A Tree Based Multicast Routing Protocol for MANET

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Abstract: In a wireless network, due to the broadcast nature of the omnidirectional antennae, a single transmission can be received by all neighbors of the transmitting node. Therefore, the multicast routing protocols designed for the traditional wired networks are not applicable to the wireless networks. Group shared multicast tree is a more scalable approach than the source based approach in which instead of building multiple trees for each multicast group, a single shared tree is used for all multicast source nodes. In this research work, a novel methodology is proposed using the same group shared multicast tree, using a muti-hop schema to allot the channel to the participating nodes.

***IndexTerms* – Multicast routing, MANET, Ad-hoc,Wireless Communication**

I. INTRODUCTION

A mobile ad-hoc network (MANET) is connected with mobile nodes with any kind of infrastructure. Mobile nodes are self-organized to serve as a network than as radio links. The main objective of MANET is to widen the mobility areas used in mobile, wireless and autonomous domains that would have a series of nodes which would form a routing infrastructure in ad-hoc manner. Multicasting has benefits in both wired and wireless networks and this is used as a critical technique in various applications, especially in audio and video conferencing, communication, groupware applications, e-learning, stock quotes, news, distribution of software, etc. In this type of communication, a small data would be shared with a myriad of recipients and the data would be replicated whenever required. In the wired settings, there are two key multi-cast tree schemes are used. There include shortest-path tree and the other one is the core-based tree. The process to build a shortest path multi-cast tree would make sure to reach every destination from the source through a shortest path wherein the source node should build the tree roots by itself. There would be a myriad of shortest path trees available on the network. Basically, in the core-based multi-cast trees, the shortest path from source to destination cannot be assured, but there is one tree that is required to connect to source nodes to a group of receiver nodes.

It is hard to save energy in the multi-cast routing of the MANET. It is merely impossible to recharge a mobile node that is powdered with batteries. When the battery life is short, the performance of the network declines. To take complete advantage of nodes completely, traffic should be diverted in the route where the energy can be saved.

MANET is a daunting area as it has the ability to use in a wide range of applications. Rigorous research was done in different fields of multicast routing protocols, especially the taxonomy, performance, capacity over MANET that carried out the study. Tariq et al has explained about the traffic models for various multicast routing protocols that are used in MANETs. The multi-cast protocols would be divided into tree-based, stateless, hybrid mesh based and flooding protocols.

MANET would be used in different areas where there is quick deployment and reconfiguration of wired network is impossible including the battlefields, emergency search areas, classrooms, and conventions where the learners would share information through mobiles. These applications are used for multi-cast operations. In the wireless medium, it is even challenging to cut down the consumption of energy on the transmission overhead. Multicasting would be used to boost the effectiveness of wireless links to send messages and take complete advantage of the broadcast nature of the wireless transmission. The role played by multicast is critical in MANET. The multicast routing for MANET would solve various problems with the traits of MANET like low bandwidth issue, mobility and low power. In fact, MANET would have low bandwidth compared to the wired networks. The information collected from the routing table would cost you high. Mobility of nodes would cause many topological changes in the underlying networks to increase the viability of the information. Moreover, when there is a power shortage, then there would be a disconnect exists between the mobile units. Multicasting routing protocols would focus on different areas. Few of the key categories of multicast techniques in MANET include:

1. A technique to have flood in the network where each node receiving messages would send to the neighboring nodes. The network flooding would serve as a chain reaction that would grow exponentially.
2. A proactive approach is used to calculate the distance of each path to reach the destination and store this data in the routing table. To have an updated database, routing data are dispensed throughout the network.
3. This method would create paths to different nodes that are actually formed. This idea would be based on the query response mechanism. In this phase, the node would use the environment. Once the query hits the destination, it starts to respond while establishing a path.

In this paper a novel approach to improve the performance of the multicast routing inside MANET has been discussed. The below section II contains a review of the literature on the research done previously followed a description of the proposed methodology in Section III. Section IV gives the results and analysis followed by Conclusion in section V.

II. LITERATURE REVIEW

Rajashekhar Biradar et al (2010) has developed the routine g scheme based on the stable mesh so that it could find the stable path multicast starting from source to the sink. The built path was based on link stability database and also the information of multicast route. It was only the link that was highly stable with selective forwarding selected for the packet forwarding. The above is seen to providing solution for the late feature and issues of node mobility.

Rajashekhar & Sunil Kumar (2012) introduced a BDP that was based on the scheme of multi routing scheme. Utilizing the backbone of multicast, trust pair of nodes has been constructed relying on links of parameters. Further, delay product has been formed by node pair that is reliable. A mesh of ring structure has been constructed at a random distance from the central area of MANET. Further, the requirement of BDP has been attained by satisfaction of the reliable community.

Dheeraj Sharma & Rohit Sethi, et al (2015) has reviewed a multi routing protocol to solve network size issues on a greater scale and also issues of MANET. Deployment of hierarchical routing to get solution for fault tolerance and link failures. In case of path discovery, the packets of RREQ are seen to spend greater energy to draft a path. This protocol helps recovery of broken links to solve multicasting issues.

Anjaneyulu & Kumari (2015) undertakes a modified routing protocol based on mesh that would leverage the performance of consumption of energy and transmission state failure. Routes chosen are of minimum energy and greater hop count to decrease load on all nodes of mobile. Owing to the topological dynamic condition, it becomes difficult to select a particular route.

Thenral & Thirunadana Sikamani (2015) integrates the stability of link in a multicast routing network based on mesh to find links that are stable from the links existing to affirm the reliability of multicast routing. Determination of multicast routing relies on lifetime of network and declining requirements of maintenance of route state. Both the overheads of control and peer to peer delay amidst the source as well as destination have been reduced on the basis of stable path.

Amit Chopra & Rajneesh Gujral (2015) has discussed multiple solutions for the QoS multicasting. Parameters of QoS are overhead, end to end delay, mobility and fairness as analyzed to solve all the issues of networking. Further, it has been suggested that there is an urgent of solution for supporting communication based on QoS.

Basarkod & Manvi (2014) proposes a unicast routing scheme based on - demand Stability and Bandwidth to seek stability of node, link them and also stability of neighbor's node. The above scheme is helpful in maintaining cache so that the recent routes are recorded to all destinations on the basis of RREQ and also RREP packets. In the process of route discovery, a database of QoS is installed. Periodical estimation of bandwidth so that the networks buffer be obtained.

Mary Valantina & Jayashri (2014) proposes stability of link on the basis of routing hop to hop that helps attain a stable path to the destination from source. Departing receivers and the administrative prices can be controlled by developing a tree structure. The hop to hop routing is more effective in terms of delay, delivery and overheads.

Jenitha Christy & Kabilan (2015) has introduced an updated protocol of multicast routing that is secured to find nodes that are malicious and also authenticate the different source presence. Procedure of link recovery along with the multicast table has been set up so that network activity status could be updated easily. Installing queries for routes that are refreshing and modified.

Senthil Kumar & Parthasarathy (2015) gave solution to efficient routing. Route selection method based on route has been proposed to attain a route reliable with both the previous and current life of residual link. Souce node is initiated about the link condition so that it can update the status of network. This routing does not identifies intruders and also isolate them.

Zhenzhi Qian et al (2014) took into consideration three different factors, infrastructure, mobility and multicast transmission that help increase network capacity. The core concern is network based on infrastructure. Hybrid routing has been chosen that it support ad hoc, upper and lower cellult network.

Shengbo Yang et al (2012) explore the opportunistic protocol based on position to better the accuracy of location that is based on consumption of energy. Strategies of broadcast nature and also geographic routing have been deployed. An approach based on void handling has been introduced to deter the communication gap. For link breaks, method of selective forwarding has been applied.

Youngmin Kim et al (2005) have developed a scheme of multicast forwarding in all wireless multihop networks. Both duplication of packets and routing loops has been avoided. Routing table has been set up in all nodes to save packet duplication in all routing. Here, the approach of rate of packet delivery has been attained.

Binod Vaidya et al (2009) have implemented the Secure and Robust Routing Scheme for all the dynamic networks is used to find the disjoint path of all nodes. Security and path reliability has been induced to obtain secure network routing.

Aamir & Zaidi (2013) explores the approach of buffer monitoring to attain the packet queing via active patterns of queue management. All the intermediate nodes have shared the space of buffer with adjacent nodes. Further transmission of data with lesser rates has been gained.

Sreedevi et al (2012) focuses on the multicast protocol of geography that has a virtual zone based elements that can improve the scalability and also managing group's efficiency. Overheads have been reduced in all groups searching and state of route maintenance based on the information of location. Here, network progression has not been applied.

Wenjing Lou et al (2009) have developed a scheme of SPREAD to better the MANET security inducing the multicast routing. On the basis of scheme of enhanced security, better peer to peer services have been attained. Similar levels by Hyung Lee et al (2014) have been given. Cluster badsd and location specific so that the traffic is prevented. Further, a connection between cluster area size and mobile nodes has been determined.

MORE has been introduced by Shigeru Kashihara et al (2014) to enhance reliable communication. Chances of packet transmission and nodes location have been used for packet delivery. Here, all nodes can attain the information of recent nodes amidst the hop due to periodical updates.

Yanbin Yang & Yulin Wei (2009) has explored a mixed approach of contention specific access scheme across various channels and token bucket algorithm to induce provision of QoS support and further adjust contention size to differentiate traffic.

Srinivasan & Kamalakkannan (2013) puts forward a routing scheme reliant on stability and levels of residual energy in phases of path discovery and maintenance. Further the link stability on packet measurements basis having better strength of signal and stability of path to meet the metrics of energy has acted as intermediary nodes.

Neelesh Gupta & Roopam Gupta (2014) introduces a network based routing to enhance the MANETs residual energy. By transmitting higher packets successfully to the destination, conservation of energy is dramatically reduced.

III. METHODOLOGY

Since the construction of a minimum cost tree (for each source) spanning all the members of the multicast group is expensive, some of the tree-based multicast routing schemes use a (core‐based) group‐shared tree to distribute packets from all the sources. In the group‐shared tree, a single tree is constructed for the whole group (e.g., regardless the sources location). Multicast packets are distributed along this shared tree to all members of the multicast group. Since the group - shared multicast tree only permits the multicast traffic to be sent out from the root to the multicast receivers, each source must forward its multicast traffic to the root. Multicast traffic of each source is then forwarded along the shared tree. The group - shared multicast tree is a well - known tree - based approach adopted by core based trees. A group - shared tree is a shortest - path tree rooted at some core node. The core node is also referred to as a center node or a rendezvous point. Core nodes may be chosen from some pre - selected set of nodes or some heuristics may be employed to select core nodes. Group - shared multicast tree is a more scalable approach than the source - based approach in which instead of building multiple trees for each multicast group, a single shared tree is used for all multicast source nodes. In this research work, a novel methodology is proposed using the same group shared multicast tree, using a muti-hop schema to allot the channel to the participating nodes.

The proposed protocol maintains a shared tree for each multicast group, consisting of only receivers and relays, thus it an on - demand routing protocol similar to MAODV that discovers the route only when a node has data to send. It is a hard state protocol, i.e., if a member node of a multicast group desires to terminate its group membership, it must request for termination. When the core revokes its own group membership, it selects one of its tree neighbors to become the new core. If the new core is not a group member, one of its downstream tree neighbors is selected to become the new core. This core selection process is continued until a group member is found to become the new core. When a mobile node wants to join a multicast group or send a message but does not have a route to the group, a Route Request (RREQ) is originated. All the nodes that are members of a multicast group together with the nodes that are not members of the group but their position are very critical for forwarding the multicast information, compose the tree structure. Every multicast group is identified by a unique address and group sequence numbers for tracing the freshness of the group situation by calculating the hop count. The nodes thus comprises of 2-hop and 3-hop group channels. Thus every node has to maintain multicast routing table for the group tree structure. This table contains the multicast group address, the multicast group leader address, the multicast group sequence number; hop count to the multicast group leader, next hop information and the lifetime. Nodes in a tree structure are described as downstream and upstream nodes. A downstream node is a neighborhood node, which is further from the group leader (more hop counts from the group leader). An upstream node is a neighborhood node which is nearer to the group leader (less hop counts from the group leader). It is obvious that a group leader has only downstream nodes. Whenever a node leaves the multicast group, the tree structure is pruned. If an edge in the multicast tree is broken, the downstream node of the edge is responsible for finding a path to the core and reforming the multicast tree. If this node cannot find a path to the core within a certain time period, the network is assumed to be disconnected and the sub tree rooted at this node becomes another multicast tree. If it is a group member, this node then becomes the core of the newly formed multicast tree; otherwise, the core selection process is used to find the core of the newly formed multicast tree. If the network becomes connected later, the multicast trees of the same group are merged into one whose core is the same as that of the multicast tree having the largest address.

ALGORITHM

- When a node receives a beacon from another node, it considers that this node is a neighbor. In order to build 2-hop neighbor lists, each node includes the bitmap of its I-hop neighbors in the beacon.
- Hence, when a node receives all the beacons from its neighbors, it is then able to build the list of its 2-hop neighbors.
- In order to build 3-hop neighbor lists, each node should include the bitmap of its I-hop and 2-hop neighbor's bitmaps in the beacon it sends.
- By using bitmap codification and sending beacons in a TDMA manner, neighboring information are exchanged efficiently between nodes without collision and with light overhead.
- All nodes willing to communicate with the same node compete on the same channel in order to access the medium and send information using CSMA/CA algorithm. Topology is organized into several depths based on the Custer-Tree topology.
- In order to increase the throughput, the SN should remain in reception mode and the nodes in depth 1 should alternate between sending mode and reception mode in order to keep part of them in transmission mode.
- Thus, we divided the network into two groups, Group1 includes odd depth nodes that are descendants of an even child of an interface (B, D, F are even children of an interface), and also includes even depth nodes that are descendants of an odd child of an interface. All other nodes are included in Group2.
- For channel allocation, each node has a 3-hop neighborhood bitmap which enables it to choose dynamically its own channel.
- The node with the highest priority in the 3-hop neighborhood chooses its channel first. Priorities are assigned according to the network addresses.
- The node with the smallest network address has the highest priority. A node proceeds to its channel allocation as soon as it becomes the node with the smallest address among its 3 hop-neighborhood that is not yet assigned a channel.
- A bitmap that represents all the nodes is also used to announce which nodes have completed the channel allocation process in order for each node to know if it is its turn to choose a channel. When a node chooses its channel, it broadcasts it in the beacon frame.
- IEEE 802.11 standard for WLAN defines a distributed coordination function (DCF) for sharing access to the medium based on the CSMA/CA protocol.
- Collision detection is not used since a node is unable to detect the channel and transmit data simultaneously.
- A node listens to the channel before transmission to determine whether someone else is transmitting.
- The receiving node sends an acknowledge packet (ACK) a short time interval after receiving the packet.
- If an ACK is not received, the packet is considered lost and a retransmission is arranged.
- Carrier sensing is done in two ways, physical carrier sensing by detecting activity on the radio interface, and virtual carrier sensing which is performed by the DCF RTS/CTS access mode.
- To implement virtual carrier sensing each node sends duration information in the header of request-to-send (RTS) and clear-to-send (CTS) packets.

- The duration information indicates the amount of time the medium is to be reserved for transmitting the data and returning ACK packets after the end of current frame.
- The stations in the same basic service set (BSS) uses this information to update its network allocation vector (NAV) that represents the amount of time it has to defer in accessing the medium.
- By using virtual carrier sending all nodes within the same BSS learn how long the channel will be used for this data transmission.
- This solves the problem of a "hidden node", a third node that may not be able to receive the RTS from the sending node will hear the CTS from the receiving node and the channel will be reserved for the transmission.

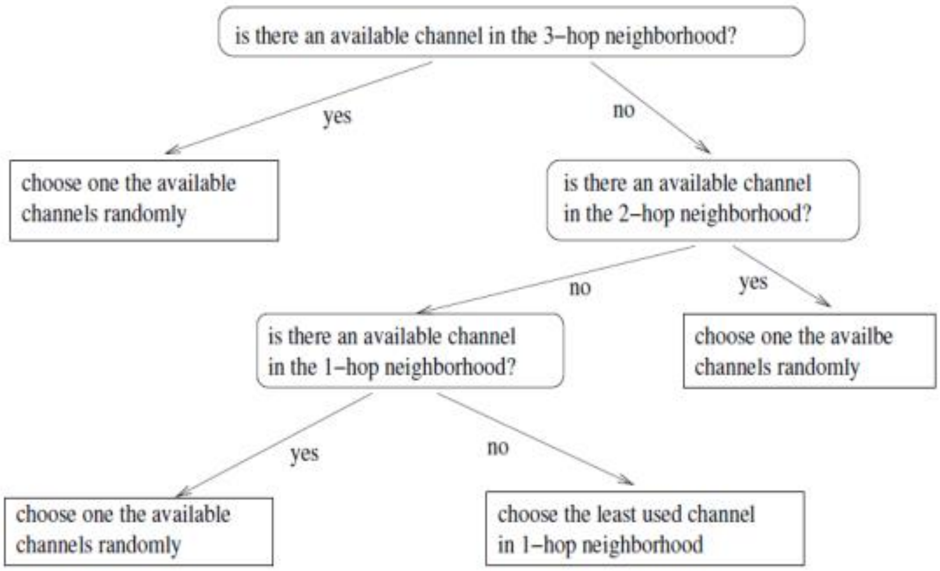

Figure 1: Channel Allocation Scheme

IV. RESULTS AND ANALYSIS

Network simulator NS2 is used in this work for predicting the behavior of the network. Various attributes of the network has been modeled environment to access the network under different conditions. In the computer network is typically modeled with devices, simulators, traffic etc. and its performance are analyzed. Typically, users can customize the simulator to fulfill their specific analysis needs. Compared to that of cost and time involved in setting up an entire test bed containing routers and data links, multiple networked computers, network simulators are relatively fast and inexpensive. This allows engineers, researchers to test the scenarios that might be particularly difficult or expensive to emulate them using real hardware. Figure 2 shows the network created on NS2.

As shown in figure 2, the nodes are created and assigned their respective node Id's starting from 0 randomly. The node at 0 is source node(SN) which will broadcast a beacon. This beacon is then propagated in a multi-hop manner so that reaches to all the nodes of the network.

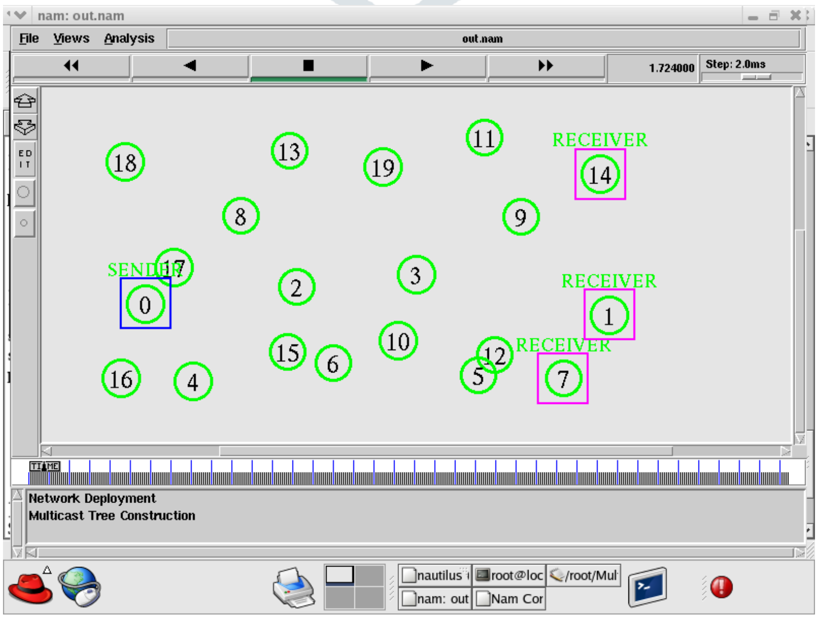

Figure 2: Network Creation in NS2

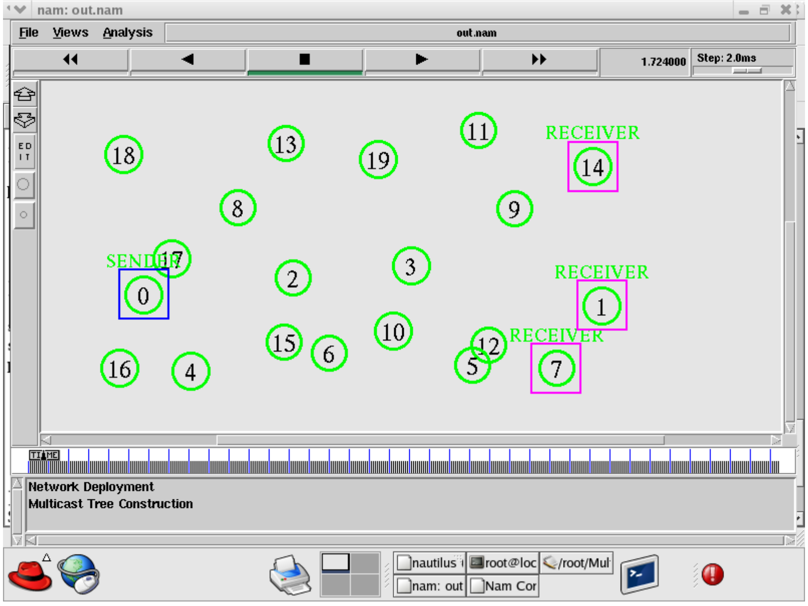

Figure 3: Network Deployment

Figure 3 shows the network deployment stage. Using the local propagation order (which is a list of all the node addresses of the network), every node is able to build and manage a bitmap that represents all the nodes in the network.

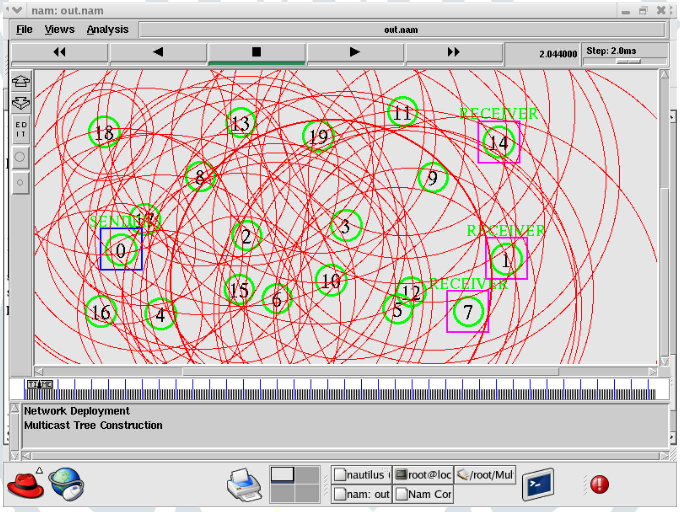

Figure 4: Multicast Tree Construction

For initiating packet forwarding, multicast tree are formed as shown in figure 4.3. The nodes on receiving the beacon consider it to be from the immediate neighbor, and builds a 2-hop neighbor list, by including the bitmap patterns of the immediate 1-hop neighbors. When a node receives a beacon from another node, it considers that this node is a neighbor. In order to build 2-hop neighbor lists, each node includes the bitmap of its 1-hop neighbors in the beacon. Similarly for 3-hop neighbor the 2-hop beacons are considered. Thus a complete tree network is formed as depicted in the above figure.

IV. PERFORMANCE MEASUREMENT

Packet Delivery Ratio: ratio of the number of packets actually delivered without duplicates to the destinations versus the number of data packets supposed to be received. This number represents the effectiveness and throughput of a protocol in delivering data to the intended receivers within the network. The number of data packets supposed to be received is a theoretical number projected from the multicast group member size and the number of packets sent from multicast sources. For some simulations, delivery ratio for each subnet was also analyzed, i.e., number of data packets originated and also received in that subnet versus data packets theoretically originated in that subnet.

PDR = (data sent/ data received)*100 1)

End to End Delay

- End to End Delay is the summation of Transmitting Delay (at MAC layer), Propagation Delay and queuing Time of a packet.
- End to End delay (ms) = (Communication end time – start time) / data received

Throughput

- Throughput is the number of packets successfully reached at destination per unit time.
- Throughput (kbps) = [(data received / (stop time – start time)) * (8/1000)]

Table 1: End to end delay comparison with normal and proposed

Simulation time(s)	Normal delay(s)	Proposesed-delay(s)
20	0.1501	0.0421
40	0.4223	0.3553
60	0.7501	0.6509
80	0.8836	0.7216

Table 2: Throughput comparison with normal and proposed

Simulation time(s)	Normal throughput	Proposed- throughput
20	0.7189	0.9234
40	1.1062	1.2506
60	1.4125	1.6329
80	1.6687	2.1856

Table 3: Packet Delivery ratio comparison with normal and proposed

Simulation time	Normal PDR	Proposed-PDR
20	1.014	1.324
40	1.182	1.298
60	1.305	1.432
80	1.596	1.786

Network lifetime

- Network lifetime is defined as the time during which the network is operational. In other words the lifetime of network is defined as the operational time of the network during which it is able to perform the dedicated task(s).
- Lifetime = [Total Consumed energy – Initial energy]

Table 4: Network Lifetime comparison with normal and proposed

Simulation time	Normal lifetime	Proposed
20	0.6095	0.7891
40	0.7723	0.9089
60	0.9252	1.0853
80	1.1009	1.2189

Packet loss

- Packet loss is the failure of one or more transmitted packets to arrive at their destination.
- Packet loss = [Data sent – data received]

Table 4.5: Number of Packets lost comparison with normal and proposed

Simulation time	Normal loss	Proposed loss
20	0.2895	0.1956
40	0.4423	0.3298
60	0.6252	0.5313
80	0.7900	0.6843

Result Graphs:

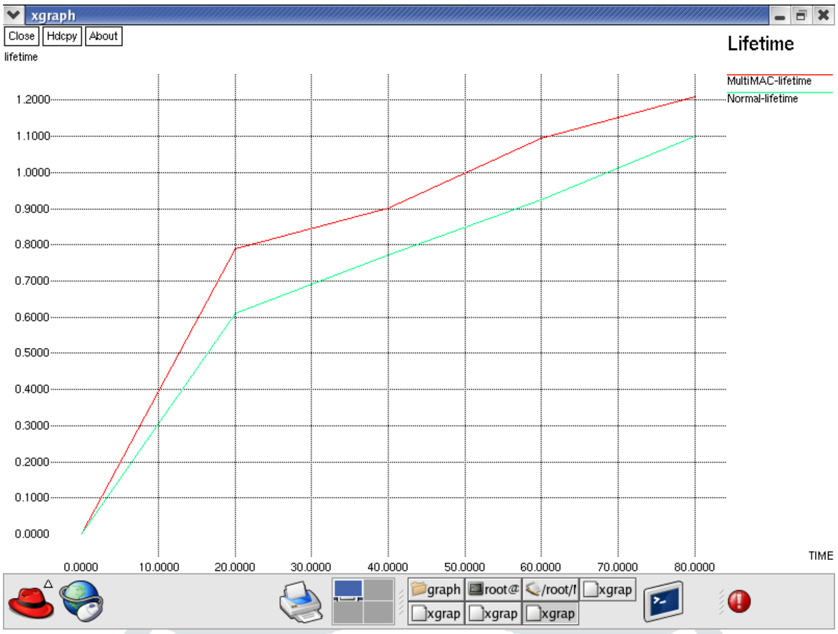

Figure 5: Network Lifetime

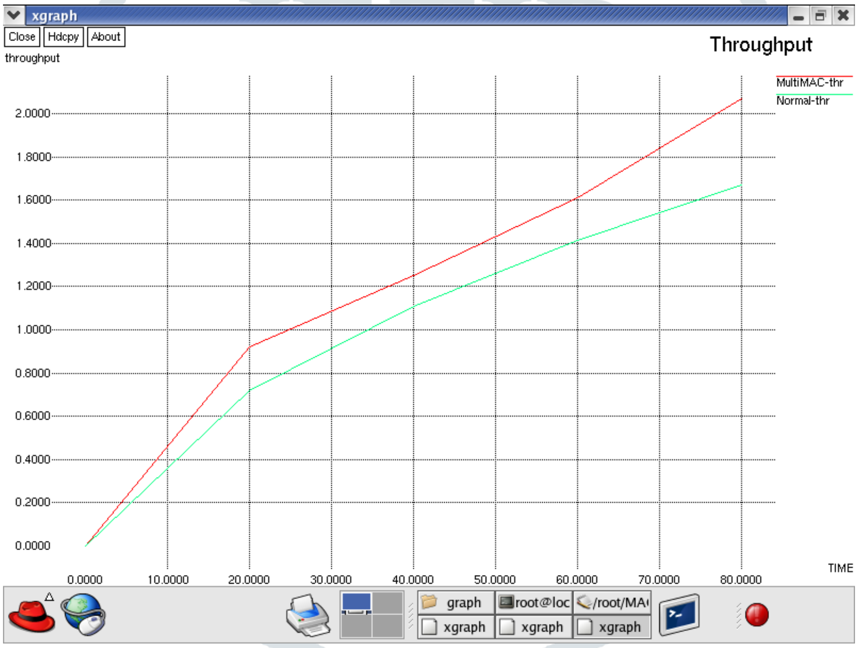

Figure 6: Throughput Graph

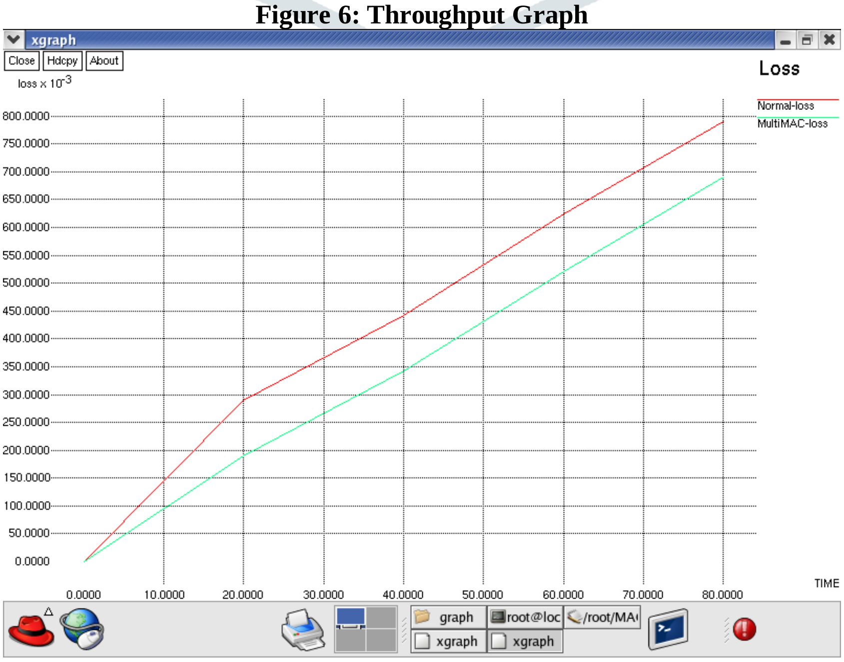

Figure 7: Packet Loss

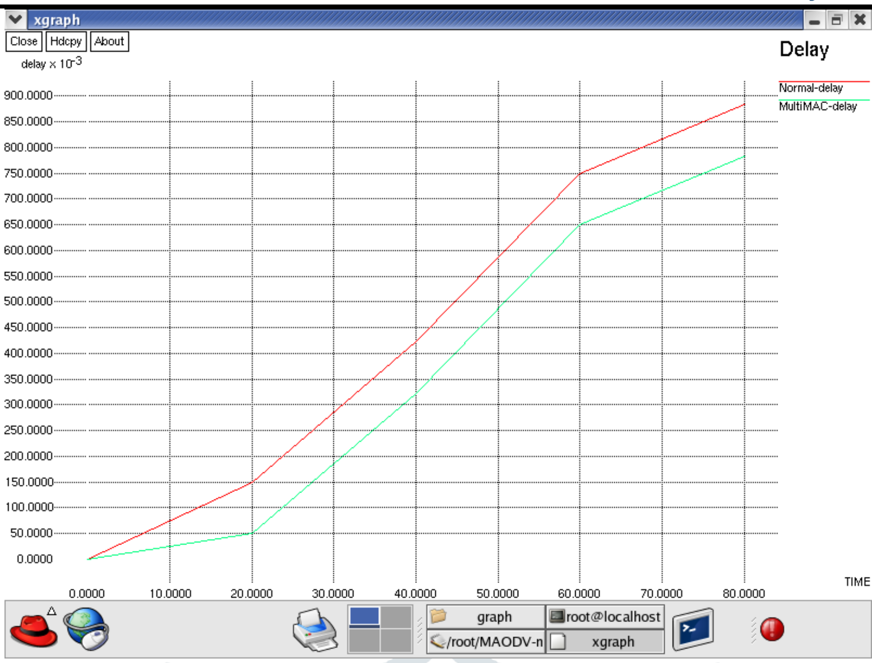

Figure 8: Packet Loss

V. CONCLUSION

The proposed method uses group tree technique where the nodes have the routing information of the neighboring nodes based on single hop, 2-hop and 3-hop and each node makes a corresponding routing table based on this information. The proposed protocol has been evaluated on the basis on a number of parameters such as throughput, packet delivery ratio, network lifetime and packet delay. The evaluated results have been compared with that of the normal MAODV protocol. The proposed protocol shows better performance as compared to the normal MAODV protocol in all these parameters. The throughput has been increased when transmitting the packets by almost 50% as compared to the normal MAODV result. The network lifetime also shows a little increment of 10% as compared to normal MAODV protocol. Similar improvements have also been registered in terms of packet delivery ratio which shows an increase of 6.25%. The numbers of packets lost is improved by 13 % approximately.

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