VOL. 13, NO. 23, DECEMBER 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

CLUSTERING AND PARAMETER OPTIMIZATION IN MANETS USING SOM AND GENETIC ALGORITHM

Saurabh Sharma[1] and Rashi Agarwal[2]
[1]Sharda University, Gr. Noida, India
[2]Department of Computer Science, Sharda University, Gr. Noida, India
E-Mail: sam7sai@gmail.com

ABSTRACT

In this research paper SOM and Genetic algorithm have been used to cluster the MANETS (Mobile Ad Hoc Networks) to enhance overall QoS of the network. The Machine Learning (ML), Artificial Intelligence (AI) and Computational Intelligence (CI)) optimize and speed up the calculation in every sphere of computation, thus they are being used in this research. In this research a system has been proposed which not only fasten clustering process of a MANET in to desirable groups but also used these clusters to optimize the path selection, Mobility prediction and congestion identification. Self Organizing Maps (SOM) and Genetic Algorithms (GA) are used here to first cluster the network, selection of suitable Cluster Head and then to optimize the results to empower the MANET, to select the best and optimum path on the criterion of Mobility, Congestion and Hop count in every type of algorithms. This research also includes the study of main reasons responsible for degrading QoS (or Quality of Service). In this proposed CI based approach the QoS is enhanced it could be verified as improved throughput and decreased Delay.

Keywords: MANET, QoS, SOM, genetic algorithm, GASOMGA.

1. INTRODUCTION

Mobile Ad Hoc Networks or MANETS are made up of self-governing nodes which are interconnected with each other without any intermediate device or interface. Ubiquitous, Ever-changing, nomadic and Ad hoc nature are the main adjectives which may be used for them. They are easy to set up, without any help of the intermediary infrastructure [1]. MANETS are also called as the multi-hoping networks, but they may work with single hop count too. These networks usually show unstable route maintenance due to continuous changing of positions as shown in Figure-1. Due to which QoS get affected. As we can see the Figure-1(A) below in which node A changes its initial position, and move to create new route path for connecting with other nodes. Frequent movement of mobile nodes creates these sorts of problems which need resource optimisation. The capability of resource optimization for different types of data and its applications force us to use unsupervised learning Algorithm SOM or Self Organizing Maps and GA or Genetic Algorithm [1] to enhance the performance of these networks, which supports the step-by-step process to establish connections in between them. Important characteristics of any performance network are convergence, converged networks and QoS which incorporates different types of data like voice, video, and text data on a single transmission media. Due to their unstable topology and multi-variable dependency makes them more complex. A number of researches have been done in order to improve their performance using congestion control, QOS enhancement, Mobility Management, location management and Security using ML, AI and CI as discussed in [2] & [3]. In the research work [2] & [4] different learning mechanism of Supervised and unsupervised learning mechanisms are there in which learning can be observed. In these works unsupervised learning may be used to cluster a multi-dimensional data to low dimensional representation. In this paper a clear idea to make a hybrid model of two or more techniques to enhance the clustering and connecting mechanism in order to discover the most responsible parameter. It starts with finding out cluster head in any MANET. Any MANET of clusters may have three different possibilities i.e. A network having most mobile nodes, a network having stationary nodes and a network having nodes of stationary nature, that unique clustering makes the network intelligent by knowing the responsible parameters.

Work done in [5], [6] & [7] show clustering done using SOM and other algorithms to give better results. In the [7] energy have been worked out as the main parameter.

In section 1, introduction regarding available solutions for the performance and QoS enhancement have been discussed with in depth literature review. Different methods used for QoS enhancement have been gone through to empower the current work.

In section 2, the main factors & QoS parameters responsible have been surveyed such that a strengthened foundation can be established to lay down suitable solution for the current problem. Different QoS enhancement methods have been analyzed in order to go in-depth into the problem & identification of main objective. Most recent works have been studied here to make strong foundation. Section 3, of this paper discusses the problem in depth and extract out the suitable model to cop up with it. A number of research work have been analyzed and concept of SOM and GA is applied using MATLAB to weave an interconnected approach to find out the optimal solution for that references related to that have been given accordingly.

Section 4 gives a full-fledged methodology for the enhancement. SOM is used intelligently with GA to make a cyclic process. A new idea always brings some challenges, so it brings a challenge to interconnect the

GASOM to GA again. SOM is used to find out the cluster & cluster head and parameters responsible are optimized. Final Cluster Head is being decided to find out the best out of suggested and extracted from SOM.

Section 5 & 6 discusses the result analysis and the final conclusion with graphical representation for identification of comparative results. The model worked out here can/may be called as GASOMGA. A number of tables associated with the results are represented in this section having a comparative result analysis from Packet dropped to Mobility analysis to energy consumption and analysis. Section 7 gives the references.

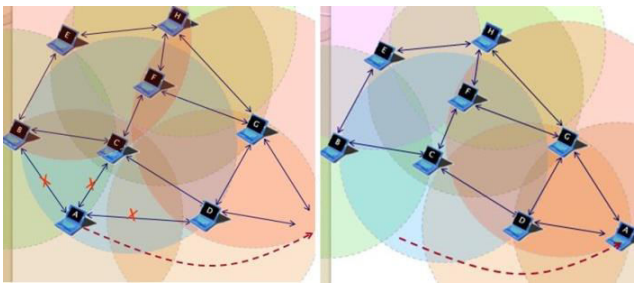

Figure-1. (a) MANET Before Mobile node (B) After Mobile node changes position.

2. LITERATURE SURVEY: QOS PARAMETERS AND FACTORS RESPONSIBLE

The United Nations Advisory Committee on International Telephony and Telegraphy (CCITT) suggest. (eg E.800) and defined QOS as "The collective effect of service performance that determines the degree of satisfaction of a service user" [9] i.e. main parameters such as bandwidth, delay or mechanics of latency as admission of 8u Control, SLA, signalling protocol, etc. they are not included in the definition, but are the basic parameters that influence the QOS and actually decide the quantification of the degree of user satisfaction.

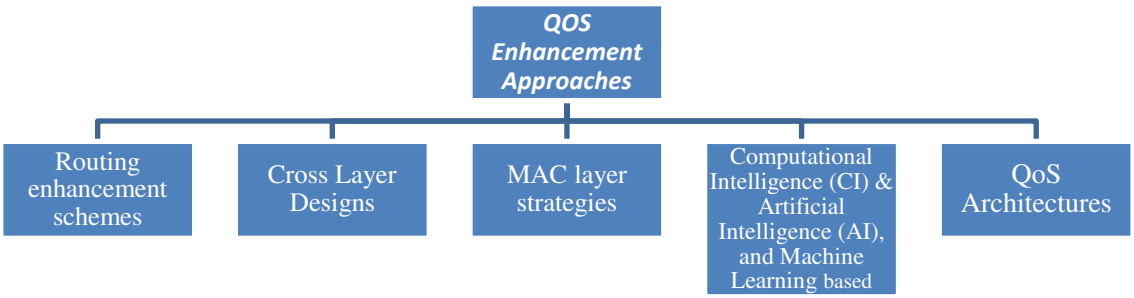

Figure-2. QoS enhancement approaches.

The following QoS provisioning methods are being used till now and researched as the main approaches for the same as shown in [8], [9] & [10]. These methods includes Routing enhancement schemes for QoS provisioning, Cross Layer Designs, MAC layer strategies, Computational Intelligence (CI), Artificial Intelligence (AI) & Machine Learning based systems and QoS Architectures as shown in Figure-2. These methods have empowered the technological development by their inputs and somehow enhanced QoS up to an extent.

Several QoS parameters are responsible for the overall network performance which is also very much responsible for certain factors which are ultimately responsible for degradation of overall network performance. [S. Sharma *et al*], [Prolopios. C. K. *et al.*,] & [J. Jindal *et al*.,] in [10], [11] and [12] several congestion control and routing mechanism are analyzed such that it can tell us the main factors related to QoS enhancement.

Collectively we can say that a specific number of parameters are responsible for the degradation of QoS.

These parameters are namely Bandwidth, Delay, Jitter, Throughput, Packet loss rate, Range of signal, power dissemination, Mobility, Speed of node, Communication overhead, Route Acquisition Time, comm. Overhead, scalability, etc. [13] [14].

The following main problem arises due to discrepancies found in these parameters, there may be some uncertainty found in certain parameters which requires special attention to improve and maintain QoS of any MANET [15], [2]. These Problems are as follows: Packet Delivery Time, Routing Strategies, High Mobility, Power Back Up, Signal Problem (Hidden Terminal Problem, Fairness Issue & Security.

More and more efforts are needed to stabilize the performance of MANETS [15]. As we have seen that various approaches had played an important role in enhancing the performance of these networks, thus this paper concentrates on enhancing the performance of the MANET using Machine learning. Such that the methodology. Self organizing Maps (SOM) are widely used to cluster the data set in unsupervised manner; this approach enhances the performance by adding the Genetic Algorithm (GA).

3. PROBLEM IDENTIFICATION: CLUSTERING APPROACH USING KOHONEN SELF ORGANIZING FEATURE MAPS & GENETIC ALGORITHM

SOM actually is inherent to the features of the problem to be called as Self Organizing Feature MAPS. The Self-Organizing Map was evolved by Professor Tevo Kohonen and has been proven useful in many applications. KSOMs were earlier used and applied successfully to classify data of different domain including speech recognition, robotics, image processing, medical, and in different aspects of computer networks too may be added [16], [17], [18] & [19]. These clusters may be analyzed and optimized using different ways to produce remarkable accuracy. In cluster analysis similar elements can be identified as per participative attributes or parameters. Competitive learning and dimension reduction both functions are performed by SOM in unsupervised learning. [20]

N number of participative nodes of networks may be classified in (n-1) number of clusters. An another step to perform clustering may be incorporated in desirable number of clusters to strengthen clustering in any of the application we may use Genetic Algorithm to find out best out of available parents, as we are using here.

For self organizing Maps we may have different approaches like hierarchical agglomerative clustering, partitive clustering using K-means etc. Large multi dimensional data set get reduced dimensionally using SOM. Few researchers only worked upon energy [21].

So, large data having similar attribute may be clustered using SOM. SOM performs clustering using prototyping and training first data has to be prototyped and then the clustering done as per that said prototype, these cluster then optimized and the computation time also decreases, thus energy consumption decreases. [22]

The process of Data pre-processing includes focusing on subset of data to focus on the exact data to be clustered. Then, the erroneous data must be removed in order to maintain the integrity of the data. Data pre-processing also need data encoding in which the encoded data is used instead to maintain integrity which must be followed by scaling.

Actually, when clustering occurs, a large MANET is divided in to Sub-Groups called Clusters. These clusters are been made as per the availability of nodes in any stipulated parameter on pre-decided cluster. In some cases it has been seen that the performance degrades due to the non-performing cluster heads. Thus, using SOM, these clusters will be re-optimized to find out new clusters, mainly power/mobility has made the main difference but it's not guaranteed and calculated that if more power backed up device is made a cluster head. It stays mobile so may own its power more quickly. Thus, a competition between probable CHs is done using GA to produce fittest child called Fittest Cluster Head.

3.1 Review of SOM

3.1.1 Clustering of self organizing map

The Self Organizing Map (SOM) is a type of algorithm which can be used in data mining as it has been said by (Vesanto & Alhoniemi, 2000). It converts low dimensional input space into understandable form from high dimensional complex form [20] and perform clustering. The number of clusters are dependent on the total number of SOM units if they are larger accordingly cluster may become large.

3.1.2 Stimulating cooperation in self organizing mobile ad-hoc networks

Work done in (Buttyán & Hubaux, 2003) [20].gives an empowered capability to each nodes to capitalize the benefits from the network to optimize the performance. Generally it has been considered that the problem of not wilfully forwarding the packet arise in civilian applications. A mechanism based on counter incorporated on each node is introduced in it.

3.1.3 A new neural network based energy efficient clustering protocol for wireless sensor networks

A solution to the energy based problem has also been countered by using SOM based Protocol Called Energy Based Clustering Self organizing map (EBCS) which works just like LEACH(Low energy Adaptive Clustering Hierarchy) & Low Energy Adaptive Connectionist Clustering (LEA2C) in (Enami *et al*., 2010) [21]. It has been compared with both in this work. To form better clusters that energy based clustering is used.

3.1.4 Energy based clustering

To cluster sensor based nodes a centralized adaptive Energy Based Clustering Protocol was developed in Enami & Moghadam, 2010) [21]. Nodes having higher energy levels attracted the nearest nodes with lower energy levels & earlier these higher energy level nodes used as weights of SOM. The results were compared with the LEACH/LEA2C.

3.1.5 A multi-criterion optimization technique for energy efficient clustering

Aslam *et al*., 2010 [22] a multi-criterion optimization technique was used in this energy efficient clustering algo. In this work multiple individual. Data matrices of multiple individuals were used in this technique to find out the competent CH (or Cluster Head). It had been used as a distributed protocol in which local information of ever node is used to optimize the results.

3.1.6 Intrusion detection in MANET using self organizing map (SOM)

Dinesh Kumar & Radhakrishnan, 2014 [23], SOM is used for intrusion Detection in MANETS. In case of intrusion and any other security attacks the threat was supposed to be pre detected and the system somehow

become secure. It had been done an ANN based SOM competitive Network which was used as a tool to detect the affected malicious nodes using input data patterns. Different parameters had been introduced to analyze the experimental results in the proposed system [24].

In Zhang *et al*., 2014, the distance between nodes combining with topology preservation is used to control a spring alike sensor network. The constraints of the neighbouring nodes were considered here to be fine tuned to enhance the accuracy of overall network. In Giorgetti *et al*., 2007 another localization service based work was done here which works only using connectivity information. Multi- Dimensional scaling was also being applied specially on low connective nodes. As we know that a part of Artificial Neural Networks (ANN) and it learn competitively by unsupervised learning method and convert high dimensional data to lower one. It completes its working in following three steps:

3.2 Training methodology

As we know as per discussed in previous section that the Self organizing map is use to train the log data of MANET, thus, it is initialized with n dimensional weight vector, means n-Dimensional parametric value. So, weight vector m_i of every node is initialized may be initialized with the following approach

$$m_i = [\mu_{i1}, \mu_{i2,}.....\mu_{in}], \mu_{ij} \ \in R^n \quad (1)$$

Where, Mqe represents, $\frac{1}{2}\sum(x_i \ - m_i)$
thus, any random vector selected here from training data to represent the network.

3.2.1 Competition: The BMU OR Best Matching Unit is then calculated as in first step using distance between the input vector and the weights of each node.

$$\text{BMU}=\sqrt{\sum_{i=0}^{n}(V_i - W_i)^2} \quad (2)$$

Where, V is the current input vector, W is node's weight vector and n is the number of weights.

3.2.2 Synaptic weight adaptation

The diameter or radius of neighborhood is calculated BMU in nearby given in the equation below.

Then in increment in the neighborhood is observed as increased.

$$\sigma(t) = \sigma_0 exp\left(\frac{t}{\lambda}\right) \quad (3)$$

Where, $\sigma(t)$ is width mesurement of lattice at time t, σ_0 is widht of the same initially at time t_0&
λ is time constant.

Every node present nearby want to become a part of BMU and want to be closer to it. Change in the weight values may be given as;

$$W(t+1) = W(T) + \theta(t)L(t)\big(V(t) - W(t)\big) \quad (4)$$

$$\theta(t) = \exp\left(-\frac{dist^2}{2\sigma^2(t)}\right) \quad (5)$$

Where θ is the influence rate & σ *is the width of* lattice at any time t

Respective iterations can be implemented then as per requirement and the winner node is determined. Due to the response of the winning neuron the excited neuron generally decrease their individual values in relation to input patterns of the involved weights. The respective responses of these neurons would results enhancement in the input pattern in total. It is used in MANETS on log data to Cluster the group of nodes into logical cluster to identify the best Cluster Head.

3.3 Review of genetic algorithm

Genetic Algorithm or GA was used this research to enhance the results of clustering and more certain Cluster Head or CH Selection. These algorithms are adaptive Multi-heuristic and search algorithms which work on evolutionary natural selection mechanism and genetics. Generally they are used to solve optimization problems and the system which are based on evolutionary values. Here, evolutionary values of node connection play an important role in determining basic introductory fittest value to establish connections. Genetic algorithms work with wide range of parameters. This research makes the parameters optimized by providing clear-cut, minimum requirement specification idea required for the maintenance of the MANET.

3.3.1 Implementation of genetic algorithm

It simulates the fittest values (optimal) amongst the available for the survival, thus applied between the Cluster Head identified nodes constituting SOM clustered and non SOM clustered, then Genetic algo. will be applied on them. The implementation of these algorithms is generally based on basic three operations:

Selection: It find out values for the survival of the fittest.

Here, in this case it has been choose that the preference is given to the better node (individual) equipped with optimized parameter values which we had identified after SOM application.

Crossover: It depicts the mating between individuals. Here, the best nodes having optimal values of Mobility (Low),

Battery (High), Bandwidth (High), Delay (Low), perform mating process. The best output then may be compared with the parents to select the best out of them.

Mutation: It initiates self modifications in the individual.

3.4 Usage of SOM and GA in empowered cluster head identification

This paper suggests a technique to optimize cluster and cluster Head (CH). The Cluster formed earlier remain assume but the SOM will be applied further to cluster wise to perform further identification of the most competitive node. This node get extracted from SOM as winner & thus that CH used as main CH to perform communication after get optimized using GA as shown in Figure-3 given below. This is required due to high mobility & requirement of optimum performing cluster head [25] & [26].

As these CHs would have to be compared with each other the one extracted from SOM and the previously made Cluster Head. These clusters formed and evolved using SOM and GA may be called as Logical Clusters. Thus, Cluster Head as Logical Cluster Head. The experiments using scenario will be then set to make comparison with previous results. Scenario then set again with keeping New Ch as Cluster Head in a Mobile environment then new results found to be improved.

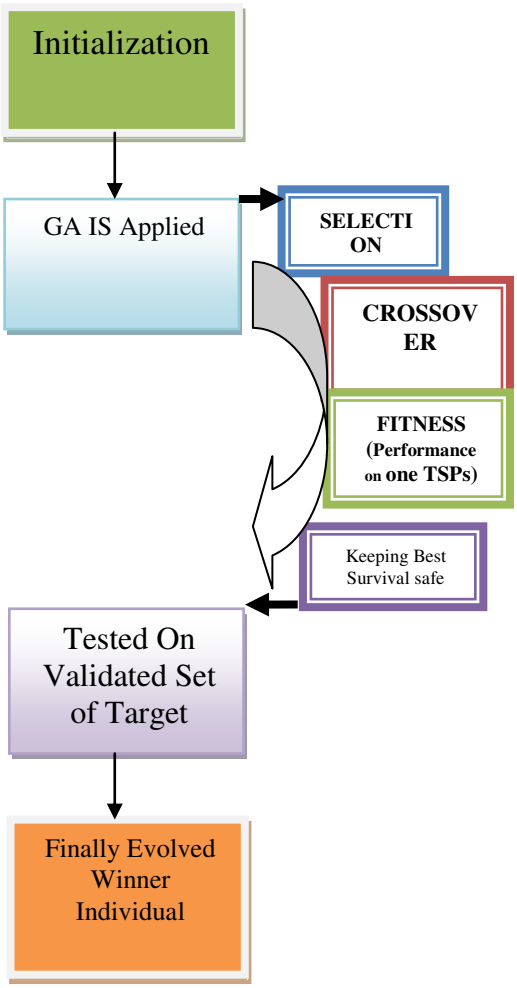

Figure-3. Enhancing clustering of MANETS.

4. PROPOSED METHODOLOGY

A scenario has been set up with 25 nodes and 5 nodes kept mobile intentionally having a set trajectory in OPNET 14.45 As trajectory changes as per time different readings of different parameters of all 25 nodes are taken as according to these values the data-set table has been formed. SOM has been trained using data set at different time intervals using MATLAB14a. Retraining SOM with data set, this MANET get converted into clusters and the data of same nature gathered along with each other to convert that data in to ¾ clusters of different nature. Using GA the results are optimized and more specific and corrected results. As it has been practiced in [10], it may be applied further in different protocols like AODV as done in [27].

The clustered environment will be made with routing information updated data which increases the sustainability of the network and increase the backup of MANET nodes. From log data MANET suppose to be clustered into different mobility zones using SOM and the mobility zones make logical clusters to empower the existing clusters GA improvise the results using optimization criterion, and thus overall help in the selection of best Cluster Head (CH).

Overall MANET clustering improves using this method of clustering method.

Self Organizing Maps and GA may be used in the clustering of MANETS with the help of several parameters available & with help of MATLAB. A novel approach of combining SOM with GA revolutionizes the previously clustered MANETS in this approach clustering will be done as follows:

Initialization

In this step N no. of nodes are initialized and their routing and QoS parameters and other parameters like mobility, Bandwidth of same energy level.

Cluster formation

In this step SOM performs clustering in two steps. SOM is chosen here because of its dimensionality feature. It reduce a multi-dimensional data into low dimension and also visualize the developed cluster on the MAP in this step reorganization of cluster regrouping & visualization is performed using SOM we know that initialization energy level of all nodes were same.

In the next sub step to determine weight Matrix any Base Station has to select M no. of nodes with similar Mobility Speed.

Next step is to find out suitable cluster head for each cluster to provide competent role to each node.

Suitable cluster head selection

In this step we have to select the suitable Cluster Head or CH. For this every node of every cluster is analyzed to select the non-mobile nodes as cluster head because high mobility leads to lower energy level. In this step the Cluster Head formed by us has got challenge from newly made CH.

Data transmission

The final step of clustering is to send the data packets. Which are sensed at the respective CHs. The data

aggregation function has to be applied to the received Packet by CHs and then protocol information & data are sent to their BS (Base Station). The genetic algorithm has to be applied to select the appropriate cluster head out of the two options amongst the respective cluster.

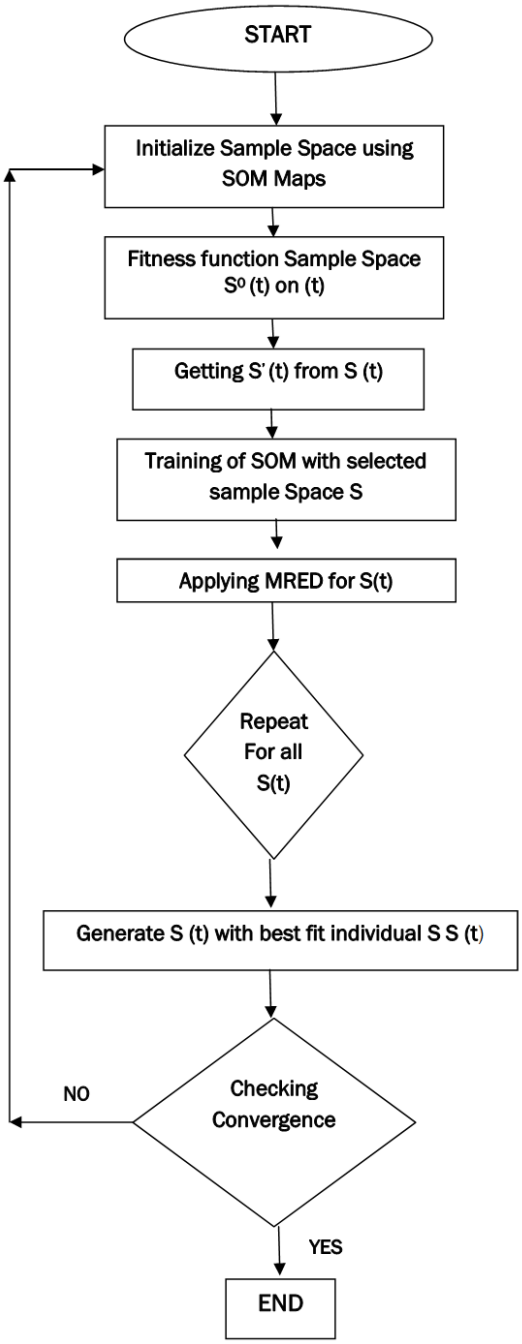

Figure-4. Combined flow diagram for clustering.

Weight Updated SOM weight Updated Equation

$$Wj(t+1) = Wi(t) + \mu(t)\lambda.W(x)(j,t)[x - Wj(t)]$$

As we know that "The weight of every Node are updated at each cycle by adding Current learning Rate X Degree of neighbourhood with respect to winner X Difference B/W current weight & input vector to current weight. Sample spaces may be defined an S here and corresponding changes as S (t) & S^o (t).

5. RESULT ANALYSIS

Multiple experiments are done to test the clustered environment and applicability of Machine Learning Based novel approach to the experiment set up.

Overall packet Delivery Rate has been analysed and it may be concluded that the new approach somehow improve the No. of Packet Vs Time graph. Initially, it don't show the improvement but gradually the growth is seen. When times lapses the values of No. of Packets delivered is seen almost a bit ahead of previous as shown in the table and Graph given in Table-1 & Figure-5.

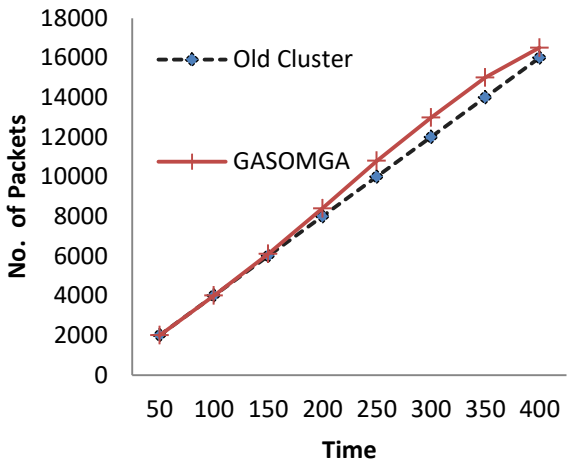

Figure-5. No. of packet vs time.

Table-1. Packet delivery rate.

S. No.	**No. of packets** (bps)		**Time taken** (ms)	
	Non-GASOMGA	**GASOMGA**	**Non-GASOMGA**	**GASOMGA**
1	2000	2020	50	50
2	4000	4050	100	100
3	6000	6100	150	150
4	8000	8400	200	200
5	10000	10800	250	250
6	12000	12980	300	300
7	14000	15000	350	350
8	16000	16805	400	400

The overall throughput of the proposed system is improved and it can be said that as and when time lapses the neural/SOM learn the capabilities and update the respective protocol. Ultimately, nothing is then required to be remained thereafter. Thus, after 700 ms the throughput in bps (remains 70000 bps) then remains. As given in the Table-2 below and can be understood from Figure-6.

Table-2. Throughput vs simulation time.

S. No.	**Through Put** (bps)		**Simulation Time** (ms)	
	Non-GASOMGA	**GASOMGA**	**Non-GASOMGA**	**GASOMGA**
1	10000	11000	100	100
2	20000	22000	200	200
3	29000	32000	300	300
4	41000	46000	400	400
5	50000	59000	500	500
6	62000	71000	600	600
7	72500	79550	700	700
8	90000	100000	800	800

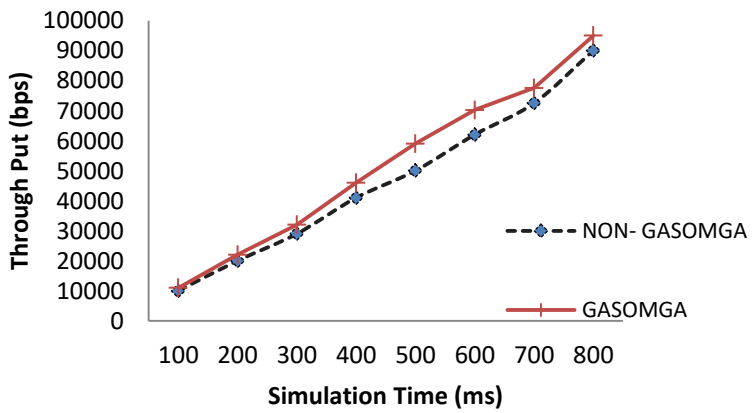

Figure-6. Throughput vs time.

The packet drops due to lack if jitter information and simulation time instability. In the current scenario and improvement the execution of the data delivery overall dropping decreases as shown in the Table-3 and Figure-7 given below.

The associated graph clearly shows that in case of non- GASOMGA more and more packets are lost as per time and stabilize after some time.

Table-3. Packet delivery rate.

S. No.	**No. of dropped packets** (No.s)		**Simulation time** (ms)	
	Non-GASOMGA	**GASOMGA**	**Non-GASOMGA**	**GASOMGA**
1	500	100	100	100
2	1110	360	200	200
3	1600	530	300	300
4	2210	705	400	400
5	2800	880	500	500
6	3450	1025	600	600
7	4100	1065	700	700
8	4800	1195	800	800

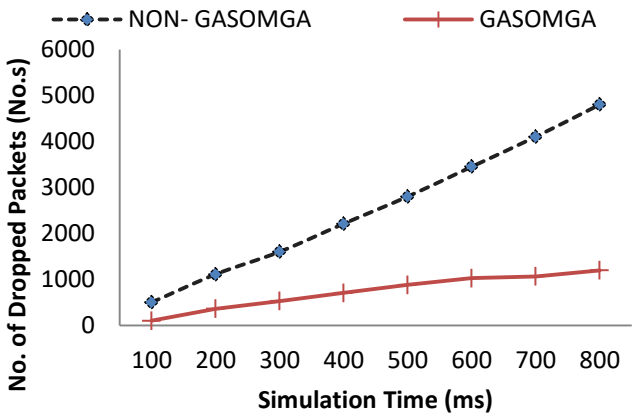

Figure-7. Dropped packet vs time.

The average delay in case of non GSOMGA method increases as per simulation time whereas in case of GASOMGA it has been increased as the nature of MANET but not in that ratio. Thus, overall delay minimized. As delay minimizes the overall performance of any network improves as shown in Figure-8 and Table-4 given below.

Table-4. Average delay.

S. No.	**Average delay** (ms)		**Simulation time** (ms)	
	Non-GASOMGA	**GASOMGA**	**Non-GASOMGA**	**GASOMGA**
1	110	100	100	100
2	300	250	200	200
3	600	400	300	300
4	775	570	400	400
5	1000	640	500	500
6	1100	800	600	600
7	1190	860	700	700
8	1280	920	800	800

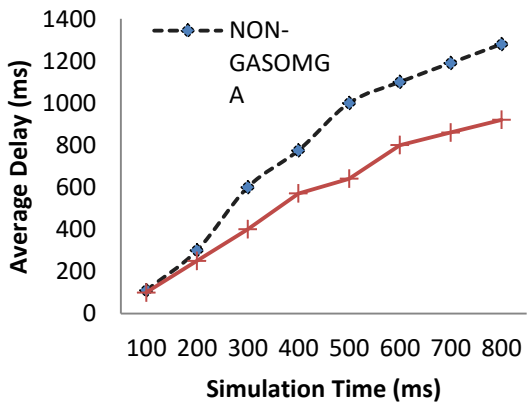

Figure-8. Average delay vs. time.

6. CONCLUSIONS

Technique using GASOMGA is introduced here in which packet delay; Packet Dropping Average Delay, Mobility and energy consumed have been discussed. It has been observed that the Packets Dropping Rate, Average Delay, No. Mobile Nodes have been improved using new enhanced method but Battery life or energy remains unaffected.

Mobility also remains unaffected but as we have selected cluster Head (CH) using this parameter only thus it has been considered. Overall Bandwidth in this small set up has been observed improved after some time initially it has been seen that it has not been affected but later o it get stabilized to be improved. Thus, throughput also improved by 10.1 % overall as shown in the Table-2 and Figure-6. It has been found that mobility came out to be the most crucial parameter in the selection of CH

(Cluster Heads) and final selection of CHs. Increase in throughput and decrease in Delay shows performance enhancement and QoS guarantees.

In future this method may be a applied to select cluster Head automatically. The automatic discovery of CH makes it more meaningful. Some higher level CI, AI or ML techniques may be used to enhance it. No of Nodes in the scenario may increase and the variation may be researched.

REFERENCES

[1] S. Kan, Z. Feq & E. Kita. 2006. Application of Self Organizing Maps to Genetic Algorithm. Computer Aided Optimum Design. Vol. XI: Chapter1. witpress.com: 3-12.

[2] Sharma S. and Agarwal R. 2015, December. Analysing Qos Parameters in MANETS: A Survey. In Second International Conference on Recent Trends in Science, Technology, Management & Social Development (RTSTMSD-15), IJSTM, and ISSN (No. 2321-1938).

[3] M.Y. Liang. 2001. Extending the Kohonen Self Organizing map Networks for Clustering Analysis. Computational Statistics & Data Analysis. 38: 161-180.

[4] Vibhuti Rana, Pritpal Singh Munda. 2016. A Review on QOS Parameters in Cognitive Radio Using Optimization Techniques, International Journal of Engineering and Innovation Technology (IJEIT) ISO 9001-2008 certified. 5(12): 59-63.

[5] Qiao Daji, Qiu Tie, Kim Hyoil. 2017. Self organizing and Smart Protocols for heterogeneous & Ad Hoc networks in the Internet of Things, Editorial/Ad hoc Networks. 55: 1-2.

[6] Pablo G.S Tiburcio, Marco Aurelio Sophn. 2010. Adhoc Grid: An Adaptive & self roganizeing Peer to Peer computing Grid, 10th IEEE International conference on computer and Information Technology, CIT 2010: 225-232

[7] X. S. Asha Shiny & R. Jaya deesh Khannan. 2015. Energy Efficient clustering protocol using self organizing Map in MANETS. Indian Journal of Science and Technology. Vol-8: 28

[8] M. Salem and U. Buehler. 2013. An Enhanced GHSOM for IDS. 2013 IEEE International Conference on Systems, Man, and Cybernetics, Manchester: 1138-1143.

[9] Harinder Singh, *et al*. 2012. Using Kohonen – SOM & K- means Clustering Techniques to Analyse QoS Parameters of RSVP. Proceedings of World Congress on Engineering and Computer Science. Vol. 1. WCESCS 2012: 24-26

[10] Sharma S., Jindal D. and Agarwal R. 2018. Analysing Mobile Random Early Detection for Congestion Control in Mobile Ad-hoc Network. International Journal of Electrical and Computer Engineering (IJECE). 8(3): 1305-1314.

[11] Karavetsios P.C and Economides A.A. 2004. Performance comparison of distributed routing algorithms in ad hoc mobile networks. WSEAS Transactions on communications. 3(1): 317-321.

[12] Jaspal Jindal, Vishal Gupta. 2013. Fuzzy Improved Genetic Approach for Route Optimization in MANET. International Journal of Advanced Research in Computer science and Software Engineering. 3(6). Available online: www.ijarcsse.com ISSN: 2277128X.

[13] T. R. Gopal Krishnan Nair, Kavitha Sood and R Selvarani. 2014. A QoS based Routing Approach using Genetic Algorithms for Bandwidth maximization in Networks. RJASET, 7.17: 3616-3622.

[14] Sherin Zafar, Prof. (Dr.) M.K. Soni. 2014 .Trust Based QOS Protocol (TBQP) using Meta-Huristic Genetic Algorithm for Optimizating and Securing MANETS. International Conference on Reliability Optimization and Information Technology, ICROIT 2014, MROU, India. 23: 82014.

[15] S. Meenakshi Sundaram, S. Palani Nd Ramesh Babu. 2014. Enhanced Optimized Link State Routing for Multimedia Traffic using Genetic Algorithm. Research Journal of Applied Sciences Engineering and Technology. 7(17): 3616-3622

[16] J. Godwin Ponsam and R. Srinivasan. 2018. Trust based intrusion detection system using fuzzy Technique and ant based authentication in manet. ARPN Journal of Engineering and Applied Sciences. 13(2): 693-697

[17] Errin Bayram, *et al.* 2009. Genetic algorithm and self organizing Maps. A powerful combination for modeling complex ORAR &QSPR Problems. Journal of computer Aided Molecular Design. 18: 483-493

[18] Vikas Siwatch et al. 2012. An Approach to Optimize QoS Routing protocol using Genetic Algorithm in MANET. IJCSSMS. International Journal ofComputer Science & Management Studies,: 12: 03

[19] J. Vesanto and E. Alhoniemi. 2000. Clustering of the self-organizing map. IEEE Transactions on Neural Networks. 11(3): 586-600.

[20] Levente Buttyán and Jean-Pierre Hubaux. 2002 Stimulating Cooperation in Self-Organizing Mobile Ad HocNetworks. Laboratory for Computer Communications and Applications. 1-21.

[21] Neda Enami, Reza Askari Moghadam. 2010. Energy Based Clustering Self Organizing Map Protocol for extending Wireless Sensor Networks lifetime and coverage. Canadian Journal on Multimedia and Wireless Networks. 1(4): 44-54.

[22] Hamid Ali, Waseem Shahzad, Farrukh Aslam Khan. 2012. Energy-efficient clustering in mobile ad-hoc networks using multi-objective particle swarm optimization. Applied Soft Computing. 12: 1913–192.

[23] V. Dinesh Kumar and S. Radhakrishnan. 2014. Intrusion detection in MANET using Self Organizing Map (SOM). International Conference on Recent Trends in Information Technology, Chennai. 1-8.

[24] Sharma S., Jindal D. and Agarwal R. 2016. An approach for Congestion Control in Mobile Ad hoc Networks.)

[25] Haider Alani and Raed Alsaqour. 2017. Routing Discovery Scheme for High Mobility in Manet. ARPN Journal of Engineering and Applied Sciences. 12(2): 536-543.

[26] Mylsamy, R. and S. Sankaranarayanan. 2016. A Preference-Based Protocol for Trust and Head Selection for Cluster-Based MANET. Wireless Personal Communications. 86(3): 1611-1627.

[27] M. Sanabani, R. Alsaqour and S. Kurkushi. 2014. A reverse and enhanced aodv routing protocol For Manets ARPN Journal of Engineering and Applied Science. 9(2): 153-159.