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A Cluster Based Differential Zone Partitioning Approach for Delay Reduction in MANET

***K.S.Riya **Dr.T.Kesavamurthy.**

[1] Department of ECE PSG College of Technology
Coimbatore, India
*[e-mail: * riya.april10@gmail.com, ** tkm71in@yahoo.co.in]*
**Corresponding author: K S Riya*

Abstract
Routing in Mobile Ad-Hoc networks (MANETs) is a key process which directly impacts the performance of the network. Before packet transmission, the source broadcasts RREQ message in the network and the relay nodes rebroadcast the RREQ packet till it found the route to the destination. This mechanism has direct effect on end to end delay. Thus in this paper cluster based differential zone partitioning algorithm has been proposed to achieve a minimum average end-to end delay in MANET. The algorithm discovers a shortest path for packet routing using one tail agent and two temporary agents. Here the agents are also involved in identifying the path to the destination instead of using only the source node. The simulation results are compared with the existing protocol and the performance of the algorithm has been measured in terms of end-to-end delay, localization error, accuracy and packet delivery ratio. The results show that the proposed approach achieves a better performance than the existing approaches.

Keywords: Zone partitioning, MANET, Delay, Routing, tail agent

1. Introduction

MANET is an autonomous collection of mobile nodes, which does not require a centralized infrastructure (Saad M. Adam, et.al., 2013). There are a numerous applications of MANETs, each with dissimilar characteristics of network size, rate of topological change, data characteristics, communication requirements and node mobility (Anwar Ali Siddiqui and Yousuf Khan Afroz, 2012). This technique is applied in military, disaster recovery and so on. Nodes in the network are permitted to move rapidly and randomly in and out of range of each other (R. Asokan and A. M. Natarajan 2007). Routing between the mobile nodes which are not in its communication range of each other has been performed by the intermediate nodes and they are connected via a wireless links (G.Rajiv Suresh Kumar, K.M.Mohana Sundaram, 2014) (T.Durga, 2015).

Broadcasting is the fundamental mechanism for the route discovery, where the intermediate or relay nodes rebroadcast the received RREQ packet blindly until the route has been established to destination (Ambarish R. Bhuyar, V. T. Gaikwad 2014). This increases the routing overhead, which in turn effectively reduces the packet delivery ratio and increases the end-to-end delay (Abhishek Jain, et.al., 2014). Hence reducing the routing overhead becomes an essential part in MANET (K.S.Dinesh, et.al., 2014).

This paper proposes a cluster based differential zone partitioning approach to achieve minimum average end-to-end delay. The approach uses a tail agent which is the longest one hop neighbor of the source node within the cluster/zone. The tail agent and the source node in different quadrants must be capable of finding the shortest route to the destination with the guidance of a quadrant manager (QM), who maintains routing information of every node in the cluster/zone. Each quadrant manger shares the shortest quadrant information with other QM to guide the cluster head (source node) and the tail agent. With the help of quadrant manager and the tail agent optimal routes can be found with a minimum routing delay.

The rest of the paper is organized as follows: Section 2 describes recent related works on delay tolerant MANET. Section 3 describes the system model for the proposed approach. Section 4 describes the proposed Cluster Based Differential Zone Partitioning Approach to find the shortest path with minimum average end to end delay. The simulation results have been discussed in section 5. Finally, Section 6 renders the conclusion.

2. Related Works

This article (V. R. Budyal and S. S. Manvi, 2013) proposed an intelligent agent based on-demand delay aware QoS routing scheme in MANETs by means of agents which make use of neuro-fuzzy logic supported by Q-learning. The DSR protocol has been extended to determine all the multiple paths and the path condition from source to destination. The Fuzzy inference system decides if the nodes on the route satisfy the delay constraint. The software agents optimize the fuzzy membership function and then rules to make decisions in the system. The scheme is compared with the existing fuzzy based DSR routing methods and it outperforms better in terms of packet delivery ratio, acceptance ratio and latency.

The work (Abhishek Jain et.al., 2014) proposed a neighbour coverage based probabilistic rebroadcasting protocol for broadcast storm problem. The method exploits the neighbour coverage knowledge effectively by determining the rebroadcast delay in order to determine the forwarding order.The rebroadcast probability has been calculated by integrating the coverage ratio and the connectivity factor. The approach

improves the performance of the network in terms of packet delivery ratio and end – to end –dealy.

The article (Hany Samuel, et.al., 2011) proposed a dominating-set routing technique within the super node system in MANET, which is the previous research paper of the author. The technique attains better resource utilization. A distribution is derived for the node-node intermeeting time and produces result to prove that the distribution has the ability to enhance the dominating-set routing technique performance.

The research (Gawas Mahadev A, et,al., 2014) proposes a Cross Layer Delay aware Node Disjoint Multipath AODV in MANET, which is based on delay constraint. The communication is made between the MAC and routing layer by applying the cross layer design to attain the channel and link awareness. It updates the path status frequently in terms of lowest delay acquired at each intermediate node. The protocol performs better than the AODV and NMDR in terms of packet delivery ratio and routing overhead.

The study (N. Enneya, et.al., 2009) proposes a next version of OLSR protocol based on a mobility parameter in order to enhance and adapt it in the situation of the mobility. Three criteria have been designed for multi-point relays (MPRs) selection technique, which is used in the OLSR protocol to reach the nodes with a finite amount of broadcast. The first criterion was defined just based on the mobility of nodes at one hop neighbors, while the other two criteria were based on the nodes at one-hop and two-hops.

The article (Aysha Al-Hinai and Haibo Zhang, 2013) presented a probabilistic routing scheme namely FG-PRoPHET, which is based on fine-grained contact characterization. In the scheme, each node maintains a historical contacts using slotted sliding window. The control mechanism of the collected data by sliding window adjustments is to reflect the contact patterns. A greedy forwarding scheme has been designed based on the fine-grained contact statistics by combining the advantages of quota-based routing and contact duration based forwarding. The scheme shows the excellence in terms of packet delivery ratio and communication overhead than the existing schemes.

The study (Zehua Wang, et.al., 2014) proposed a lightweight proactive source routing (PSR) protocol to facilitate the source routing. The protocol maintains more information than the existing distance vector protocol. The simulation results show that the protocol performs better than the existing protocol in terms of data transportation.

The work (Saad M. Adam, et.al., 2013) provides an overview of the reactive routing protocols in terms of QoS requirements. This paper considers the delay as one of the important QoS metrics to fulfill the application requirements.

3. System Model

Consider anX × Y network model consisting of n number of mobile nodes. The figure1 illustrates the topology of MANET. The network is divided into ‘z’ number of zones (clusters) of varying size and each zone contain ‘x’ number of mobile nodes. Further the zones are over spitted in to four quadrants equally. Each mobile node belongs to multiple intersecting zones. Since the nodes are mobile, the nodes can move from one zone to another.The nodes are equipped with adjusting power level to increase its coverage region for a more distant node or shrinks for a node available in lesser coverage region.

Here, Quadrant Manager and the cluster head management programs have been used to achieve a minimum routing delay while discovering the optimal paths to reach the destination. The node which initiates a route discovery process was termed as a current header of the cluster. A limited number of quadrant managers have been used in this approach to reduce the overhead in the network and the numbers of quadrant managers may vary according to the network size. The capacity of each QM is same in the network.

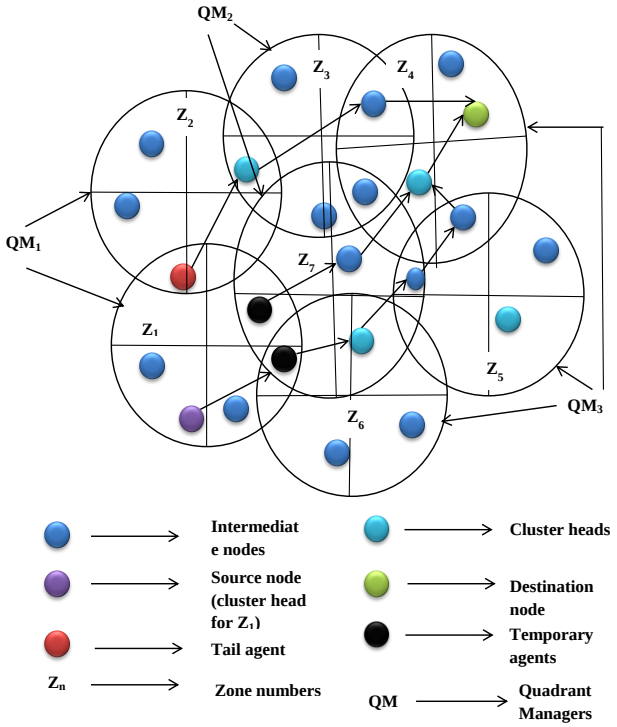

Figure 1: Zone partition topology of MANET

4. Cluster based Differential Zone Partitioning (CDZP) Approach for routing delay in MANET

In MANET the frequent changes of network topology causes the routing overhead due to forwarding the RREQ control packet. During route discovery process a large amount of routing traffic has been induced blindly by flooding the whole network with RREQ packet. This routing overhead directly affects the packet delivery ratio and routing delay. Thus the paper proposed cluster based differential zone partitioning approach which is performed dual partitioning of cluster to find an optimal path with minimum routing delay.

4.1 Cluster Allocation to Quadrant Manager

Quadrant Manager (QM) implemented in this approach guides the nodes to find the optimal paths with minimum delay. Initially N number of clusters is allocated to the quadrant managers based on the capacity of the QM. The process of cluster allocation to quadrant manager has been explained through the following example.

Consider a network which is composed of n number nodes and let the number of partitioned zones be 7. Assume that each QM can handle 8 nodes totally. As shown in the figure 1 the Z_1 and Z_2 have been allocated to QM_1, where it handles 8 nodes only and excludes the remaining nodes in the intersected zone areas. Likewise the Z_3 and Z_7 are handled by the QM_2 and Z_4, Z_5 and Z_6 are handled by the QM_3. In this manner, the clusters are allocated to QM.

4.2 Routing Process

When node desires to transmit a data to another node in the network, it needs to establish communication link with that node. This is achieved by means of route discovery process which involves the transmission of RREQ packets (Rakesh Kumar, et.al., 2010). In this approach, the transmission of RREQ packets is performed by the source node, a tail agent and the temporary agents. The source node location has been provided by its Quadrant manager.

Prior to broadcasting the RREQ packets, the source node discovers its one hop neighbors by broadcasting the hello. After determining the one hop neighbors, the header chooses a node which is located far away from it and considers it as a tail agent, to minimize the number of hop counts. The source node reports the information regarding the elected tail agent to its quadrant manger. The Quadrant Manager (QM) upon receiving the message splits the cluster into four equal quadrants and checks whether the source node (header) and the tail agent are located in the same or different quadrant. If the header and tail are in different quadrants then the QM permits the source node to consider the node as a tail agent because it leads to discover the optimal routes with minimum delay. Otherwise the QM informs the header to elect the other one hop neighbor as a tail agent.

After electing the tail agent the source node assign two more temporary agents to the rest of quadrant that are left out. The tail, temporary agents and source node which are in different quadrants discover the route to reach the destination, which may reduce the overhead of source node during the route discover process. The quadrant manager guides the nodes about the shortest quadrant information to reach the destination for discovering the routes with in minimum routing delay. The cluster heads must update its routing table information to the quadrant manager on successful reach to the destination.

As shown in the figure 1 the tail, temporary agent and the source node discover the route to destination using minimum number of quadrants. The source node selects the path based on the number of quadrants and the energy consumption. It adds the consumed energy to increase its coverage region for a more distant node or shrinks for a node available in lesser coverage region.

5. Simulation Results

The proposed Cluster based Differential Zone Partitioning (CDZP) approach attempted to minimize average end to end delay to improve the network performance. The NS2 simulation has been used to assess the performance of the proposed approach and the simulation setup is shown in the table 1. The performance of the proposed approach is compared with other existing approach such as Region Split Broadcast (RSB), Divide and Forward (DF). The Performance of the approach is measured in terms of broadcast delay, accuracy probability, and localization error and packet delivery factor

Table 1 Simulation setup

Simulation Parameter	Value
Simulator	NS-2
Topology size	500×500
Number of nodes	50,100, 150, 200
Transmission range	250 m
Traffic type	CBR
Packet size	512 bytes
Pause time	0s
Min speed	1 m/s
Max speed	5 m/s
MAC protocol	IEEE 802.11
Simulation time	100s

A. Performance metrics

Broadcast Delay:

Broadcasting is the fundamental mechanism where the packet transmitted from the source to all other nodes in the network to reach the destination. The broadcast delay can be defined as the difference between the time of packet received by destination and the time of packet sent by the source node.

$$Broadcast\ delay = Packet\ Received\ time - Packet\ Sent\ time \quad (1)$$

Accuracy Probability:

Accuracy probability is the probability that the location of the nodes has been accurately determined

Localization Error:

Localization error is considered as one of the important metrics in the distributed network and it provides the localization error of node i.

$$E_{i} = \frac{E_{Max}}{\sqrt{\pi}} \quad (2)$$

E_{Max} is the maximum localization error and it has been estimated as follows

$$E_{Max} = \left(r - d\sqrt{2}\right)\sqrt{2};\ d\sqrt{2} < r < 2d \quad (3)$$

$$d = \sqrt{\frac{A}{N}} \quad (4)$$

Where r is the equivalent communication radius for node i in a network model and it can be estimated as follows

$$r = \frac{A\rho_i}{N\pi} \quad (5)$$

Where A is the area of network, N is the number of nodes and ρ_i is the connectivity order ie the number of nodes connected to the node i

The average value of localization error E for deployed network can be estimated as follows

$$E = \frac{1}{N}\sum_{i=1}^{N} E_i \quad (6)$$

Packet Delivery Factor

Packet delivery factor is defined as the ratio of Received data packets by the destinations to those generated data packets by the source.

$$PDF = \frac{Number\ of\ Received\ data\ packet}{Number\ of\ generated\ data\ packet} \quad (4)$$

Discussion

In the proposed approach the broadcast delay will be minimized by searching the destination with the group of agents and the guidance of the Quadrant manager. The distance between the nodes increases and it will directly increase the broadcast delay. As in the proposed approach the nodes have variable power size to cover its neighbors so the delay incurred by number of forwarding packets to the intermediate nodes can be minimized. Figure 2 shows the broadcast delay with respect to the distance. The bcst delay incurred by the proposed CDZP for 10 m distance is 16, while the RSB and DF incurred 20, 22 respectively.

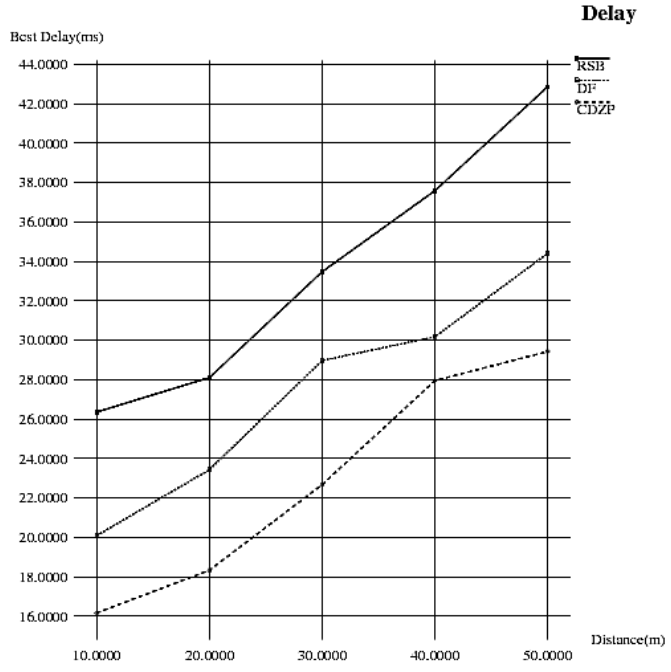

Figure 2 Broadcast Delay

The priori information of the location is produced by the quadrant manager in the proposed approach; it makes to improve the accuracy of self-positioning for mobile ad hoc network. Moreover, the method is simpler than other approaches by the quadrant manager, which knows the information of the mobile nodes in its clusters. Figure 3 shows the accurate probability with respect to the node density. The accuracy probability incurred by the proposed CDZP for 50 nodes is 0.87, while the DF and RSB incurred 0.73, 0.61 respectively.

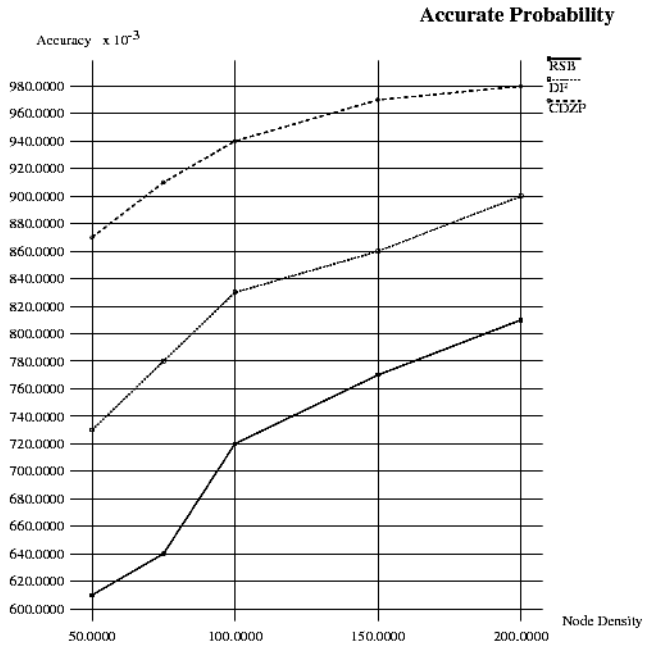

Figure 3 Accurate Probability

The approach is based on dual partitioning, where the location of the nodes can be easily located than the existing approaches. The localization error can be increased when the distance between the nodes increases. Figure 4 shows the Localization error with respect to the distance. The localization error incurred by the proposed CDZP for 10 m distance is 4 %, while the RSB and DF incurred 26%, 18% respectively.

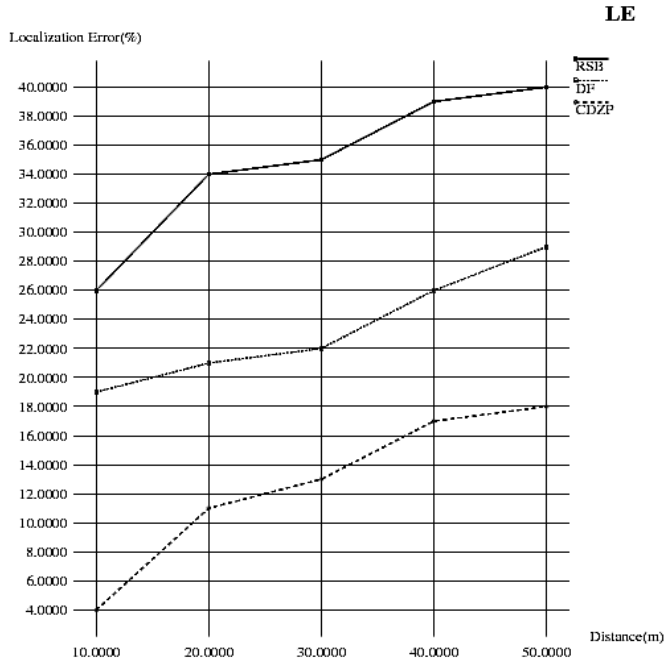

Figure 4 Localization error

When the number of groups (cluster) involved in the packet transmission increases the packet delivery ratio will decrease. While in the proposed a minimum number of groups have been used than the existing approaches in the distributed network. Figure 5 shows the packet delivery ratio with respect to the number of groups. For 2 groups the proposed approach CDZP acquired 0.92, while the RSB and DF incurred 0.81, 0.88 respectively.

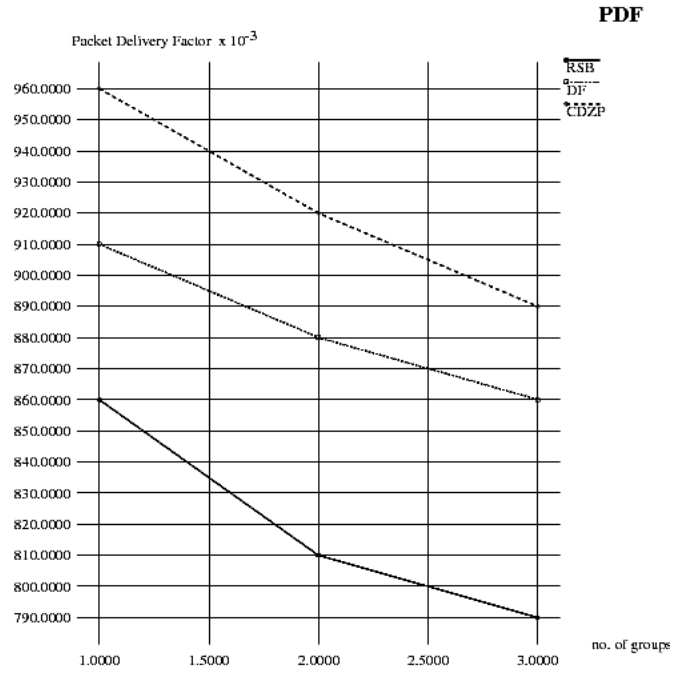

Figure 5 Packet Delivery Factor

6. Conclusion

This paper proposes cluster based differential zone partitioning approach for discovering the routes with minimum delay which based on dual partitioning of cluster. The agents are employed to discover the routes in different direction along with the source node to minimize the overhead of the source node during route discovery process. A Quadrant manager program has been implemented in this approach to guide the nodes to discover the routes with minimum quadrants. The simulation results are compared with the existing protocol and the performance of the algorithm has been measured in terms of broadcast delay, localization error, accuracy and packet delivery ratio. The results show that the proposed approach achieves a better performance than the existing approaches.

References

[1]. Budyal, V.R and ManviS.S., 2013, "Intelligent Agent Based Delay Aware QoS Unicast Routing in Mobile Ad hoc Networks", International Journal of Multimedia and Ubiquitous Engineering, 8(1).

[2]. Hany Samuel, WeihuaZhuang, and Bruno Preiss, 2011, " Improving the Dominating-Set Routing over Delay-Tolerant Mobile Ad-Hoc Networks via Estimating Node Intermeeting Times", EURASIP Journal on Wireless Communications and Networking, 2011, p.12, 2011.

[3]. GawasMahadev., Gudino, A., Lucy., Anupama, J., Rodrigues, K.R., Joseph., 2014, "A Cross-Layer Delay-Aware Node Disjoint Multipath Routing Algorithm For Mobile Ad Hoc Networks", International Journal of Wireless & Mobile Networks, vol 6, issue 3, page 39, 2014.

[4]. Enneya. N., Oudidi, K., Elkoutbi, M., 2009, "Enhancing Delay in MANET Using OLSR Protocol", International Journal of Communications, Network and System Sciences, Scientific Research, 5, p.392-399, 2009.

[5]. Aysha Al-Hinai and Haibo Zhang., 2013, "Probabilistic Routing Based on Fine-Grained Contact Characterization in Delay Tolerant Networks", International conference on Local computer networks, IEEE, p.581-588, 2013.

[6]. Ambarish R. Bhuyar, Gaikwad, V.T., 2014, "A Review on Reducing Routing Overhead in Mobile Ad Hoc Network using Probabilistic Rebroadcast Mechanism", International Journal of Computer Science and Information Technologies (IJCSIT), 5, p.390-393..

[7]. Asokan, R and Natarajan, A.M., 2007, "An Approach for Reducing the End-to-end Delay and Increasing Network Lifetime in Mobile Adhoc Networks", International Journal of Information Technology, vol 4, no 2, 2007.

[8]. Khaja Anwar Ali Siddiqui and Yousuf Khan Afroz, "Minimum Delay Routing Protocol with Enhanced Mutimedia Transmission over Heterogeneous MANETs" Trends in Innovative Computing, 2012.

[9]. Abhishek Jain, Ashish Jain, Rohit Thete, Akshay Shelke, Harshada Mare, "MINIMUM DELAY BASED ROUTING PROTOCOL IN MANET, International Journal of Technical Research and Applications, vol 2, issue 5, pages 78-81, 2014.

[10]. Rajiv Suresh Kumar,G., Mohana Sundaram, K.M., 2014, "Queuing Based Load Balancing Approach for Improving Network Performance in MANET", International Journal of Inventions in Computer Science and Engineering, 1(8), p. 2348-3539.

[11]. K.S.Dinesh, "Routing Overhead Reduction and Selection of Stable Paths in MANET", International Journal of Inventions in Computer Science and Engineering (IJICSE), vol 1, issue 9, pages 2348-3539, 2014.

[12]. T.Durga, "Maximizing the Network Lifetime by Using a Mobile Aware Topology Control Algorithm in MANET", Journal of Recent Research in Engineering and Technology, pages 2349-2252, vol 2, issue 3, 2015.

[13]. Zehua Wang, Yuanzhu Chen, "PSR: A Lightweight Proactive Source Routing Protocol For Mobile Ad Hoc Networks", International Conference on Vehicular Technology, IEEE, vol 63, no 2, 2014.

[14]. Rakesh Kumar, Manoj Misra, Anil K. Sarje, " A Simplified Analytical Model for End-To-End Delay Analysis in MANET" International Journal of Computer Applications (IJCA), no 4, 2010.

[15]. Saad M. Adam, Rosilah Hassan, "Delay aware Reactive Routing Protocols for QoS in MANETs: a Review", Journal of Applied Research and Technology, vol 11, issue 6, pages 844-850, 2013.