi Sundaram, S. and S. Palani, 2012. Modified OLSR protocol for priority based multimedia traffic shaping. Int. J. Comput. Sci. Telecommun., 3(5): 11-14.

Mohan, B. and H. Saroja Devi, 2012. Study of scalability issues in Optimized Link State Routing (OLSR) protocol. Int. J. Adv. Technol. Eng. Res., 2(4): 40-44.

Shakkeera, 2010. Optimal path selection technique for flooding in link state routing protocol using forwarding mechanisms in MANET. Proceeding of International Conference on Communication and Computational Intelligence (INCOCCI), pp: 318-323.

Sivanandam, S.N. and S.N. Deepa, 2007. Introduction to Genetic Algorithms. Springer, Berlin, Heidelberg, New York.

Yang, S., H. Cheng and F. Wang, 2010. Genetic algorithms with immigrants and memory schemes for dynamic shortest path routing problems in mobile systems, man and cybernetics. IEEE T. Appl. Rev., 40(1): 52-63.