Computational Intelligence Based Efficient Routing in MANET: A Review

[1]Mr. Nareshkumar R. Mustary, [2]Dr. Phanikumar. S
[1]Research Scholar, [2]Professor & HOD of Computer, [1,2]GITAM University, Hyderabad, India.
[1]*nareshkumarmustary@gmail.com*, [2]*phanikumar.s@gmail.com*

Abstract: Routing plays a vital role in varied forms of networks. There are two main types to route the packets i.e., unicast and multicast. The unicast routing problem is to find the shortest path between two nodes in the network and multicast routing problem is to determine optimal tree spanning the source and all the destinations.in recent years both the shortest path routing and multicast routing have been well addressed using intelligent optimization techniques. With the advancement in wireless communication more and more mobile wireless network appear e.g., Mobile ad-hoc Network(MANETs).The significant features in MANETs is the topology dynamics that is the network topology changes over time due to energy preservation or node mobility. Therefore both routing problem turn out to be dynamic optimization problem in MANETs. It is essential for designed solution is to quickly adapt to environmental (i.e. the network topology changes) changes and produce high quality solution after each change as soon as possible.

Keywords: ACO, DOP, DTN, EC, MANETs, PDR, QoS, Swarm Intelligence.

I. INTRODUCTION

A Mobile adhoc network (MANETs) is a rising type of wireless networking. It is a collection of communication nodes that wish to communicate with each other but has no fixed infrastructure and no predetermined topology of wireless links. Each node in network is free to move independently in any direction and will therefore change its links to other devices frequently [1]. Individual nodes are responsible for dynamically discovering other nodes that not all other nodes can directly communicate with. Due to the limitation of signal transmission range in each node, they can directly communicate with one another. Each node must forward traffic unrelated to its own use, and therefore be a router. The main challenge to build a MANET is equip each device to continuously maintain the information required to correctly route traffic. Therefore nodes are required to spread packets on behalf of other nodes in order to deliver data across the network.

The primary operation of networks is relaying information, which completely depends on routing.

Routing in MANETs is very complex due to multiple constraints imposed by the nature of MANETs such as mobility, partial battery life, and common interference of nearby nodes, along with other constraints.

Figure.1 shows a mobile ad hoc network with nodes,

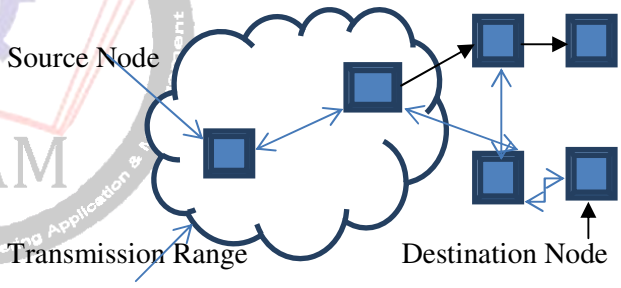

Fig. 1 Mobile Ad-hoc Network

In an above figure, each node indicates mobile nodes representing as Source node, Destination node and Transmission node. N nodes are mobiles in MANETs and changes their locations rapidly so discovery a delivery path to a destination is a challenging task as shown in Fig.1.On the other hand some unique features of such network like frequent changes in topology, mobility patterns, varying density over time and unstable communication conditions cause many unique research challenges for routing protocols being used in MANETs. Apart from these, the speed and size of the network decreases the performance of routing protocols and cause new challenges in front of researchers to design an proficient routing algorithm for MANETs environment [2-3]. However, a number of unique

approaches have been proposed by many researchers in few years ago to defeat the routing issues of MANETs but still not a single routing approach is designed to perform efficient in routing the packets of ad-hoc networks. Each planned solution has its unique merits in constrained networking environments, but mobile nodes should be able to operate in every background that cause challenge to researchers in terms to design an efficient routing algorithm [4-6]. This paper surveys the routing issues of accessible routing protocol in environment of MANETs and details about optimized routing solution which enhance the routing recital in challenging environment of MANETs.

Ad hoc networks are suitable for use in situation where infrastructure is either not available or not trusted, such as a communication network for military soldiers, a mobile network of laptops in a conference setting, wireless sensor networks for biological research. Even its application for mobile social networks such as Facebook, MySpace and Twitter, and mobile mesh networks for Wi-Fi devices [1].

Some intelligent optimization techniques in literature which provides quick solution after each topology changes are,

A. Unicast refers source to all the destinations with a guaranteed QoS.

A Unicast QoS routing involves finding a minimum cost path from a source to a destination node satisfying a set of constraints usually given as upper bounds that the path must respect.[7-8].

B. Evolutionary Computation (EC)

A Evolutionary optimization in dynamic environments has attracted a lot of research effort during the last ten years and has become one of the most dynamic research area in the field of evolutionary computation [9]. Solving dynamic optimization problems (DOPs) is very challenging since it requires an intelligent optimization algorithm to not only locate an optimal solutions of a given problem but also track the changing optimal solutions over time when the problem changes. Evolutionary computation and swarm intelligence are superior gear to address DOPs due to their motivation from natural self structured systems and biological growth which have always focus to changing environments.

Although basic from a biologist's viewpoint, these algorithms are adequately complex to give robust and powerful adaptive search mechanisms. Fig.2 outlines a typical evolutionary algorithm (EA). A population of individual structures is initialized and then evolves from generation to generation by constant applications of assessment, assortment, recombination, and transformation. The population size N is generally constant in an evolutionary algorithm, although there is no a prior reason (other than convenience) to make this hypothesis.

```
procedure EA; {
t = 0;
initialize population P(t);
evaluate P(t);
until (done) {
        t = t + 1;
        Parent selection P(t);
        recombine P(t);
        mutate P(t);
        evaluate P(t);
        survive P(t);
        } }
```

Fig.2: A typical evolutionary algorithm

C. Particle Swarm Optimization

It is similar as EC techniques in that a population of potential solutions to the problem under consideration is used to probe the search space. Whereas in PSO, each of the population has an adaptable velocity (i.e. position change) according to that it moves in the search space. Each individual has a memory, remembering the best position of the search space it has continually visited. Thus its movement is an aggregated quickening towards its best before visit position and towards the best individual of a topological neighbourhood [9-11].

II. BACKGROUND WORK

In this paper, we give a procedural literature review of Intelligent Optimization Techniques that are applied to the routing in MANETs. In order to have clear, complete and broader prospective many sources have been explored. The objective of carrying literature review is to gain deeper understanding of mitigation techniques that exists in literature and to find gap in the study.

The search term was "Intelligent Optimization Techniques". The search was filtered to include the research papers and conferences. This was done to limit the scope of research to the present trends.

Eseosa Osagie, Parimala Thulasiramanand Ruppa K. Thulasiram [12]. Intended on Ant Colony Optimization (ACO) enthused by real ants. The performance of the

routing algorithm is examined through simulation and is compared to an current popular MANET routing protocol, Ad hoc On Demand Distance Vector (AODV). Several performance measures are considered in various scenarios with varying mobility levels and traffic load. But when it comes towards dynamic optimization the topology of the network get changes as there changes in the node.

Jianping Wang, Eseosa Osagie [13], proposed Swarm intelligence is a computational intelligence technique that includes collective behaviour of self-driven agents that locally communicate among them in a distributed environment to solve a provided problem in the hope of finding a global solution to the problem. In this, we recommend a hybrid routing algorithm based on ACO for MANETs and region routing structure of border casting. The algorithm, HOPNET, founded on ants hopping from one region to next, consists of the local proactive route discovery within a node's vicinity and reactive communication among the vicinity. However, the results using the random drunken model show that border casing is not always efficient.

M. Belkadi, M. Lalam[14], In this paper , they have combined a various flow control mechanisms with the QoS routing protocol.The proposed new QoS (Quality of Service) routing protocol pooled with the flow control mechanism. This routing protocol chooses the route saving more resources in an intelligent manner and does not rely on diffusion. This routing protocol uses a new metric to find the route with greater transmission rate, less latency and better firmness. The solution of this proposed system improves the network performance with greater bandwidth, less delay and better stability by finding the better route. The added mechanisms of flow control parameter adjustments for each node which further enhances the network performance but still this system has drawback in case of non-cooperative environment, where some nodes are selfishly refusing to forward packets to other nodes.

Ashima, Srinivas and Debojyoti[15].They introduced a new ant based routing protocol to improve the route discovery and increase the efficiency of routing in terms of Packet Delivery Ratio (PDR) using the blocking expanding ring search and n-hop local ring techniques. Also the proposed routing protocol improves the efficiency and controls the overhead with optimal path and the efficiency of proposed routing protocol is better than AODV. It enables the optimal path routing and fast route discovery with packet delivery ratio and end-to-end delay but still it has a routing problem when it turn out to be dynamic optimization problem in MANET's.

Sathish, Thangavel and Vaidehi [16]. In this paper proposed a cache based ant colony routing for mobile adhoc networks for building highly adaptive and on-demand routing algorithm initiated by source. The proposed system provides the method for handling loss of ants and avoids retransmission of lost packets by reserving resources at nodes, which in turn enhances the performance. The proposed system fails when network topology changes dynamically.

Orhan, Abdullah and Alice [17]. In this paper, proposed new model to conceptualize an autonomous topology optimization for mobile adhoc networks using multiple mobile agents. The representation of wireless adhoc network communications as network flows and optimization using a maximum flow model is very responsive to small changes in topology when evaluating network connectivity and performance but has a big challenge in dynamic nature of the problem.

Jeroen Hoebeke, Ingrid Moerman and Piet Demeester [18], designed adaptive multi-mode routing framework that has several compatible modes of operation. Based on this framework, an adaptive protocol has been implemented with the original feature that individual nodes can adapt their mode of operation at any moment, while an overall uniform state of the routing tables is maintained. However, this is definitely not straightforward, even for existing ad hoc protocols. Also, this it has focused on the mode switching capabilities and its potential and has only gave procedure for advanced monitoring and alternative applications of the protocol have been provided.

Barreiras, Munaretto, Delgado and Viana [19], DTN's suffer connectivity loss, variable delays and large resource consumption when sending a message between the source and destination nodes. The problem of message forwarding in DTN's can thus be modelled like multimodal optimization problems as we try to find not just one solution but a set of solutions routing in DTN's as a combinatorial problem. Hence, proposed a hybrid protocol called Cultural Greedy Ant. The cultural greedy ant chooses each next node toward the message destination based on global information whenever it is available. The performance of cultural greedy ant achieves a higher delivery ratio and lower byte redundancy then epidemic and prophet. But this system fails when it extract information online from dynamic conditions can be explored in many different situations from almost static to completely mobile and disconnected network environments.

Suman Banik, Bibhash Roy, Parthi Dey, Nabendu Chaki[20], presented QoS routing may suffer badly due to different aspects which include radio interference on available bandwidth, and inefficient flooding of information

to the neighbouring nodes. As a result the performance of the network decreases substantially. Hence they proposed for energy efficient QoS routing by proper utilization of network resources such as energy and bandwidth. MANET nodes operating on battery try to follow the energy efficiency heuristically by decreasing the energy them consumed. As a solution prediction mechanism and smart prediction mechanism are used. This performs better than OLSR protocol and reduces the traffic load, of course 100% accurate state information cannot be calculated due to continuously changing topology. However accuracy can be increased by using some other techniques.

D. Karthikeyan, M. Dharmalingam [21], proposed a energy efficient routing algorithm for MANETs based on ACO for reducing energy consumption of the nodes. The proposed ABIRP algorithm improves the energy efficiency, robustness and reliability. The efficiency of proposed routing protocol is better than AODV routing protocol. It uses optimal path routing and fast route discovery which provides reliable, shorter and faster communication. But shortest path (SP) problem in MANETs is a dynamic problem because of the non-deterministic MANETs environment and the continuously changing topology.

Amin, Haitham S. Hamza, Imane A. Saroit [22], proposed modified Harmony Search (HS) algorithm to find a best possible solution to the dynamic SP problem in MANETs. Solving shortest path problem in a dynamic environment is more challenging since it requires the optimization techniques not only to find the optimal solution but also to track the changing optimal solution that in stationary environments.

Mirco Musolesi, Stephen Hailes, Cecilia Mascolo [23],proposed Asynchronous communication such as email which is by far the finest form of networked person-to-person communication, has a normal fit to such moderately connected environments, but has been relatively little explored in the context of mobile ad-hoc networking. Hence proposed Context-Aware Routing (CAR) algorithm (CAR) is a novel approach to the provision of asynchronous communication in moderately connected mobile ad hoc networks, based on the intelligent placement of messages. CAR performs notification in terms of message delivery to the sender with low overhead. Hence this system requires standard mechanism which minimises the message delivery replication and overhead. Also acknowledgement mechanism in order to notify the sender about the correct delivery of messages.

R.Singh, P.Singh and M.Duhan [24], proposed & Implemented the security based algorithmic approach in the mobile ad-hoc networks. The mobile network begin after the invention of wifi they are mostly used for connecting among themselves and for connecting to the internet via any fixed infrastructure. Vehicle like car, buses and trains equipped with router acts as nested mobile ad-hoc network. These advances in MANET helps the vehicle to communicate with each other at the time of emergency like accident or during climatic changes like snow fall and road block, this information will be informed to the nearby vehicle. But this scheme suffers when system has less bandwidth, which leads to network connectivity lost.

B.Nancharaiah and B.Chandra Mohan[25], the main challenge of MANET's is finding routes between the source and the destination which leads to many routing protocols. It proposes that a modified ant colony algorithm performs better compared to existing algorithms and cooperative Opportunistic Routing in Mobile Adhoc Networks in terms of route acquisition time and total cache replies. The AODV is optimized to find routes based in cost and delay. The cost is considered at the number of hops between the source and the destination, as well as energy of nodes. Each ants finds the next hop according to the constraints of delay and cost and finds the shortest route. But this protocol suffers with lack of security as well with higher overhead in terms resources and bandwidth.

Abbas, Mustafa Ilkan and Emre Ozen[26], projected fuzzy-based approach to enhance the adhoc on-demand distance vector (AODV) reactive routing protocols performance by choosing the most trusted nodes to build the route between the source and destination nodes. Fuzzy logic appears to be an efficient approach for constructing robust routes and avoiding some simple single metric routing protocols such as the traditional AODV reactive routing protocol. This concept performs better than the conventional AODV routing protocol and least battery cost routing protocol in terms of average control overhead, packet deliverance ratio, network throughput, and average end-to-end delay. But this system fails in optimal selection in dynamic topology. Hence more factors and metrics may be considered in the fuzzy inference engine to enhance the route selection decision making.

Prabha R. and Ramaraj N[27], proposed an Ad hoc On-demand Multi-path Distance Vector(AOMDV) based on link availability, node mobility and bit error rate because current adhoc on demand vector routing algorithms start route discovery after path break, provide high cost to detect the disconnection and to establish a new route. The solution of AOMDV routing protocol was increased when compared to AODV with high end-to-end delay. Hence this requires some mechanisms to reduce the end-to-end delay in AOMDV routing protocol.

Ritu Parasher and Yogesh Rathi[28], proposed Advanced AODV protocol (A_AODV), for to increase the performance of Network in MANETs routing protocol. It is advanced version of traditional Ad-hoc on demand distance vector routing protocol for enhancing existing protocol in addition to reducing the flooding, overhead effects and minimizing the rate of link breakages. This approach reduces the number of hops dynamically by continuously monitoring active routing paths and redirecting the path whenever a shortcut path is available. This system fails to reduce the hop overhead in dynamic optimization problem. Hence it needed efficient optimization technique which can reduce the overhead effects and end-to-end delay.

Jipeng Zhou,Haisheng Tan and Yuhui Deng[29], in this paper presented, in order to extend the network lifetime, how to select the finest route is a critical issue for routing protocols in MANETs. Hence they proposed ant colony based energy control routing protocol to find an optimal route by using the feedback character of ACO. In ACEC routing protocol, the routing choice depends on not only the number of hops between nodes and the nodes energy but also the average and the minimum energy of the routes. This protocol provides better performance and efficiency with static network topology for energy paths and extending network lifetime but fails to prove in dynamic topology because there nodes will change their positions dynamically. Thus it is difficult to provide balance energy and end-to-end communication to all the nodes.

Ratul Dey and Himadri Nath Saha[30], we had been observed that the protocols do not adequately mitigate attacks by misbehaving nodes which not only modify packets but also selectively drop some of the packets. These misbehaving nodes cause various network communication problems. Hence it proposed secure routing protocols for MANET alternative design towards more efficient. For the secure routing protocol first need digital signature of each and every authenticated nodes and also need mutable information to control packets. These routing schemes provide authentication services which acing as guard against modification and replying of routing protocol messages for providing secure routing. If network fails than this system will fail to provide secure routing.

P.Madhavan and Dr.P.Malathi[31], due to mobility in nature, routing information need to be updated frequently. As nodes are wireless in nature there exists security threats that disturb the deployment and maintenance of MANET. To achieve this problem secure agent based multicast routing protocol for wireless network is proposed which is an extension of existing AQMRA. The proposed Secure-AQMRA performs better in terms of end to end delay, overhead effects and packet delivery ratio. This scheme suffers due to dynamic nature of mobile nodes and restricted resources and providing desired quality of service is a challenging task.

III. CONCLUSION

The systematic literature review has been carried out in an order to find techniques that were proposed for using Intelligent Optimization Techniques in MANETs like Optimized Ant Colony, Modified Ant Colony Optimization, Swarm Intelligence Based Routing Protocol, Particle Swarm Optimization, Security Based Routing Protocol etc., for to improve the performance, Network Connectivity, enhancing MANET routing in AODV and explore good route and new path among set of nodes. There are various techniques that exist in literature but have limitations and requirements. Therefore, Intensive research and study was done in the field to study and get in depth knowledge about the Computational Intelligence Based Efficient Routing Protocol in MANET.

ACKNOWLEDGMENT

It gives me an immense pleasure and satisfaction in submitting this paper. In this endeavour of preparing this paper many people gave a helping hand, I would thank them all. I heartily pay gratitude to my guide Dr. S. Phanikumar and Dr. I. I. Subba Reddy, Coordinator of Academic Research who gave me this opportunity to work upon this topic.

REFERENCES

[1] Prof. Xin Wang &Fenglien Lee."***Routing in Mobile Ad hoc Networks, Mobile Ad-Hoc Networks: Protocol Design***",2011.ISBN:978-953-307-402-3, InTech, Available from: http://www.intechopen.com/books/mobile-adhoc-networks-protocol-design/routing-in-mobile-ad-hoc-networks.

[2] Eman S. Alwadiyeh, Ala' F A Aburumman, **" *Interference-Aware Multipath Routing Protocols For Mobile Ad Hoc Networks*"** 13th Annual IEEE Workshop on Wireless Local Networks, 2013.

[3] MENG Limin, SONG Wenbo, ***"Routing Protocol Based on Grover's Searching Algorithm for Mobile Ad-hoc Networks"*** Network Technology And Application, China Communications • March 2013.

[4] B. Ramakrishnan, Dr. R. S. Rajesh, R. S. Shaji, ***"CBVANET: A Cluster Based Vehicular Adhoc Network Model for Simple Highway Communication"*** Int. J. Advanced Networking and Applications Volume: 02, Issue: 04, Pages: 755-761 (2011).

[5] Mohammad Al-Rabayah and Robert Malaney ***"A New Scalable Hybrid Routing Protocol for VANETs"*** IEEE Transactions on Vehicular Technology, Vol. 61, No. 6, July 2012.

[6] Pratap Kumar Sahu, Eric Hsiao-Kuang Wu ***"BAHG: Back-Bone-Assisted Hop Greedy Routing for VANET's City Environments"*** IEEE Transactions on Intelligent Transportation Systems, Vol. 14, No. 1, March 2013.

[7] C.Taddia, A.Giovanardi, G.Mazzini, M.Zorzi, ***"Energy efficient unicast routing protocols over 802.11b"***; Proc. in IEEE Global Telecommunications Conf., (GLOBECOM'05), Nov. 2005.

[8] Senthilnathan Palaniappan, Kalaiarasan Chellan, ***"Energy Efficient stable routing using QoS monitoring agents in MANET"***,Licenced Springer, Journal on Wireless Communication and Networking(2015) 2015:13DOI 10.1186/s13638-014-0234-9.

[9] Trung Thanh Nguyen, Shengxiang Yang, and Juergen Branke, ***"Evolutionary dynamic optimization: A survey of the state of the art,"*** Swarm and Evolutionary Computation, vol. 6, no. 0, pp. 1-24, 2012. [Online].

[10] S. P. Manikandan and R. Manimegalai, ***"OTSIR:An Optimal Trust Based Swarm Intelligent Routing in Manet",*** Asian Journal of Information Technology 15(11):1739-1745,2016.

[11] Mehtab Alam, Asif Hameed Khan and Ihtiram Raza Khan, ***"Swarm Intelligence in MANETs:A Survey",*** International Journal of Emerging Research in Management & Technology,Volume:5,Issue:5,ISSN:2278-9359,Page No.141-150.

[12] Eseosa Osagie, Parimala Thulasiraman∗and Ruppa K. Thulasiram,***"PACONET: imProved Ant Colony Optimization routing algorithm for mobile ad hoc NETworks"***, 22nd International Conference on Advanced Information Networking and Applications, 1550-445X/08 © 2008 IEEE DOI 10.1109/AINA.2008.77.

[13] Jianping Wang, Eseosa Osagie,***"HOPNET: A hybrid ant colony optimization routing algorithm for mobile ad hoc network"***,Ad Hoc Networks Conference 7 (2009) 690–705.

[14] M. Belkadi and M. Lalam, ***"Intelligent Routing and Flow Control in MANETs"***, Journal of Computing and Information Technology - CIT 18, 2010, 3, 233–243 doi:10.2498/cit.1001470.

[15] Rout, Ashima, Srinivas Sethi and Debhajyoti Mishra, ***"Optimized Ant Based Routing Based Protocol for MANET"***. Proceedings of the 2011 International Conference on Communication, Computing and Security-ICCCS(2011).

[16] S.Satish, KThangavel and V.Vaidehi, ***"Cache based ant colony routing algorithm for mobile adhob networks"***. Proceedings of the 1st International Conference on Wireless Technologies for Humaniatorian Relief-ACWR-2011.

[17] O.Dengiz, A,Konak and A.Smith, "***Connectivity management in mobile adhoc networks using particle swarm optimization***". Adhoc Networks, Vol.9, No.7,PP.1312-1326,2011.

[18] Jeroen Hoebeke, Ingrid Moerman and Piet Demeester,***"Adaptive routing for mobile ad hoc networks"***, Hoebeke et al. licensee Springer,EURASIP Journal on Wireless Communications and Networking 2012, 2012:126 http://jwcn.eurasipjournals.com/content/2012/1/126.

[19] A.Vendramin, A. Munaretto, M.Delgado and A.Viana, ***"Cultural GreedyAnt in Mobile Adhoc Network"***, proceedings of the 14th International Conference on Generic and Evolutionary Computational Conference Optimization-GECCO'12, 2012.

[20] Suman Banik, Bibhash Roy, Parthi Dey, Nabendu Chaki, ***"QoS Routing using OLSR with Optimization for Flooding",***2013**.**

[21] D. Karthikeyan, M. Dharmalingam ,***"Ant based Intelligent Routing Protocol for MANET",*** Proceedings of the 2013 International Conference on Pattern Recognition, Informatics and Mobile Engineering (PRIME) February 21-22.

[22] Amin, Haitham S. Hamza, Imane A. Saroit, ***"HARMONY SEARCH BASED ALGORITHM FOR DYNAMIC SHORTEST PATH PROBLEM IN MOBILE AD HOC NETWORKS"***, ISBN: 978-0-9891305-0-9 ©2013 SDIWC.

[23] Mirco Musolesi, Stephen Hailes, Cecilia Mascolo, ***"Adaptive Routing for Intermittently Connected Mobile Ad Hoc Networks"***, 2014.

[24] R.Singh, P.Singh and M.Duhan, ***"An effective implementation of security based algorithmic approach in mobile adhoc networks"***, Human Centric Computing & Information Sciences, Vol.4, No. 1, 2014.

[25] B.Nancharaiah and B.Chandra Mohan, ***"Modified Ant Colony Optimization to enhance MANET routing in Adhoc on Demand Distance Vector"***, 2nd International Conference on Business and Information Management (ICBIM)-2014.

[26] Nihad I.Abbas, Mustafa Ilkan and Emre Ozen,***"Fuzzy approach to improving route stability of the AODV routing protocol"***,Springer,Journal on Wireless Communications and Networking (2015) 2015:235 DOI 10.1186/s13638-015-0464-5.

[27] Prabha R. and Ramaraj N, "***An improved multipath MANET routing using link estimation & swarm intelligence"***, Springer,Journal on Wireless Communication & Networking (2015) 2015:173.

[28] Ritu Parasher and Yogesh Rathi, ***"A_AODV:A Modern Routing Algorithm for Mobile Adhoc Network"***, IRJET,Volume:02,Issue:01,April-2015.

[29] Jipeng Zhou,Haisheng Tan and Yuhui Deng, ***"Ant Colony based energy control routing protocol for mobile adhoc networks***

***under different node mobility models*"**,Springer, Journal on Wireless Communication & Networking (2016) 2016:105.

[30]Ratul Dey and Himadri Nath Saha, **"*Secure Routing Protocols for Mobile Ad-Hoc Network (MANETs) –A Review*"**,IJETTCS, Volume 5, Issue 1, January - February 2016.

[31] P. Madhavan and Dr.P.Malathi, **"*Intelligent Framework for Qos Optimization In Manet Using Soft Computing Models*"**, International Journal of Advanced Engineering TechnologyE-ISSN0976-3945.2015.

