DOI: 10.21917/ijct.2019.0307

ENHANCED EFFICIENT GEOGRAPHIC MULTICAST ROUTING PROTOCOL (EEGMRP) FOR MANETS

V. Balasubramaniyam[1] and M. Manoranjani[2]
[1]Department of Computer Science, Sengunthar Arts and Science College, India
[2]Department of Computer Applications, SSM College of Arts and Science, India

Abstract
A Mobile Adhoc Network (MANET) is an art of networking without network. In ad hoc networks, mobile nodes communicate with each other using multi-hop wireless links. Most of the previous research in ad hoc networks focuses on the development of dynamic routing protocols that can find routes between two communicating nodes. Although routing is an important issue in ad hoc networks, data access is very important. The existing Efficient Geographic Multicast Routing Protocol (EGMP) is based on the two-tier virtual zone-based structure. In EGMP, the tree is formed with the guidance of location information. EGMP consumes more energy and each time it sends signal to all the available nodes in the path to the destination to send the data packets and could not manage with the large group size and network size. The major drawbacks of the EGMP are empty zone problem, local monitoring, groups are formed based on zones but not on nodes for group management. The proposed Enhanced Efficient Geographic Multicast Routing Protocol (EEGMRP) for MANET is to provide the routing protocol for ad hoc networks. The proposed research work attempts to improve the stateless multicast protocol, which allows a better scalability of group size. EEGMRP uses a location-aware approach for more reliable membership management and packet transmissions, and supports scalability for both group size and network size. EEGMRP uses the zone formation method and introduction of sleep wake method for the nodes to improve the energy consumption. The main objective is to reduce the topology maintenance overhead and support more reliable multicasting and make use of the position information to for multicast routing. Making use of position information to design a virtual zone based scheme for efficient membership management allows a node to join or leave a group quickly. The energy efficiency of the zone leader is an important concern. Thus the proposed routing protocol uses the Sleep-Wake scheduling method to reduce the energy consumption during the data transmission. Multicasting and energy utilization is scalable and efficient in EEGMRP. The results of EEGMRP shows the better performance in high packet delivery ratio and low control overhead and multicast group joining delay under all cases studied, and is scalable to both the group size and network size. The network performance metrics such as energy consumption, collision, and throughput are evaluated and compared with the existing EGMP protocol to confirm the scalability and efficiency of the proposed protocol using Glomosim simulator.

Keywords:
Geographic Routing, Wireless Networks, Mobile Adhoc Networks, Multicasting, Protocol

1. INTRODUCTION

Ad-Hoc Networks also called as Mobile Ad-Hoc Network (MANET) is a group of wireless mobility nodes which is self-organized into a network without the need of any infrastructure [8] [10]. It is a big challenge in developing a robust multicast routing protocol for dynamic Mobile Ad-Hoc Network (MANET). MANETs are used in many magnificent areas such as disaster relief efforts, emergency warnings in vehicular networks, support for multimedia games and video conferencing. Multicast is the delivery of a message or information to a group of destinations simultaneously in a single transmission using routers, only when the topology of the network requires it [1] [5] [6] [13] [16].

The proposed work “Enhanced Efficient Geographic Multicast Routing Protocol”, (EEGMRP), support a large group size and large network size. The EEGMR protocol is comprehensive and self-contained, yet simple and efficient for more reliable operation and consumes less energy when compared to existing one. Instead of addressing the specific part of the problem in the EGMP, the proposed work includes a zone-based scheme to efficiently handle the group membership management. The advantage of the membership management structure is to efficiently track the locations of all the group members and energy consumption using the Sleep-Wake scheduling method. The zone structure is formed virtually and the location of the nodes in the zone is calculated based on the position of the node and a reference origin.

The topology-based multicast protocols are generally difficult to scale to a large network size, as the construction and maintenance of the conventional tree or mesh structure involve high control overhead over a dynamic network. The main drawback of existing protocol EGMP consumes much energy and increase in the collision rate by network traffic. EGMP could not cope up with the large group size and network size. In the existing, the zones are partitioned according to the position but in proposed protocol EEGMRP, the zones are partitioned according to the transmission range of the mobility nodes. EEGMRP uses the zone formation method and Sleep-Wake scheduling method for the nodes in the network. At the initial stage all the nodes are at sleep mode. Because of the sleep mode the energy and power utilization becomes very less. By making use of the location information, EEGMRP could quickly and efficiently build packet distribution paths, and reliably maintain the forwarding paths in the presence of network dynamics due to unstable wireless channels or frequent node movements. The problems of existing protocol EGMP are overcome by the proposed protocol EEGMRP uses a location-aware approach for more reliable membership management and packet transmissions, and supports scalability for both group size and network size.

2. RELATED WORK

Multicasting in MANETs is a relatively unexplored research area, when compared to the area of unicast routing for MANET. As a consequence, multicast routing in mobile ad-hoc networks has attracted significant attention over the recent years.

Ji and Corson [14], proposed a Differential Destination Multicast (DDM) Protocol. In DDM, the sources control multicast group membership to ease certain aspects of security administration. More importantly, and a departure from other proposed MANET multicast protocols, DDM encodes the destinations (i.e. the multicast group members to whom the data needs to be delivered) in each data packet header in a fashion different. Firstly, there is no control overhead expended when the group which is idle and the characteristic is shared with DSR. The hope is that the unicast algorithm can converge much faster, with DDM then making immediate use of new unicast routing knowledge.

Royer and Perkins [17] given an idea of ad hoc networks of mobile nodes date back to the days of the DARPA packet radio network. The improvements include greater power longer battery life and decreased weight because so many laptop computers are now in use and because these computers are easily portable due to their compact and lightweight design the ability to communicate from one such computer to another and from one such computer to a fixed network is desired. Although multicast is not necessary to establish communication between nodes it is frequently a desired feature for a network. The Lightweight Adaptive Multi cast LAM protocol is an example of one of these protocols LAM is tightly coupled with the Temporally Ordered Routing Algorithm TORA as it depends on TORAs route finding ability and cannot operate in dependently An advantage of LAM is that since it is tightly coupled with TORA it can take advantage of TORAs route finding ability and thereby reduce the amount of control overhead generated.

Chiang et al. [4] a new multicast protocol for multihop mobile wireless networks. Instead of forming multicast trees, a group of nodes in charge of forwarding multicast packets is designated according to members' requests. Multicast is then carried out via "scoped" flooding over such set of nodes. The forwarding group is periodically refreshed to handle topology/membership changes. The key innovation with respect to wired multicast schemes like DVMRP is the use of flags rather than upstream/downstream link state, making the protocol more robust to mobility.

Lee et al. [9] proposed a protocol named ODMRP which creates a mesh of nodes the forwarding group which forward multicast packets via flooding within the mesh, thus providing path redundancy. ODMRP is an on-demand protocol, thus it does not maintain route information permanently. Member nodes are refreshed as needed and do not send explicit leave messages. In ODMRP, group membership and multicast routes are established and updated by the source on demand. Similar to on-demand unicast routing protocols, a request phase and a reply phase comprise the protocol.

3. ENHANCED EFFICIENT GEOGRAPHIC MULTICAST ROUTING PROTOCOL

The proposed work is based on the zone support geographic forwarding and routing. The proposed methodology explains about reduce in topology maintenance overhead to support reliable multicasting, and make use of the position information for multicast routing. EEGMRP uses a virtual-zone-based structure to implement scalable and efficient group membership management.

A network wide zone-based bidirectional tree is constructed to achieve more efficient membership management and multicast delivery. The position information is used to guide the zone structure building, multicast tree construction, and multicast packet forwarding, which efficiently reduces the overhead for route searching and tree structure maintenance. Several strategies have been proposed to further improve the efficiency of the protocol.

3.1 ZONE CLUSTERING USING ZONE ROUTING PROTOCOL

The Proposed protocol EEGMRP is virtual based zone structure. Making use of the position information, a scalable virtual zone-based scheme for efficient membership management is formed, which allows a node to join and leave a group quickly. The zones are configured using the transmission range. The zone structure is formed virtually and the location of the nodes in zones is calculated based on the position of the node and the reference origin using Zone Routing Protocol (ZRP). So the construction of zone structure does not depend on the shape of the network region, and very simple to locate and maintain a zone. The nodes are distributed in zones by their transmission range. A node uses the Global Positioning System (GPS) to obtain its geographic location information. The locations of other nodes can be obtained by employing some distributed location service. The zones partitioned in EEGMRP provide the location reference and support lower-level group membership management.

However, in practice, the maintenance of nodes location and to find with accuracy in an ad hoc environment is difficult when nodes move around. Some well-known location-based routing algorithms are location-aided routing (LAR) protocol [12], distance routing effect algorithm for mobility (DREAM) [3] and Grid Location Service (GLS) are used to maintain the location of the node. A multicast group can cross multiple zones. With the virtual zone structure, EEGMRP not only the track individual node movement but tracks the membership changes of zones, which significantly reduces the management overhead and increases the robustness of the proposed multicast protocol. EEGMRP supports scalable and reliable membership management and multicast forwarding through a two-tier virtual zone-based structure.

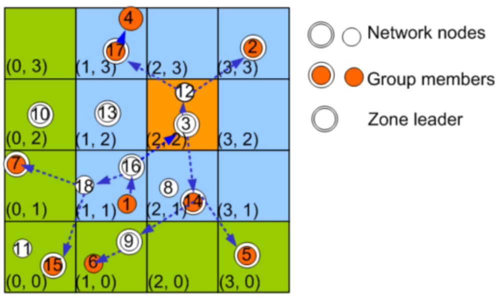

Fig.1. Example of Zone Structure

At the lower layer, in reference to a predetermined virtual origin, the nodes in the network self-organize themselves into a set of zones as shown in Fig.1, and a leader is elected in a zone to manage the local group membership. At the upper layer, the leader serves as a representative for its zone to join or leave a multicast group as required. At the upper layer, the multicast packets will flow along the multicast tree both upstream to the root zone and downstream to the leaf zones of the tree. At the lower layer, when an on-tree zone leader receives the packets, it will send them to the group members in its local zone. The following are some of the notations used in zone partitioning.

- *Zone* - The network terrain is divided into square zones as shown in Fig.1.
- *r* - Zone size, the length of a side of the zone square. The zone size is set to
- $r \le \frac{r_t}{\sqrt{2}}$, where r_t is the transmission range of the mobile nodes.
- *Zone ID* - The identification of a zone. A node can calculate its zone ID (a,b) from its position coordinates (x,y) as:
- $a = [(x-x_0)/r]$, $b=[(y-y_0)/r]$, where (x_0,y_0) is the position of the virtual origin, which can be a known reference location or determined at network setup time.
- *ZLdr* - Zone leader is elected in each zone for managing the local zone group membership and taking part in the upper tier multicast routing.

In EEGMRP, the zone structure is virtual and calculated based on a reference point. Thus the construction of zone structure does not depend on the shape of the network region, and it is very simple to locate and maintain a zone.

3.2 DEFINING GROUP LEADER USING THE HIERARCHICAL TREE STRUCTURE

A leader is elected in a zone only when the zone has group members in it to avoid unnecessary management overhead. When a multicast group member moves into a new zone, if the zone leader (*zLdr*) is unknown, group member queries the neighbor node in the zone for the leader. When failing to get the leader information, group member announces itself as a leader by flooding a LEADER message into the zone. The following are the steps involved in defining the group leader with neighbor table generation.

- Multicast Tree Construction
- Neighbor Table Generation and Selection of Group Leader
- Tree Updation

3.2.1 Multicast Tree Construction:

EEGMRP maintains a multicast tree for each multicast group with their members. Each multicast group has a unique multicast group address and a group leader. The group member that first constructs the tree is designated as the group leader or the primary root of the tree. EEGMRP, instead of connecting each group member directly to the tree, the tree is formed in the granularity of zone with the guidance of location information, which significantly reduces the tree management overhead. With a destination location, a control message can be transmitted immediately without incurring a high overhead and delay to find the path first, which enables quick group joining and leaving. Once the whole network is traced in search of multicast group and still no reply is received by the request node, the node assumes that the requested multicast group does not exist. The node then declares itself as the leader of the multicast group and becomes the primary root of the tree and broadcasts this information to all nodes within its zone.

The broken individual links are repaired, so the robustness of the multicast tree is adversely affected with the time delay. Over a period of time due to high mobility of the nodes the overall structure of the tree would be far from optimal, hence leads the tree at risk to even more link breakages. In EEGMRP, the tree is updated regularly and also the preventive maintenance is done which keep the tree robust.

3.2.2 Neighbor Table Generation and Selection of Group Leader:

For efficient management of states in a zone, a leader is elected with minimum overhead. As a node employs periodic BEACON message to distribute its position in the underneath geographic unicast routing [15], to facilitate leader election and reduce overhead, EEGMRP simply inserts in the BEACON message a flag indicating whether the sender is a zone leader. With zone size $r \le \frac{r_t}{\sqrt{2}}$, a message will be received by all the nodes in the zone.

Each node maintains its neighbor table without extra signaling. By receiving a BEACON message from a neighbor, a node records the node ID, position, and flag contained in the message in its neighbor table. The Table.1 shows the sample neighbor table of node 18 from Fig.1.

Table.1. Neighbor table of node 18

Node ID	Position	Flag	Zone ID
16	(x_{16},y_{16})	1	(1,1)
1	(x_1,y_1)	0	(1,1)
7	(x_{17},y_{17})	1	(0,1)
13	(x_{13},y_{13})	1	(1,2)

When a node appears in the network, sends out a BEACON message announcing existence. Then, the node waits for a time period for the beacons from other nodes. Every time a node will check its neighbor table and determine its zone leader under different cases.

- The neighbor table contains no other nodes in the same zone; the node will announce itself as the leader.
- The flags of all the nodes in the same zone are unset, which means that no node in the zone has announced the leadership role. If the node is closer to the zone center than other nodes, the node will announce its leadership role through a beacon message with the leader flag set.
- More than one node in the same zone have their leader flags set, the one with the highest node ID is elected.
- Only one of the nodes in the zone has its flag set, and then the node with the flag set is nominated as the leader.

3.2.3 Tree Updation:

In order to maintain the tree structure even when nodes move, group members periodically send tree update messages to the root node. The multicast tree can be updated using the path information included in the tree update request messages. If any change is found in the path of the root node the changes in the topology also reflect in the tree structure. Tree update need to be initiated by leaf nodes only as each uplink next hop puts its own uplink on the tree update message, therefore contains all uplinks as it travels towards backup root node. The periodic updation must be carefully chosen to balance the overhead associated with tree update and the delay caused by the tree not being timely updated when nodes move.

When a link breakage is detected, the member node of the break node leaves from the group leader initiates to repair the link by broadcasting a demand within the zone. Only a tree node with lesser hop count to the leader that is nearer to the group leader may respond to this demand. The node receives a reply and grafts a new branch using graft message up to the node which sent the demand.

3.2.4 Route Discovery:

Each node knows its location in every moment and this location information is used for route discovery in the network. Routing is done using the last known location and with assumption. Route discovery is initiated when source does not know a route to the destination or previous route from source to destination is broken. The proposed research methodology EEGMRP is based on the Dynamic Source Routing (DSR) [11] in the discovery of route the source and destination. A node, on receiving a data packet, only needs to forward the packet to the next node on the route. The advantage of intermediate hosts does not need to maintain any routing information locally. However, the overhead is on the longer packet headers, which may traverse several hops.

The node selects its next hop as the neighboring node whose zone is the closest to the destination zone and closer to the destination zone than its own zone. If multiple nodes are available, the neighbor closest to the destination is selected as the next hop. To compare the distances of different zones to the destination zone, the distance value is calculate for the node $dis(a,b)$ of a zone (a,b) to the destination zone (a_{dst}, b_{dst}) as

$$dis(a,b) = (a - a_{dst})^2+(b - b_{dst})^2 \quad (1)$$

A zone with a smaller dis value is closer to the destination zone. The simulation results confirm that using zone forwarding mode can help reduce the number of undelivered packets. The drawback of the existing protocol is all the nodes are in wake state always, even if there is no data communication. Hence unnecessary loss of energy is occurred in the mobile nodes. By the energy loss in the nodes, the route link between the nodes gets breakdown. So there is loss in communication and reduce in the throughput. To avoid this problem Sleep-Wake scheduling method is introduced in the node to save energy when there is no data communication.

3.3 SLEEP-WAKE SCHEDULING METHOD

In MANET, there are no base stations and each node acts as a router and packet forwarder. Hence, the computation and communication load is high, it is to say power control impacts on the routes employed. The routing protocol aims to find the optimal path which can reduce the energy consumption of mobile nodes and increase the life-span of network. Death of nodes due to energy exhausted may lead to the network partition and cause communication failure with other active nodes. To solve the problem, EEGMRP uses the path with lowest energy consumption and balances the traffic load in network. The proposed protocol provides the hop-by-hop as well as end-to-end energy control. On one hand, it adjusts transmission power for per-hop to implement energy control. On the other hand, it discovery the feasible routes based on residual energy and transmission power of nodes so as to enhance the overall performance of network.

EEGMRP supports energy conservation by making mobile nodes put their wireless network cards to sleep when no data communication is taking place. Sleep-Wake scheduling consists of two main phases.

- Setup Phase
- Operation Phase

The setup phase is further divided in two sub-phases are Initialization and Route Update. In the setup phase, the transmission range for the node is initialized and the route update information is gathered. All the nodes in the network are partitioned using different transmission power. Each node computes its energy level and position in the networks. This information is used in sleep-wake up scheduling, route update, and event reporting.

The operation phase is further divided in two sub-phases are Sleep scheduling and Event Reporting. Sleep wake scheduling is performed based on traffic loads. In each sleep-wake cycle, node wakes up at set time intervals, waits for events to occur, scans the medium, and senses or receives the data.

3.4 MULTICAST PACKET FORWARDING

The successful delivery of a packet in MANET depends on the accurate addressing of the packet. After the multicast tree is constructed, all the sources of the group could send packets to the tree and the packets will be forwarded along the tree. In most tree-based multicast protocols, a data source needs to send the packets initially to the root of the tree. The packets send to the root would introduce extra delay when a source is far away from the root. Maintaining the multicast table and the member zones normally cannot be reached within one hop from the source.

For example, a node N has a multicast packet to forward to a list of destinations (D_1, D_2, D_3), the node N decides the next hop node towards each destination for a zone, its center is used by the geographic forwarding strategy. After deciding the next hop nodes, N inserts the list of next hop nodes and the destinations associated with each next hop node in the packet header. The list is $(N_1{:}D_1, D_3; N_2{:}D_2)$, where N_1 is the next hop node for the destinations D_1 and D_3, and N_2 is the next hop node for D_2. Then N broadcasts the packet promiscuously for reliability and efficiency. Upon receiving the packet, a neighbor node will keep the packet if that node is one of the next hop nodes or destinations, and drop the packet otherwise. When the node is associated with some downstream destinations, then the node will continue forwarding packets similarly as done by node N.

3.4.1 Energy Factor Calculation:

Qin et al. [7] has proposed an energy efficient routing metric called as Energy factor. They have used this metric for multipath concept where the most energy efficient as well as shortest path is selected to deliver the data packets. Similarly, in our method we use this metric to select the next hop node while discovering the path to destination. The energy efficient routing metric for selecting the node has the sufficient energy to route the packets. The terms used in metric are as follows: p: Node, EF_p: Energy Factor of node p, RE_p: Remaining Energy of node p, and IE_p: Initial Energy of node p.

Energy factor is calculated using the Eq.(2) for every node when it receives route request or data packet.

$$EF_p = RE_P / IE_P \quad (2)$$

The EF of all the nodes along a valid path are multiplied together to obtain the EF of the path. The minimum cost is given by,

$$\text{Minimum Cost} = \Pi_{p\in N} EF_p$$

where, N: Number of nodes between source S and Destination D.

Minimum cost metric selects the most energy-efficient path. The purpose of multiplication of EF values is to select the nodes having sufficient energy so that the minimum cost of the path from source to destination is high. The minimum energy cost represents energy consumption of the network in order to prolong all connections between source and destination nodes. The energy cost is calculated using realistic energy consumption by the nodes with the channel quality and each packet is successfully received.

3.4.2 Route Maintenance and Optimization:

Route maintenance is important in ad-hoc networks. The links are broken and established as nodes move relatively to each other with limited radio coverage. In the zone structure, by the movement of nodes between different zones, some zones may become empty. Route maintenance and optimization is critical to handle the empty zone problem in a zone-based protocol. The connections of individual nodes are managed to a much lower rate of zone membership change and hence lower overhead in maintained in the zone-based tree. When a member node moves to a new zone, the node must rejoin the multicast tree through the new leader. When a leader is moving away from its current zone, the leader node must handover its multicast table to the new leader in the zone, so that all the downstream zones and nodes will remain connected to the multicast tree.

4. RESULTS AND DISCUSSIONS

The system was implemented successfully using Global Mobile Simulation (Glomosim 2.03) library. The necessary input parameters are given in the Config.in file. The simulation procedure should be specific about certain parameters as mentioned below to enable hassle free simulation. The result of proposed protocol EEGMRP is discussed and compared with the existing protocol EGMP. To measure the performance of the proposed work, Energy Consumption, Collision rate, and Throughput are evaluated.

4.1 ENERGY CONSUMPTION

The performance of energy consumption is a measure of energy spent for forwarding a packet to the sink node. EGMP devour more energy and each time it sends signal to all the available nodes in the path to the destination to send the data packets EGMP could not cope up with the large group size and network size. This problem is overcome in the proposed research work EEGMRP. Sleep-Wake scheduling method is used to avoid the energy consumption problem.

The Fig.2 shows the comparison chart of EGMP and EEGMRP. The energy consumption is calculated by the cost of transmitting packet, receiving of packets and discarding of the packets during the period of error. The energy consumption of existing protocol is average of 50J. The energy consumption for the proposed protocol is average of 15J.

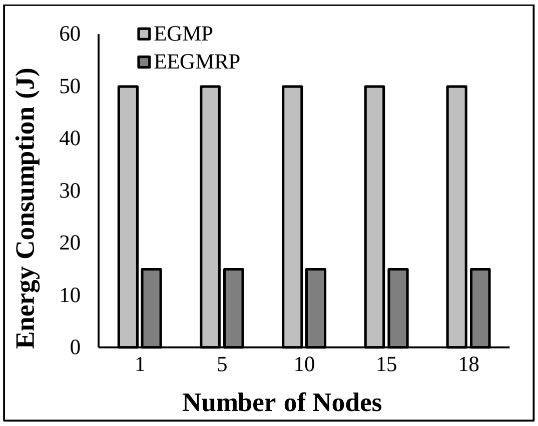

Fig.2. Energy Consumption for EGMP and EEGMRP

The energy consumption is highly reduced by the Sleep-Wake Scheduling method. The energy utilization factor of EEGMRP using sleep-wake scheduling is extremely very low when compared with the EGMP.

4.2 COLLISION RATE

In a network, when two or more stations attempt to transmit a packet across the network at the same time, a packet collision occurs. In the proposed routing protocol EEGMRP the collision rate is highly reduced when compared to the existing protocol EGMP

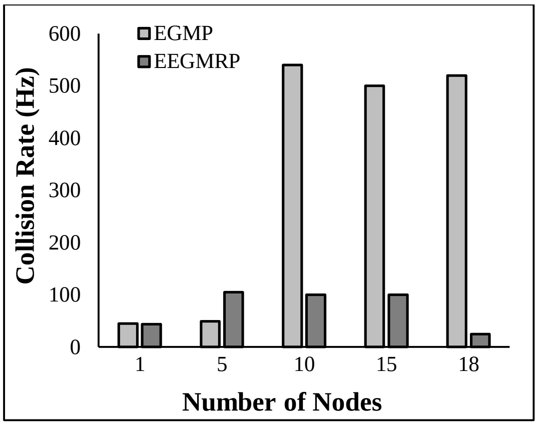

Fig.3. Comparison Chart of Collision Rate of EGMP and EEGMRP

The Fig.3 shows the comparison chart of EGMP and EEGMRP. The collision rate is much decreased in the proposed work using the sleep-wake scheduling. The nodes get awake, only when the node receives the signal to receive the data or divert the data packets to other nodes otherwise the node stays idle. In EEGMRP protocol sleep-wake schedule is defined for all the nodes which increase the number of wake idle nodes especially as move away from the sink node. Thus the result shows that the EEGMRP protocol is much efficient and could perform better as the size of the network becomes larger.

4.3 THROUGHPUT

The amount of data transferred from one place to another or processed in a specified amount of time. Data transfer rates for networks are measured in terms of throughput. The Throughput measures the number of packets received per second at the sink node.

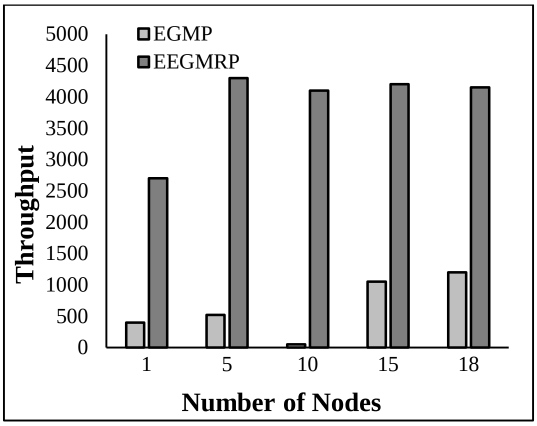

Fig.4. Comparison Chart of Throughput for EGMP and EEGMRP

The throughput of EEGMRP is much increased in the proposed work using the Sleep-Wake scheduling. Since the nodes are idle sends the data packets faster than in any other mode. EEGMRP has achieved throughput greater than the EGMP for greater network size. Thus the EEGMRP protocol is scalable and performs better in the larger network size.

When compared to EGMP, EEGMRP gives better result in terms of zone formation method and introduction of sleep/wake scheduling method. By the comparative results it is clear that the EGMP is quite not efficient and scalable when compare to EEGMRP. Multicasting and Energy utilization is scalable and efficient in EEGMRP.

5. CONCLUSION

Conventional multicast protocols generally do not have good scalability due to the overhead incurred for route searching, group membership management, and creation and maintenance of the tree structure over the dynamic MANET. EGMP devour more energy and each time it sends signal to all the available nodes in the path to the destination to send the data packets and EGMP could not cope up with the large group size and network size.

The proposed research work achieves the drawbacks of existing protocol EGMP. The scalability of EEGMRP is achieved through a two-tier virtual-zone-based structure, which takes advantage of the geometric information to greatly simplify the zone management and packet forwarding. Sleep-wake scheduling has been proposed to reduce energy consumption. The empty zone problem is also handled in the proposed work, which is challenging for the zone-based protocols. The simulation results of EEGMRP shows the better performance in high packet delivery ratio and low control overhead and multicast group joining delay under all cases studied, and is scalable to both the group size and the network size. Compared to the geographic multicast protocol EGMP, the proposed protocol EEGMRP has significantly lower control overhead, data transmission overhead, throughput, multicast group joining and energy utilization. As the future work focus on the clustering protocols to serve different requirements of adhoc networks. Besides minimizing the resource consumption over the whole network, an efficient clustering protocol should also maximize the lifetime of MANET by evenly distributing energy consumption over all mobile nodes. The relationship between the prediction accuracy and the cluster activation strategy still remains an open issue.

REFERENCES

[1] A.A. Abbasi, K. Akkaya and M. Younis, "A Distributed Connectivity Restoration Algorithm in Wireless Sensor and Actor Networks", *Proceedings of 32nd IEEE Conference on Local Computer Networks*, pp. 103-108, 2007.

[2] S. Basagni, I. Chlamtac, V.R. Syrotiuk and B.A. Woodward, "A Distance Routing Effect Algorithm for Mobility (DREAM)", *Proceedings of 4th Annual ACM/IEEE International Conference on Mobile Computing and Networking*, pp. 1-6, 1998.

[3] K. Chen and K. Nahrstedt, "Effective Location-Guided Tree Construction Algorithms for Small Group Multicast in MANET", *Proceedings of 21st Annual Joint International Conference of the IEEE Computer and Communications Societies*, pp. 1180-1189, 2002.

[4] C. Chiang, M.Gerla and L. Zhang, "Forwarding Group Multicast Protocol (FGMP) for Multihop, Mobile Wireless Networks", *Cluster Computing*, Vol. 1, No. 2, pp. 187-196, 1998.

[5] A.E.F. Clementi, P. Crescenzi, P. Penna, G. Rossi and P. Vocca, "On the Complexity of Computing Minimum Energy Consumption Broadcast Subgraphs", *Proceedings of Annual Symposium on Theoretical Aspects on Computer Science*, pp. 121-131, 2001.

[6] Cordeiro C. De Morais, H. Gossain and D.P. Agrawal, "Multicast over Wireless Mobile Ad Hoc Networks: Present and Future Directions", *IEEE Network*, Vol. 17, No. 1, pp. 52-59, 2003.

[7] Y. Qin, Y.Y. Wen, H.Y. Ang and C.L. Gwee, "A Routing Protocol with Energy and Traffic Balance Awareness in Wireless Ad Hoc Networks", *Proceedings of 6th International Conference on Information, Communications and Signal Processing*, pp. 1-5, 2007.

[8] X. Xiang, Z. Zhou and X. Wang, "Self-Adaptive On Demand Geographic Routing Protocols for Mobile Ad Hoc Networks", *IEEE Transactions on Mobile Computing*, Vol. 11, No. 9, pp. 1572-1586, 2007.

[9] Sung-Ju Lee, William Su and Mario Gerla, "On-Demand Multicast Routing Protocol in Multihop Wireless Mobile Networks", *Mobile Networks and Applications*, Vol. 7, No. 6, pp. 441-453, 2002.

[10] Sunil Taneja, Ashwani Kush and Amandeep Makkar, "Power Management in Mobile Ad Hoc Network", *International Transaction Journal of Engineering, Management, and Applied Sciences and Technologies*, Vol. 2, No. 2, pp. 215-225, 2011.

[11] D.B. Johnson and D.A. Maltz, "Dynamic Source Routing in Ad Hoc Wireless Networks", *Mobile Computing*, Vol. 353, pp. 1-16, 1996.

[12] Ko Y. B and Vaida N. H, "Location-Aided Routing (LAR) in Mobile Ad Hoc Networks", *Proceedings of International Conference on Mobile Computing*, pp. 66-75, 1998.

[13] F. Kuhn, R. Wattenhofer, Y. Zhang and A. Zollinger, "Geometric Ad-Hoc Routing: Of Theory and Practice", *Proceedings of 22nd Annual Symposium on Principles of Distributed Computing*, pp. 63-72, 2003.

[14] J. Lusheng and M.S. Corson, "Differential Destination Multicast: A MANET Multicast Routing Protocol for Small Groups", *Proceedings of International Conference on Computer Communications*, pp. 22-26, 2001.

[15] S.J. Lee, W. Su, J. Hsu, M. Gerla and R. Bagrodia, "A Performance Comparison Study of Ad Hoc Wireless Multicast Protocols", *Proceedings of International Conference on Computer Communications Societies*, pp. 26-30, 2000.

[16] J. Li, J. Jannotti, D.R. Karger and R. Morris, "A Scalable Location Service for Geographic Ad Hoc Routing", *Proceedings of International Conference on Mobile Computing and Networking*, pp. 120-130,. 2000.

[17] E.M. Royer and C.E. Perkins, "Multicast Operation of the Ad Hoc On-Demand Distance Vector Routing Protocol", *Proceedings of International Conference on Mobile Computing*, pp. 207-218, 1999.