Comparative Study on Routing Protocol in Mobile Ad Hoc Networks using Soft Computing Techniques

Amarjit Singh[1*], Tripatdeep Singh[2]

[1]IKG Punjab Technical University, Jalandhar, Punjab, India
[2]Department of Computer Applications, GNIMT, Ludhiana, Punjab, India

[*]*Corresponding Author: amarjit.rhce@gmail.com, Tel.: +91-9779809181*

Abstract— Mobile Ad Hoc Network is able to communicate with different nodes. In this research paper we are mainly in view of the study of routing protocols in mobile ad hoc networks. As we know, still there are numbers of diverse metrics to work on. In the MANET, we are study basically a few numbers of metrics such as delay and energy-throughput in mobile ad hoc networks. According to this, further concise the study related these metrics. This research paper includes relative with different techniques and future work is also applicable.

Keywords—MANET, Artifical Neural Networks, Soft Computing Techniques, Networks, Routing Protocols

I.   INTRODUCTION

In this wireless technology, networks are no fixed federal station. Mobile ad hoc network consists of numbers of nodes. This can be represents in the phrase of node such as Node $_1$, Node $_2$ and so on. The network size depends upon their node value like Node $_N$. As we know that mobile ad hoc network which are able to connect the node connectivity. Also it is based on wireless with specific network node scope. Mobile ad hoc network is used into various sectors for communication purpose. In previously, it can be implemented in battlefield are for communicating between domestic bodies for passing the information. The Mobile Ad hoc networks are mainly deliberation about their working condition and passing the information precisely. This can be done through various aspects. These aspects are further classified into various categories. Categories are needed to implement and get the valuable results. But it mainly depends upon the sender and receiving capabilities.
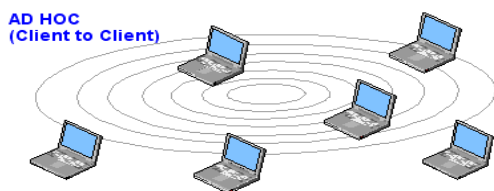

Figure 1.1 Ad Hoc Networks

In the above figure which represents the image the mobile ad hoc network with communicating with their neighbouring nodes [26].

Mobile ad hoc network (MANETs) communication is possible between the nodes and making the temporary communication [1]. It supports the both single and multi hop wireless communication which change dynamically. All the network nodes are randomly changes and communicating with each other. In Addition, it maintains their specific routes and sends the information between sending to receiving station. Node availability is one of the major points to route deciding on the time of giving information. Node can be present at the time of arrival of data packets. It could be helpful for disaster level or less communication areas like any rescue operations etc. So, it is helpful for communicating and sends the information according to their requirement.

Mobile Ad Hoc Networks can give data sharing with no base framework where the few nodes can consolidated and share their data and trade their information receiving and sending to it rapidly. Nodes can send or get their information bundles from their worry mobile host node. In the MANETs are commonly characterized into their sort of classifications: Proactive, Reactive and Hybrid [2].

Routing is central part of the mobile ad hoc networks. There are many routing protocol exists and able to communication according to their behaviours. As mentioned, there are types of routing protocol reactive, proactive and hybrid. These are further classified into various routing protocol.
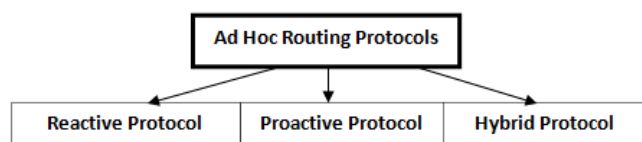
Figure 1.2 Ad Hoc Routing Protocols

In the mobile ad hoc network (MANETs) routing is the important factor for the communication. As mentioned in previous paragraph routing protocol consists of number of categories. Reactive, proactive and hybrid protocol under this there are numerous routing protocols such as DSR, AODV and TORA etc. These protocols are working according to their functionality and sending the information or data packets with the help of mobile ad hoc network. Each of this can able to providing the best service or path providing to their network nodes.

In this research paper, Section 1 contains the information about the basic meaning and working of mobile ad hoc network. Section 2 elaborates the various routing protocol information and their working. In the section 3 contains the information literature study about mobile ad hoc network. According to this, in section 4 contains various soft computing approaches which mobile ad hoc network further classified into various techniques. Section 5 contains the comparative analysis about delay and energy-throughput. At last section 6, it includes the conclusion part and future study of related work.

II.   AD HOC ROUTING PROTOCOLS

Routing protocol is mandatory when we transmitting the information to source to destination path. As previous section we studied that, we have three main base of routing protocol reactive, proactive and hybrid routing protocol in mobile ad hoc network. These main routing protocols are main responsibilities to sending the information.

2.1 **Table-Driven Routing Protocols**: - In this proactive routing protocol network topology maintain their routing table within stipulate time and managing their tables of routing information. According to routing table information all nodes perform functioning. There are various well known protocol exists in proactive routing protocol such as DSDV, OLSR, WRP etc.

A) **Destination Sequenced Distance Vector (DSDV) Routing Algorithm**: DSDV is the well known protocol in the proactive routing protocol. It is classical Bellman-Ford routing method [4]. In the working of DSDV it all well maintained advance routes their nodes. Each node is information is maintaining in the routing table. In the routing table information contains the information like as destination address, the number of hops and the

sequence number. DSDV mainly use two types of route packet. The first packet is full dump which is used to transmitted information. And the second packet is incremental packets which are mainly used to relay the information [5].

B) **Wireless Routing Protocol (WRP):** In this routing protocol nodes can know their neighbours from the receipt of acknowledgments. For example if node not sends a packet it must send the HELLO message within a specific time period to ensure the communication.

C) **Cluster Switch Gateway Routing (CSGR):** This protocol is a table driven routing protocol where every node is combined into clusters and cluster has a cluster head. This Cluster representation is in the form of hierarchy. Mainly cluster routing provides channel access, bandwidth allocation [6].

D) **Source Tree Adaptive Routing (STAR):** STAR is proactive routing protocol that is not requiring periodic routing updates. STAR is mainly maintaining the path information, using the network nodes path for checking the valid links.

2.2 **On Demand (Reactive Routing Protocol)**: In this category which are not maintain the network information. But they can only network path is required with the help of establishment of the connection. In this routing protocols do not able to exchange their routing information time to time. There are some protocols such as AODV, DSR and TORA in reactive routing protocol.

(A) **Ad-Hoc on-Demand Distance Vector (AODV) Routing**: In the AODV routing protocol which is upgraded of DSDV [7]. As the studied of AODV routing protocol, it minimize the routing information and it develop the demand based basis as compare to the other routing protocol. As we look into the DSDV case it occupied the complete list of information regarding the routes and their source to destination nodes. AODV get full advantage to perform the required information [8].

AODV Path Discovery
In AODV routing protocol is mainly sending the message with the help of source to destination end. But when it is trying to send the particular message even routing protocol do not aware of their working routes [9]. Now this protocol is ready to initiate the path discovery process. Now a small data packet send through sender to receiver end that packets called route request message (RREQ) which broadcasts the all concern neighbouring nodes in the specific network. Route Request Message (RREQ) delivers to all concern nodes and it remains the routing information.   This information related to broadcast identification number and sequenced number of particular node. As we know routing table contains such information and same information can

use for future reference of related nodes. According to these references information routes ensure their date packet reaching to their destination point. That process continues until route can get the confirmation about the same sequenced and broadcast id information with the help of routing information. As it maintained record for transmitting their data packets later on through their routing information table. This would be ensuring their active or working routes of their concern network nodes. There are three main nodes can help to send the data packets. First and foremost is source node, intermediate node which sending the information from source node and destination node which receive from the data packets from the intermediate nodes. In the above figure represents the basic working of AODV sending the RREQ through multiple paths in particular network. Initially it sends the RREQ data packets to their destination path.
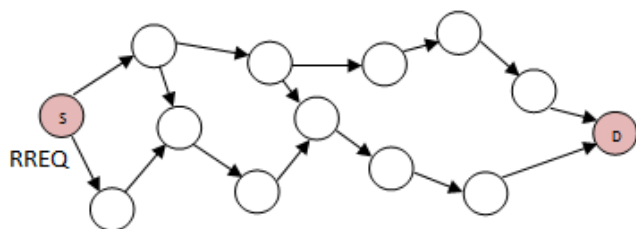

Figure 2.1: AODV Path Discovery sending the data packets from multiple routes

Now it select best routed path from the existing network and sends confirmation to their sender node. Again it sends the information from destination side to their sender node.
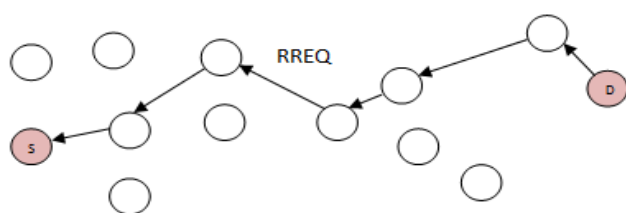

Figure 2.2: AODV Path Discovery confirmation of selective routes

AODV Route Maintenance

AODV also perform the route maintenance part in mobile ad hoc networks. In this process, AODV require node acknowledgment for shifting or move their network node path. In other words, any kind of node can change their network path. For instance, if intermediate nodes change or move it must sends the acknowledgement to neighboring nodes. The acknowledgment in the form of data packet called link notification packet.
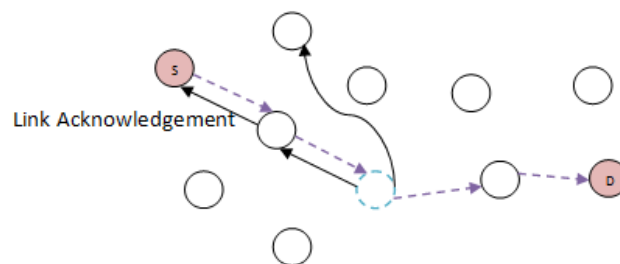

Figure 2.3: Intermediate node changes their path and sends the link notification to neighbouring nodes

B) **Dynamic Source Routing (DSR):** The Dynamic Source Routing is based on-demand routing protocol. In this technique sender propagates a packet. The involvement of sender, intermediate and destination nodes are applicable. Routing information contains the packets header. In the DSR, every node maintains the route record and stores their information. The working of DSR is quite little bit change as compare to the other protocol. First of all DSR maintain and store the sender cache for maintaining node records. For example if any nodes wants to send the information through data packet, it check their record first and then proceed accordingly. If record found in their cache it discards other process and sends the information to their destination point. Otherwise it broadcast the route request data packets to their neighboring nodes and awaits their confirmation. In this process DSR mainly using the route discovery and route maintain steps.
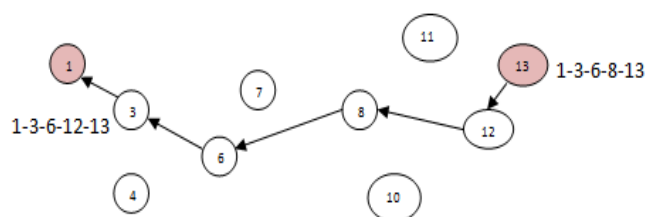

Figure 2.4: Represents propagate route reply using DSR Routing Protocol

D) **TORA (Temporally Ordered Routing Algorithm):** It is source initiated which provides multiple routes for the desire source and destination communication channels. The main functionalities of the TORA is to control messages to very small set of nodes which is topology dynamically change. [11] There are mainly works on three phases a) route creation b) route maintenance c) route erasure.

2.3 Hybrid Routing Protocol

A) **ZRP (Zone Routing Protocol):** This protocol with the combination of on demand and proactive routing protocol. The routing zone is just like clusters and their cluster heads within the specific zone table driven based

protocol is used which implies the routes updates which is performed in within the node. If the destination node outside the zone it will be implemented on demand routing based protocols [12].

III.   QOS (QUALITY OF SERVICE) IN MOBILE AD HOC NETWORKS

Mobile ad hoc network (MANETs) is mainly considerable in Quality of service (Qos). Better Quality of service providing is better service and reliable network. Network nodes can able to communication better as compare to less Qos based network. So, it is important factor to analysis the quality of service using mobile ad hoc routing protocol. In real time scenario, there are many metrics related to analysis in mobile ad hoc network. These metrics are such as bandwidth, delay, PDR, energy, node availability and so on. Node performance can calculated is based on their statistics information. The network node path depends upon their routing protocol behavior. Nowadays, it is analyzing various aspects of Quality of service (Qos) using reliable routing techniques. Source nodes and destination nodes varies the quality of service. But it is still important to use which type of routing protocol could be effective [3].

IV.   RELATED WORK

Kuppusamy et al [27] had presented the performance of the TORA routing protocol and also described the acyclic multipath algorithm which builds a alternative routes. Temporary-Ordered Routing Algorithm which also implemented the link-reversal algorithm. But one of the major drawbacks is to degrade their performance because of their additional routes setup.

Zafar et al [28] had presented the new Qos-aware routing scenario source: Q-SMS routing which can be specific admission control decision. In this Q-SMS there is nothing mentioned about routes breaks or loss their performance of the mobile ad hoc network.

Singh et al [29] proposed the paper about the prediction of end-to-end-delay in mobile ad hoc network. In this research paper author described using routing protocol such as AODV, DSDV, DSR which is based on GRNN and Radial Basis. It concludes the best result of network.

Surjeet et al [30] had presented a demand Qos routing protocol MQAODV for analysis of delay in mobile ad hoc networks. It is based on bandwidth constrained path delay on the basis of hop count. However, author did not mention any drawbacks about their networks.

Wang et al [31] had presented the alternative patch based protocol which data packets not delivered to their primary

routes. In this research paper is based on shortest path first algorithm for ad hoc networks.

Lee et al [32] had presented AODV Backup Routing protocol which can be implemented and improve the reliable packet delivery. This protocol configuration provides multiple routes. This can be utilized when packet is not delivered through their source route. In Addition, route discovery process also implemented when fails routes.

Charles E. Perkins et al [4] described the AODV based routing protocol which offer the better service environment for mobile ad hoc networks. Based on AODV feature it minimizes their low memory consumption and low network utilization.

Bagwari et al [33] had presented the Qos based Mobile Ad Hoc Network. It used AODV based protocol which reduced their network consumption and also extend the network coverage.

Chiyangwa et al [34] had presented the timing behavior of AODV. In this research paper mainly depend upon their lifetime of routes. Author concentrated on different parameter like NET DIAMETER.

S.K.Shah et al [35] had presented the AODV routing protocol based on Artificial Neural Network in order to send the hello interval. It mainly improves their overall performance of the mobile ad hoc network. Speed and transmission are considering getting the better result. Author concludes that ANN based AODV improve than the previous AODV.

Parimal et al [36] had presented the neural network based approach for MANET. Author also described the number of attempts using Hopfield Neural Network (HNNs). This is mainly cause to solve the problem related to their long routes. This study provides better solution for finding shortest path in the network.

Siddesh et al [37] described the routing using ad hoc network using the soft computing techniques such as neural network, fuzzy and genetic algorithm. In this research paper, author implemented the simulation using existing routing protocol with the help of hypernet simulator. In Addition, author concludes their future prediction about the ANN, Fuzzy and Genetic Algorithm would enhance the performance of the network in future.

G. IIanchezhiapandian et al [38] had presented the Qos based approach. In this research paper author proposed cross layer using AODV protocol. The Cross layer using SNR which select routing patch and provide high quality of service using minimum hop count. Author proposed the CLAODV routing protocol which improve the performance of MANET. In

Addition, CLAODV which is increase the performance by calculating delivery ratio, delay and packet as compared to the existing AODV protocol.

Jindal et al [39] had presented the soft computing approach i.e. fuzzy improved genetic approach for route optimization in MANET. Author used and implement the genetic approach to find out the shortest path first in the mobile ad hoc network. It also avoids the network congestion in the network. In Addition, author obtains the result from genetic approach and implement in fuzzy technique for better path optimization. It also improved energy efficient from genetic approach and get effect the overall performance of the MANET.

Abdullah A [40] et al had presented the "Performance Evaluation of AODV, DSR and DSDV Routing Protocol" by enhancing the performance of the networks. In this research paper comparative performance and get DSDV better performance as compare to AODV and DSR routing protocols.

S.Mohanpatra [41] et had presented the performance analysis AODV, DSR and DSDV routing protocol using NS2 Simulator". In this research paper author studied the performance of mentioned routing protocols and calculate e2e delay, PDR and throughput and DSR get better performance with other routing protocols.

V.   SOFT COMPUTING APPROACH

In soft computing mainly deals with three approaches to improve the quality of service and their optimization in mobile ad hoc network which discuss as follows:

2.1.1 Neural Network
The Artificial neural network is the biologic term which is capable for reasoning, decision and think making and also provide parallelism. It provides real time solution as compare to other techniques. Artificial neural network is power technique to solve unsolved issues. It inspired to the biological nervous system. The fuzzy and genetic algorithms are the additional flavours of artificial neural network technique.
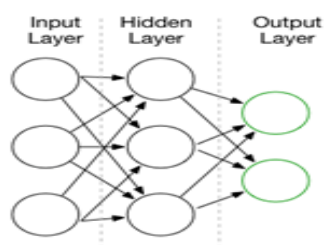

Figure 5.1: Understanding of Neural Networks

Types of Neural Network
There are basically two types of topological behaviour. Feed Forward and Feed Back. Both have their different properties and working conditions.

Feed Forward Topology
In the neural network this technique working in unidirectional. A small unit is sending the information to other concern unit which can't get any information updates. They are basically in generation, recognition and classification.
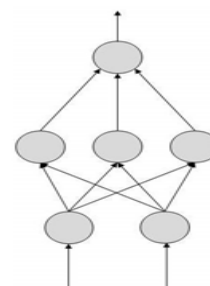

Figure 5.2: Feed Forward in Neural Networks

Feed Back Topology

In this topology can working their looping and get memorize their addressable information.
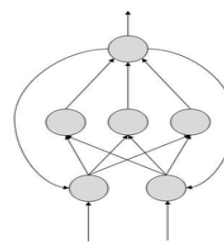

Figure 5.3: Feed Back in Neural Networks

Neural Networks is capable for learning. There are multiple learning techniques these are:

Supervised Learning
In the supervised learning can involvement of operation. For instance, trainer already knows each answer by taking test to their students. But it can be helpful for the implementation of pattern recognizing and etc.

Unsupervised Learning
In the unsupervised learning technique there is no way to get the predictions. It can further implemented in clustering technique where large amount of nodes grouping and implementing unknown pattern with compare with existing data   set   information.

VI. Comparison Analysis Using Soft Computing Approach

Authors Topic Covered	QOS Metrics	Base Protocol	Soft Computing Approach	Simulator Used	Feature Provided	Future Enhancement
Artificial Neural Network based reactive AODV routing protocol [13]	Packet Delivery	AODV	Neuro Fuzzy Based	Qualnet	Better packet delivery ratio	-
Genetic Algorithm for Energy-Efficient QoS Multicast Routing [14]	Delay, Energy	Multicast	Genetic Based	MS VC++	Less Delay and Minimum Energy	Yes
Delay Prediction in Mobile Ad Hoc Network using ANN [15]	Delay	AODV, DSDV, DSR	GRNN	MATLAB	Minimum Delay	Yes
A Multi-Objective QoS Optimization with Fuzzy Based [16]	End-to-end delay, Jitter, Packet loss rate, Blocking Probability	-	Fuzzy Based	-	High availability, Good load balancing	Yes
QoS Routing in Mobile Ad-hoc Networksusing Agents [17]	Less Error Rate Packet	DSR	Neuro-Fuzzy	C Tool	Agent based QoS routing	Yes
Proactive Reputation-Based Defense for MANETs Using Radial Basis Function Neural Networks [18]	Security	-	RBF-NN	-	Prevents from malicious nodes	Yes
Intelligence QoS management for multimedia service support in wireless mobile ad hoc network [19]	Delay	AODV	Fuzzy Based	NS2	Improved Traffic	-
Dynamic genetic algorithms for the dynamic load balanced cluster problem in mobile ad hoc network [20]	Load Balancing	DLBCP	Genetic Based	-	Better load balancing	Yes
Fuzzy Controllers Based Multipath Routing Algorithm in MANET [21]	Delay	AOMDV, AODVM	Fuzzy Based	NS2	Reduce reconstructions of ad hoc network	-
Energy aware and self-adaptive anomaly detection scheme based on network [22]	Security, Energy	-	Neural	NS2	Enhance Security and minimum consumption of energy	Yes
The Path Length Prediction of MANET using Moving Average model [23]	Path Length	AODV, DSR	-	NS2	Shortest path in ad hoc network	-
Fuzzy Improved Genetic Approach for Route Optimization in MANET [24]	Congestion	-	Fuzzy-improved Genetic	MATLAB	Shortest path in ad hoc network	Yes
Routing in Ad Hoc Wireless Networks using Soft Computing techniques and performance evaluation [25]	Delay	-	NEURO-FUZZY-GENETIC	Hyper Net	Minimum time	-

VII. CONCLUSION

In the Conclusion, research paper that these are the comparative study of various soft computing techniques with their individual metrics. We can now easily identify and work accordingly. In addition, a mobile ad hoc network is the vast area of internetworking and get enhance for future using by with the help of soft computing methods. These methods improve the lifetime of the network as well as increase their performance of the networks.

REFERENCES

[1]. Gurdeep Kaur, Vinay Bhatia, Dushyant Gupta "Comparative Study of the performance of existing protocols of MANET with simulation and justification of an improved Routing Protocol" *International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 6, Issue 6, June 2017.*

[2]. M. Marimuthuand A. Kannammal"A Survey on Fuzzy Based QoS Routing in Mobile Ad Hoc Networks", Proceedings of7th International Conference on Intelligent Systems and Control (ISCO 2013)

[3]. Yasser L. Morgan and Thomas Kunz "A Proposal for an Ad-Hoc Nenvork QoS Gateway "iEEE, 2005.

[4]. C. E. Perkins and E. M. Royer, "Ad-hoc on demand distance vector routing," in Proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications (WMCSA'99), New Orleans, LA, USA, February 1999, 1-11.

[5]. B.SOUJANYA,   T.SITAMAHALAKSHMI,CH.DIVAKAR —STUDY OF ROUTING PROTOCOLS IN MOBILE AD-HOC NETWORKS‖, B.Soujanya et al. / International Journal of Engineering Science and Technology (IJEST),ISSN :0975-5462 Vol. 3 No. 4 April 2011.

[6]. Anuj Joshi, Pallavi Srivastava and Poonam Singh, —Security Threats in Mobile Ad Hoc Network‖, S-JPSET : ISSN : 2229-7111, Vol. 1, Issue 2, samriddhi, 2010

[7]. T. Camp, J. Boleng, and V. Davies, "A survey of mobility models for ad hoc network research", Wireless Communications and Mobile Computing (WCMC): Special issue on Mobile Ad Hoc Networking: Research, Trends and Applications, 2002, 1-26.

[8]. C. E. Perkins and E. M. Royer, "Ad-hoc on demand distance vector routing", Proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications (WMCSA'99), 2(9), 1999, 727-732.

[9]. C. Perkins and P. Bhagwat, "Highly dynamic destination-sequenced distance-vector routing (DSDV) for mobile computers", Proceedings of the ACM SIGCOMM'94-Conference on Communications Architectures, Protocols and Applications, 1999, 234-244.

[10]. C. E. Perkins and E. M. Royer, "Ad-hoc on demand distance vector routing", Proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications (WMCSA'99), 2(9), 1999, 727-732.

[11]. G.V.S Raju, G. Hernandes. and Q. Zou,—Quality of Service Routing in Ad Hoc Networks‖ Proceedings of the IEEE Wireless Communications and Networking Conference , Vol. 1, pp. 263 – 265, 2000

[12]. C.P.P. Bhagwat, —Highly Dynamic Destination-Sequenced Distance Vector Routing for Mobile Computers,‖ in proceedings of ACM SIGCOMM' 94, pp. 234-244, September 1994.

[13]. Satish k Shah and MsDharmistha D Vishwakarma "Development and Simulation of ANN based decision on parametric values for performance optimization of reactive routing protocol for MANET using Qualnet", IEEE, 2010.

[14]. Ting Lu and Jie Zhu "Genetic Algorithm for Energy Efficient QoS Multicast Routing", IEEE, Vol 17, 2013

[15]. Jyoti Prakash Singh at el "Delay Prediction in Mobile Ad Hoc Network using Artificial Neural Network", Elsevier, 2012

[16]. SatyanandaChampatiRai, BijanBihariMisra, Ajit Kumar Nayak, Rajib Mall, Sateesh Kumar Pradhan: A Multi-Objective QoS Optimization with Fuzzy Based Parameter Setting for Real-Time Multicasting, Int. J. Communications, Network and System Sciences, 2010, 3, 530-539

[17]. V.M. Harnal and V.R. Budyal "QoS Routing in MANETUsing agents", International Journal of Smart Sensors and Ad Hoc Networks (IJSSAN) ISSN No. 2248□9738 Volume□1, Issue□3, 2012

[18]. Eyosias Y. Imana et al" Proactive Reputation-Based Defense for MANETs Using Radial Basis Function Neural Networks, IEEE, 2010

[19]. LyesKhoukhi et al "Intelligence QoS management for multimedia service support in wireless mobile ad hoc network", Elsevier, 2010

[20]. Hui Cheng et al "Dynamic genetic algorithms for the dynamic load balanced cluster problem in mobile ad hoc network", Elsevier, 2012

[21]. 21. Shangchao et al "Fuzzy Controllers Based Multipath Routing Algorithm in MANET", Elsevier, 2011.

[22]. Wei Wang et al "Energy aware and self-adaptive anomaly detection scheme based on network", Elsevier, 2012.

[23]. Arindrajit Pal et al "The Path Length Prediction of MANET using Moving Average model", Elsevier, 2013.

[24]. Jaspal Jindal et al "Fuzzy Improved Genetic Approach for Route Optimization in MANET", International Journal of Advanced Research in Computer Science and Software Engineering 2013.

[25]. Siddesh.G.K, K.N.Muralidharaet al "Routing in Ad Hoc Wireless Networks using Soft Computing techniques and performance evaluation using Hypernet simulator", International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-1, Issue-3, July 2011.

[26]. Web Link www.pcmag.com/encyclopedia/term/47135/mobile-ad-hoc-network

[27]. P. Kuppusamy and K. Thirunavukkarasu, "A Study and Comparison of OLSR, AODV and TORA Routing Protocols in Ad Hoc Networks", *Proceedings of the IEEE 3rd International Conference on Electronics Computer Technolog*y, Kanyakumari, pp. 143–147, India, 2011

[28]. H. Zafar *et al*., "QoS-aware Multipath Routing Scheme for Mobile Ad Hoc Networks", *International Journal of Communication Networks and Information Security*, vol. 4, 2012, pp. 1–10.

[29]. J. P. Singh, *et al*. , "Delay Prediction in Mobile Ad Hoc Network Using Artificial Neural Network", *Procedia Technology*, vol. 4, 2012, pp. 201–206, 2012.

[30]. B. Surjeet *et al*., "QoS Bandwidth Estimation Scheme for Delay Sensitive Applications in MANETs", *Journal of Communications and Network, Scientific Research*, vol. 5, pp. 1–8, 2013.

[31]. J. Wang *et al*., "QoS routing with mobility prediction in MANET", *Proceedings of the IEEE Pacific Rim Conference on Computers and Signal Processing*, Victoria, BC, Canada, pp. 357–360, 2001.

[32]. S. Lee and M. Gerla, "AODV-BR: Backup Routing in Ad hoc Networks", Wireless adaptive mobility laboratory, Computer Science Department, University of California, pp. 1311–1316, 2000

[33]. Ashish Bagwari et.al , " Performance of AODV Routing Protocol with increasing the MANET Nodes and its Effects on QoS of

Mobile Ad Hoc Networks", International Conference on Communication Systems and Network Technologies, pages 320-324, IEEE, May 2012.

[34]. Sibusisiwe Chiyangwa and Marta Kwiatkowska, "A Timing Analysis of AODV" Proceedings of international conference on Formal Methods for Open Object-Based Distributed Systems, Springer, Volume 3535, pp 306-321, 2005.

[35]. S.K. Shah and Vishwakarma D.D ," Development and Simulation of Artificial Neural Network Based Decision on Parametric Values for Performance Optimization of Reactive Routing Protocol for MANET Using Qualnet ", International Conference on Computational Intelligence and Communication Networks (CICN), IEEE, pages 167-171, November 2010.

[36]. Parimal Kumar Giri, Member,IACSIT,2012.A Survey on Soft Computing Techniques forMulti-Constrained QoS Routing in MANETIJCIT, ISSN 2078-5828 (PRINT), ISSN 2218-5224 (ONLINE), VOLUME 03, ISSUE 02, MANUSCRIPT CODE: 130103

[37]. Siddesh.G.K,K.N.Muralidhara,Manjula.N.Harihar,2011. Routing in Ad Hoc Wireless Networks using Soft Computing techniques and performance evaluation using Hypernet simulator International Journal of Soft Computing and Engineering (IJSCE)ISSN: 2231-2307, Volume-1, Issue-3, July 2011.

[38]. G. Ilanchezhiapandian Research Scholar Sathyabama University P. Sheik Abdul Khader Professor and Head, Dept of CA B.S.A University, 2013. Quality of Service (QoS) Routing in Mobile Ad-hoc Network (MANET) using AODV protocol: Cross-Layer Approach International Journal of Computer Applications (0975 – 8887) 2nd National Conference on Future Computing February 2013.

[39]. Jaspal Jindal Vishal Gupta Associate Professor in ECE Deptt. M.Tech(ECE) Student P.I.E.T College Smalkha(Panipat) P.I.E.T College Smalkha(Panipat) ,2013. International Journal of Advanced Research in Computer Science and Software Engineering Volume 3, Issue 6, June 2013 ISSN: 2277 128X,June 2013.

[40]. Abdullah A. Al-Khatib, "Performance Evaluation of AODV, DSDV and DSR Routing Protocols in MANET Using NS-2 Simulator" Springer International Publishing AG 2018.

[41]. S Mohanpatra, "Performance Analysis of AODV, DSR and OLSR and DSDV Routing Protocols using NS2 Simulator", International Conference on Communication Technology and System Design 2011.