A Supporting Efficient and Dynamic Multicasting Over Multiple Regions in Mobile Ad Hoc Networks

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Abstract

Designing multicast routing protocol is a big challenge due to difficulty in achieving group membership management, packet forwarding and maintenance of multicast structure over the dynamic network topology. In this paper, we proposed a novel Efficient Geographic Multicast Protocol (EGMP). A network wide zone-based bi-directional tree is used to achieve efficient membership management and multicast delivery. In Efficient EGMP an efficient distributed algorithm is used, that support dynamic changes to the multicast group during tree building and allows overlapping join/leave operations. The multicast tree is constructed based on zone depth, which is efficient in guiding tree branch building and tree structure maintenance. Nodes in the network self-organized into zones and zone-based bidirectional-tree-based distribution paths are built. Our simulation results demonstrate that EGMP has high packet delivery ratio, low control overhead and multicast group joining delay under all test scenarios, and is scalable to both group size and network size.

1. Introduction

A Given the increasing demand for flexibility as well as technological advances in mobile communication devices such as wireless LANs, laptop computers and smart phones, wireless communications are becoming more and more common. There are several advanced efforts to enable wireless communication over mobile networks. Multicasting is one such effort that strives to provide support for wireless communication in mobile networks. 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. It is a big challenge in developing a robust multicast routing protocol for dynamic Mobile Ad-Hoc Network (MANET). Multicast is a fundamental service for supporting information exchanges and collaborative task execution among a group of users and enabling cluster-based computer system design in a distributed environment. Although it is important to support multicast in a mobile ad hoc network (MANET), which is often required by military and emergency applications, there is a big challenge to design a reliable and scalable multicast

routing protocol in the presence of frequent topology changes and channel dynamics

In this work, we propose a Efficient Geographic Multicast Protocol, EGMP, which can extent to a large group size and large network size and this protocol will provide efficient multicast packet transmissions in a dynamic mobile ad hoc network environment. We introduce several virtual architectures for more robust and scalable membership management and packet forwarding in the presence of high network dynamics due to unstable wireless channels and frequent node movements. Both the data packets and control messages will be transmitted along efficient tree-like paths, however, different from other tree-based protocols, there is no need to explicitly create and maintain a tree structure. A virtual-tree structure can be formed during packet forwarding with the guidance of node positions. Furthermore, EGMP makes use of position information to support reliable packet forwarding. The protocol is designed to be comprehensive and self-contained. Instead of addressing only a specific part of the problem, it introduces a zone-based scheme to efficiently handle the group membership management, and takes advantage of the membership management structure to efficiently track the locations of all the group members without resorting to any external location server. The zone structure is formed virtually and the zone where a node is located can be calculated based on the position of the node and a reference origin.

Conventional topology-based multicast protocols include tree-based protocols and mesh-based protocols. Tree-based protocols construct a tree structure for more efficient forwarding of packets to all the group members. Mesh-based protocols expand a multicast tree with additional paths which can be used to forward packets when some of the links break. In topology-based cluster construction, a cluster is normally formed around a cluster leader with nodes one hop or k-hop away, and the cluster will constantly change as network topology changes. Although number of efforts were made to develop the scalable topology-based routing protocols. Now, In contrast, there is no need to involve a big overhead to create and maintain the geographic zones proposed in this work, which is critical to support more efficient and reliable communications over a dynamic MANET. By

making use of the location information, EGMP 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.

2. Related work

In this section we present and classify existing multicast routing protocol for MANETs. A brief overview of a few existing multicast protocols that are relevant to our work is provided. Conventional topology-based multicast protocols include tree-based protocols (e.g., [17],[10], [18], [19]) and mesh-based protocols (e.g., [20], [21]). Tree-based protocols construct a tree structures for more efficient forwarding of packets to all the group members. Mesh-based protocols expand a multicast tree with additional paths that can be used to forward multicast data packets when some of the links break. A topology-based multicast protocol generally has the following three inherent components that make them difficult to scale: Group membership management, Creation and maintenance of a tree- or mesh-based multicast structure, Multicast packet forwarding. Besides the three components included in conventional topology-based multicast protocols, a geographic multicast protocol also requires a location service to obtain the positions of the members. The geographic multicast protocols presented in [22], [1] and [3] need to put the information of the entire tree.

The Position Based Multicast Protocol [10] which uses the geographic position of the nodes to make forwarding decisions. PBM neither requires the maintenance of a distribution structure nor resorts to flooding. A multicast source node finds a set of neighbouring, next-hop nodes and assigns each packet destination to one next-hop node. The next-hop nodes, in turn, repeat the process. Thus, no global distribution structure is necessary.

The Location-Guided Tree [4] is applicable for small communication group. In this protocol an upper overlay packet delivery tree is created on top of the underlying unicast protocol. LGT requires each group member to know the locations of all other members, and proposes two overlay multicast trees: a bandwidth-minimizing LGS tree and a delay-minimizing LGK tree. In GMP [23], which proposed for sensor networks, a node needs to perform a centralized calculation for more efficient tree construction. Therefore, it is more applicable for a smaller group in a static network.

The HRPM [6] and SPBM [13] are more related to our work, as the two share the essence as EGMP in improving the scalability of location-based multicast by using hierarchical group management. he Hierarchical Rendezvous Point Multicast (HRPM) protocol, which significantly improves the

scalability of stateless multicast with respect to the group size.

HRPM consists of two key design ideas: 1) hierarchical decomposition of a large group into a hierarchy of recursively organized manageable-sized subgroups and 2) the use of distributed geographic hashing to construct and maintain such a hierarchy at virtually no cost. Although it is interesting to apply hashing to find the rendezvous point (RP) for the network to store and retrieve state information, the hashed location is obtained with the assumption of the network size, which is difficult for a dynamic network. Also, as the hashed location is virtual, it is possible that the nodes could not find the (consistent) RP. The mobility of nodes will introduce additional challenge to the protocol, which may not only result in frequent RP handoff, but also increase the chance of RP search inconsistency and failure. Additionally, requiring a node to contact RP first for a Join will increase joining delay. Also the change of the membership of a zone does not need to be sent to a far-away RP but only needs to be updated locally. Instead of using one RP as a core for group membership management, this may lead to a point of failure.

In contrast, EGMP does not make any assumption of the network size in advance, and the change of the membership of a zone does not need to be sent to a far-away RP but only needs to be updated locally. Instead of using one RP as a core for group membership management, which may lead to a point of failure, EGMP introduces the root zone which is much more stable than a single point, and manages group membership more efficiently within the local range. Instead of using the overlay-based multiple unicast transmissions, EGMP takes advantage of the promiscuous mode transmission to forward packets along more efficient transmission paths.

The Scalable Position-Based Multicast (SPBM) [13], is a multicast routing protocol for ad-hoc networks. SPBM uses the geographic position of nodes to provide a highly scalable group membership scheme and to forward data packets with a very low overhead. SPBM bases its multicast forwarding decision on whether there are group members located in a given direction or not, allowing for a hierarchical aggregation of group members contained in geographic regions: the larger the distance between a region containing group members and an intermediate node, The larger can this region be without having a significant impact on the accuracy of the direction from the intermediate node to that region. Because of aggregation, the overhead for group membership management is bounded by a small constant while it is independent of the number of multicast senders for a given multicast group.

In SPBM, the network terrain is divided into a quad tree with L levels. The top level is the whole

network and the bottom level is constructed by basic squares. Each higher level is constructed by larger squares with each square covering four smaller squares at the next lower level. All the nodes in a basic square are within each other's transmission range. At each level, every square needs to periodically flood its membership into its upper level square. Such periodic flooding is repeated for every two neighbouring levels and the top level is the whole network region. Significant control overhead will be generated when the network size increases as a result of membership flooding. With this proactive and periodic membership updating scheme, the membership change of a node may need to go through L levels to make it known to the whole network, which leads to a long multicast group joining time.

Instead, EGMP uses more efficient zone-based structure to allow nodes to quickly join and leave the group. EGMP introduces root zone and zone depth to facilitate simple and more reliable group membership management. EGMP does not use any periodic network-wide flooding, thus it can be scalable to both the group size and network size.

3. Efficient geographic multicast protocol

3.1. Protocol Overview

EGMP supports scalable and reliable membership management and multicast forwarding through a two-tier virtual zone- based 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, based on position information and a leader is elected on demand when a zone has group member to manage the local group membership. The leader manages the group membership and collect the position of the member nodes in its zone. At the upper layer, the leader serves as a representative for its zone to join or leave a multicast group as required. As a result, a network-wide zone-based multicast tree is built. For efficient and reliable management and transmissions, location information will be integrated with the design and used to guide the zone construction, group membership management, multicast tree construction and maintenance, and packet forwarding. The zone-based tree is shared for all the multicast sources of a group.
Some of the notations to be used are:

Zone: The network terrain is divided into square zones.

R: Zone size the length of a side of the zone square. The zone size is set to $r <= rt/2^{1/2}$, where rt is transmission range of the mobile nodes. To reduce intra-zone management overhead, the intra-zone nodes can communicate directly with each other without the need of any intermediate relays.

Zone ID: The identification of a zone. A node can calculate its zone ID (a, b) from its position

coordinates (x, y) as :$a= ((x-xo)/r)$, $b=((y- yo)/r))$, where (xo, yo) is the position of the virtual origin, which is a known reference location. A zone is virtual and formulated in reference to the virtual origin.

Zone center: For a zone with ID (a, b), the position of its center (xc, yc) can be calculated as: $xc=yo+ (b+ 0.5)* r$.

zLdr: Zone leader. A zLdr is elected in each zone for managing the local zone group membership and taking part in the upper tier multicast routing.

tree zone: The tree zones are responsible for the multicast packet forwarding. A tree zone may have group members or just help forward the multicast packets for zones with members.

root zone: The zone where the root of the multicast tree is located.

zone depth: The depth of a zone is used to reflect its distance to the root zone. For a zone with ID (a, b), its depth is

$$Depth = max (|ao-a|,|b0-b|)$$

Where (ao, bo) is the root-zone ID. For example, in Fig. 1, the root zone has depth zero, the eight zones immediately surrounding the root zone have depth one, and the outer seven zones have depth two.
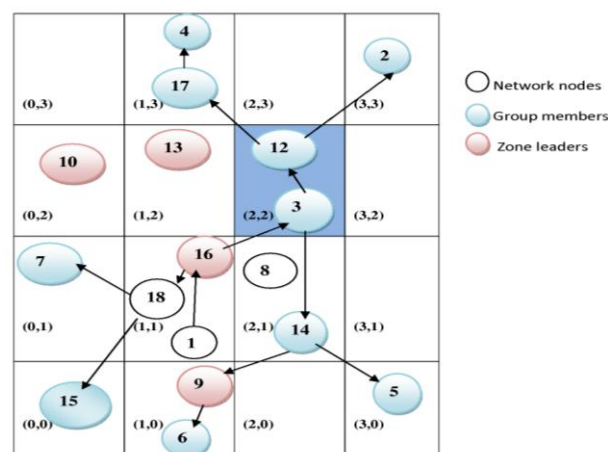

Figure 1. Zone structure

In EGMP, the zone-structure is virtual and calculated based on a reference point. Therefore, 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. The zone is used in EGMP to provide location reference and support lower level group membership management. A multicast group can cross multiple zones. With the introduction of virtual zone, EGMP does not need to track individual node movement but only needs to track the membership change of zones, which significantly reduces the management overhead and increases the robustness of the proposed multicast protocol. We choose to design the zone without considering node density so it can provide more reliable location reference and

membership management in a network with constant topology changes.

3.2 Neighbour Table Generation and Zone Leader Election

A node constructs its neighbour table without extra signalling. When receiving a beacon from a neighbour, a node records the node ID, position, and flag contained in the message in its neighbour table. The zone ID of the sending node can be calculated from its position. To avoid routing failure due to outdated topology information, an entry will be removed if not refreshed within a period TimeoutNT or the corresponding neighbour is detected unreachable by the MAC layer protocol. A zone leader is elected through the cooperation of nodes and maintained consistently in a zone. When a node appears in the network, it sends out a beacon announcing its existence. Then, it waits for an Intvalmax period for the beacons from other nodes. Every Intvalmin a node will check its neighbour table and determine its zone leader under different cases: 1) the neighbour table contains no other nodes in the same zone; it will announce itself as the leader. 2) 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 centre than other nodes, it will announce its leadership role through a signal message with the leader flag set. 3) More than one node in the same zone have their leader flags set, the one with the highest node ID is elected. 4) Only one of the nodes in the zone has its flag set, and then the node with the flag set is the leader.

Table 1: The neighbour table of node 18 in fig. 1

Node ID	position	flag	Zone ID
16	(x16,y16)	1	(1, 1)
1	(x1,y1)	0	(1, 1)
7	(x7,y7)	1	(0, 1)
13	(x13,y13)	1	(1, 2)

3.3 Zone-supported Geographic Forwarding

Nodes from the same zone are within each other's transmission range and are aware of each other's location. Transmission between nodes in different zones, however, often needs intermediate nodes to relay the packets. In EGMP, the network-tier forwarding of the control messages and data packets is through the underneath geographic unicast routing. However, in the geographic unicast routing, location service is required for the source to get the destination node's position, which will add extra overhead. In EGMP, to avoid the network-range location service, we combine the location service with our hierarchical zone structure. At the network tier, the packet is

forwarded to the centre of the destination zone without the need of any specific node's position. Only when the packet reaches the destination zone, it will be forwarded to a specific node or broadcasted depending on the message type. And for the intra zone communications, only one transmission is required as all the nodes are within each other's transmission range. In the above design, for scalability and reliability, the centre of the destination zone is used as the land mark for sending an packet to the group members in the zone although there may be no node located at the center position. This however may result in failure of geographic forwarding. For example, in fig. 1, node 7 is the only node in zone (0,1), while node 18 in zone(1,1) is closet to the center of zone(0,1). When node 16 sends a packet to zone (0,1) with its center as the destination the underlying geographic unicast protocol will forward the packet to node 18 greedily as it is closer to destination. As node 18 cannot find a neighbor closer to center of the zone (0,1) than itself, the perimeter mode may used to continue forwarding. This cannot guarantee the packet to arrive at node 7, as the destination is the virtual reference point. To avoid this problem, we introduce a zone forwarding mode in EGMP when the underlying geographic forwarding fails. Only when the zone mode also fails, the packet will be dropped. In zone mode, a sender node searches for the next hop to the destination based on its neighbor table, which can more accurately track the local network topology. The nodes selects as tis next hop the neighboring node whose zone is the closest to the destination zone and closer to the destination zone than its own zone. It multiple candidates are available, the neighbor closest to the destination is selected as the next hop. To compare the distance of different zones to the destination zone, the node can calculate the distance zone the node can calculate the distance value dis (a, b) of a zone (a, b) to the destination Zone (adst, bdst) .

$Dis (a, b)= (a- adst)^2+(b-bdst)^2$

A zone with a smaller distance value is closer to the destination zone and to avoid possible routing loop and intermediate node only forwards a packet that is received.

3.4 Multicast Tree Construction

In this section, we will present the multicast tree creation and maintenance schemes, and describe the multicast packet delivery strategy. In EGMP the group members are not directly connected to form a tree. Instead of this the tree is formed in the granularity of zone with the guidance of location information. And this will reduce the tree management overhead. The control messages are transmitted with the help of destination location. Thereby reducing overhead and delay to find the path first, this enables quick group joining and

leaving. Distributed algorithm is used to build an efficient multicast tree. The basic algorithm generates a correct tree provided the following conditions hold:

- The multicast group is known to all participants.
- The multicast group does not change once execution of the algorithm has begun.

A practical distributed algorithm must handle changes to the multicast group during tree setup. Two types of changes are possible: additional nodes may wish to join the multicast group and current members of the multicast group may wish to leave. The modifications proposed in this section extend the basic algorithm to support concurrent changes to the multicast group during generation of the tree.

3.4.1 Initialization

When a multicast session is initiated, the source node S will announce the existence of G by flooding a message NEW SESSION(G; zone IDS) into the whole network. This message consists of G and the ID of the zone where S is located. When a node M receives this message and is interested in G, it will join G by sending a JOIN REQ(M; PosM; G; fMoldg) message to its zLdr, carrying its address, position, and group to join. The address of the old group leader Mold is an option used when there is a leader handoff and a new leader sends an updated JOIN REQ message to its upstream zone. Once the leader accepted the JOIN REQ message the leader will send back a JOIN REPLY message to the source of the JOIN REQ message. And the node M will sets the isAcked flag in its membership table to show that joining procedure is completed. After this a fragment is created for each node . Initially, each node is the fragment leader of its fragment. Each node can able to access the routing table of other node and from this they can able to determine the cost of other node in order to transmit the messages to other nodes. The fragment leader is responsible for coordinating mergers with other fragments and for updating group members in its fragment.

3.4.2 Merge Negotiation

Each node looks through its routing table to find the closest multicast participant, which becomes its preferred node. Once a fragment leader selects a preferred node, it sends a MERGE REQUEST containing FragID to that node and waits for a reply. When a fragment leader receives a MERGE REQUEST, if the sender is the preferred node, then it sends an ACCEPT message and both leaders enter the connection phase. If the sender is not the preferred node, then it will send a BUSY reply to

the sender. If a non-leader receives a MERGE REQUEST, it forwards the MERGE REQUEST message to its leader for processing and transmits a BUSY reply, with its FragID attached, to inform the sender of the identity of the fragment leader. When a node receives a BUSY reply to a MERGE REQUEST, the fragment sending the BUSY initiates a MERGE REQUEST later, so the node receiving the BUSY waits for a MERGE REQUEST. A node receiving a BUSY reply to a MERGE REQUEST may ACCEPT a MERGE REQUEST from another fragment, if the cost is less than or equal to its current preferred fragment.

3.4.3 Connection Phase

The purpose of the connection phase is to join two fragments. The fragment leader with the lower ID sends a CONNECT message along the shortest path between the fragments. Upon receiving the CONNECT message, if a node is not a member of another fragment and is not reserved it will forwards the CONNECT message along the shortest path. If a node receiving a CONNECT is a member of another fragment or reserved, the merge fails. The node sends a NACK backward along the shortest path. Each node receiving the NACK cancels its reservation and reverts to its previous status. The procedure then restarts with the selection of another preferred node. If the CONNECT message reaches the tail of the shortest path between the fragments, a MERGED message is sent back along the shortest path between the fragments. The MERGED message makes the reservations permanent and propagates a list of node IDs back to the leader, who adds the new members F. The leader node with the lowest node ID becomes the leader of the combined fragment. The node with the higher ID sends its fragment membership list, via an UPDATE TABLES message, to the new leader. The leader of the combined fragment calculates a new preferred node and multicasts an UPDATE TABLES message to the other fragment members. When a fragment member receives the UPDATE TABLES message, it updates FragID and F, and then computes its own preferred node. If this preferred node is closer than the one suggested by its leader, it returns an UPDATE message with its preferred node and the cost, otherwise it sends back an ACK message. The fragment leader gathers the UPDATE/ACK messages and determines the closest multicast participant that is not a member of the fragment, which becomes the new preferred node. The leader then sends out a MERGE REQUEST and the process repeats.

3.4.4 Join Requests

Requests for entering the multicast group after the tree setup has started are handled as follows: The new node becomes a new singleton fragment,

contacts a member of the multicast group, and then sends a merge request to its preferred fragment. The new node uses its own ID for its fragment identifier and considers itself the leader of this singleton fragment. Two possibilities exist: the multicast tree has already been established or the tree generation is still underway. The new node is unaware of the status of the tree, but knows the identity of the source node. Therefore, it sends a JOIN REQUEST toward. If the tree has already been built, this request is processed in the network by an independent protocol that dynamically adds group member to an existing tree. Otherwise, the join request must be intercepted by our tree-building protocol and processed as a late join. As the JOIN REQUEST propagates toward the multicast source, it either encounters another fragment or reaches the source. The fragment member that receives the JOIN REQUEST forwards it to the fragment leader, which adds this node to its copy. In order to ensure that all nodes in a fragment have a consistent view of the multicast group, the multicast membership lists are merged when fragments merge. A LATE JOIN REPLY is returned to the new node.

3.4.5 Leave Requests

Leave requests are more complicated than join requests, since the node to be deleted may have already been incorporated into a fragment. If the node is still a singleton fragment, it simply sends a NOT INTERESTED response to any MERGE REQUESTs. The node receiving the NOT INTERESTED response to a MERGE REQUEST marks the node as deleted.

3.4.6 Termination and Tree Refinement

The algorithm terminates when there is only one fragment remaining. At some points, additional changes to the multicast group must be postponed so that a multicast tree can be built. This can be done by bounding the number of joins that a fragment accepts. Subsequent JOIN REQUEST is then processed as if the tree has already been build.

Once the algorithm has completed, it may be beneficial to run an optional protocol that prunes leaf node that are marked deleted or are steiner nodes. The state information maintained by multicast group member and steiner nodes may be reduced or eliminated once the tree is built.

3.5 Multicast data forwarding

In our protocol, only zLdrs maintain the multicast table, and the member zones normally cannot be reached within one hop from the source. When a node N has a multicast packet to forward to a list of destinations (D1; D2; D3; :), it decides the next hop node towards each destination using 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. An example list is (N1: D1; D3; N2: D2; :), where N1 is the next hop node for the destinations D1 and D3, and N2 is the next hop node for D2. Then N broadcasts the packet promiscuously. Upon receiving the packet, a neighbor node will keep the packet if it is one of the next hop nodes or destinations, and drop the packet otherwise. When the node is associated with some downstream destinations, it will continue forwarding packets similarly as done by node N. For example, in fig. 1, after node 3 receives the packet from zone (1, 1) it will forward the packet to downstream zones (2.1), (1, 3) and (3, 3). It determines the next hop node for destination and insert the list (12: (1, 3), (3, 3); 14: (2, 1)) in the packet header. After broadcasting the packet its one-hop node 12, 14 and node 8 will drop this packet, while node 12 and 14 will continue forwarding. Node 12 replaces the list carried in the packet header with (17: (1, 3); 2: (3, 3)) and broadcast the packet. Node 14 finds group information from its multicast table and broadcast the packet with a header (9: (1, 0); 5: (3, 0)).

3.6 Multicast Route Maintenance and Optimization

In a dynamic network, it is critical to maintain the connection of the multicast tree, and adjust the tree structure upon the topology changes to optimize the multicast routing. In the zone structure, due to the movement of nodes between different zones, some zones may become empty. It is critical to handle the empty zone problem in a zone-based protocol. Compared to managing the connections of individual nodes, however, there is a much lower rate of zone membership change and hence a much lower overhead in maintaining the zone-based tree. As the tree construction is guided by location information, a disconnected zone can quickly re-establish its connection to the tree. In addition, a zone may be partitioned into multiple clusters due to fading and signal blocking.

4. PERFORMANCE EVALUATION

In this section, we study the performance of EGMP by simulations. We are mainly interested in the protocol's scalability and efficiency in a dynamic environment. We implemented the EGMP protocol using NS2 Simulation. A multicast source broadcasts Join-Query messages to the entire network periodically. An intermediate node stores the source ID and the sequence number, and updates its routing table with the node ID from which the message was received for the reverse path back to the source. A receiver creates and broadcasts a Join Reply to its neighbours, with the next hop node ID field filled by extracting information from its routing table. The neighbour node who's ID matches the next-hop node ID of

the message realizes that it is on the path to the source and is part of the forwarding group. It then broadcasts its own Join Table built upon matched entries. This whole process constructs (or updates) the routes from sources to receivers and builds a mesh of nodes, the forwarding group. We focus on the studies of the scalability and efficiency of the protocol under the dynamic environment and the following metrics were used for the multicast performance evaluation:

1) Packet delivery ratio:

The ratio of the number of packets received and the number of packets expected to receive. Thus for multicast packet delivery, the ratio is equal to the total number of received packets over the number of originated packets times the group size. In EGMP packet delivery ratio was high when compare to other protocol.

2) Normalized control overhead:

The total number of control message transmissions divided by the total number of received data packets. Each forwarding of the control message was counted as one transmission. Control overhead was less in EGMP.

3) Normalized data packet transmission overhead:

The ratio of the total number of data packet transmissions and the number of received data packets. Packet transmission overhead is less in EGMP.
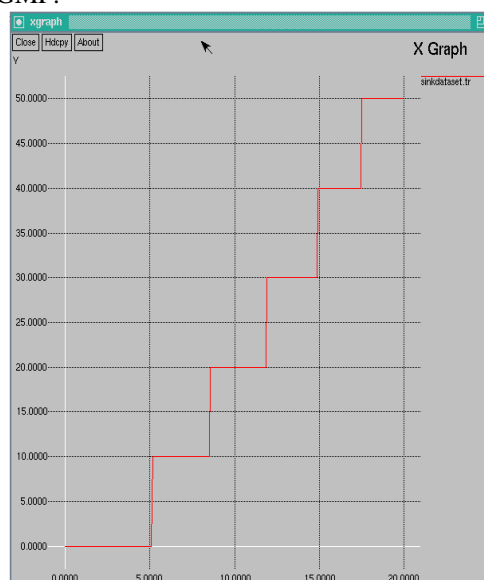

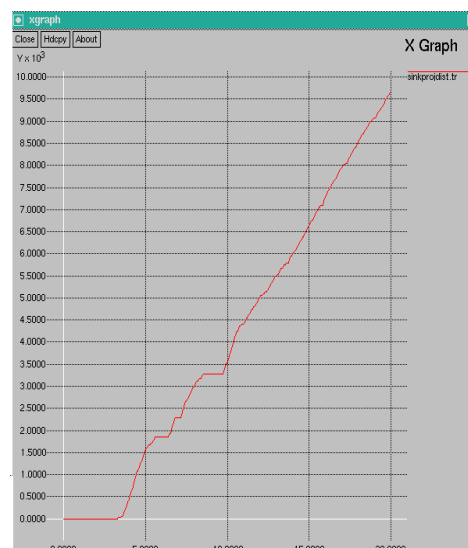Figure 2: Performance analysis of packet delivery ratio

Figure 3 : Performance analysis of Normalized control

4) Joining delay:

The average time interval between a member joining a group and its first receiving of the data packet from that group. Joining delay is also less in EGMP.

On comparing the performance of EGMP with geographic multicast protocol SPBM, EGMP has lower control overhead, lower group joining delay, higher packet delivery ratio, lower data transmission overhead, higher bandwidth utilization, and higher performance. SPBM is seen to have more than six times overhead of EGMP due to the use of periodic local and network-wide flooding in its membership management. And also in EGMP, when a node wants to join a group it will start the joining process immediately because of this joining delay is less. Whereas in SPBM the joining delay will be high most of the time because of the use of periodic multilevel membership update mechanism, it may take a long time for a bottom level square of SPBM to distribute its membership change to the upmost level. And also the increase of mobility also leads to significant increase of transmission of SPBM, as the membership change of a low layer square in SPBM cannot be distributed quickly to upper layer which results in outdated membership information and higher packet transmission overhead. Whereas EGMP will have lower packet transmission overhead. Further in SPBM when there is an existence of collision, it cannot repair it locally but in EGMP when there is existence of collision the packets can travel through any other shortest path and reduces delay in packet transmission to the destination. All these comparison results have shown that EGMP will produce high quality trees when compared to geographic multicast protocol

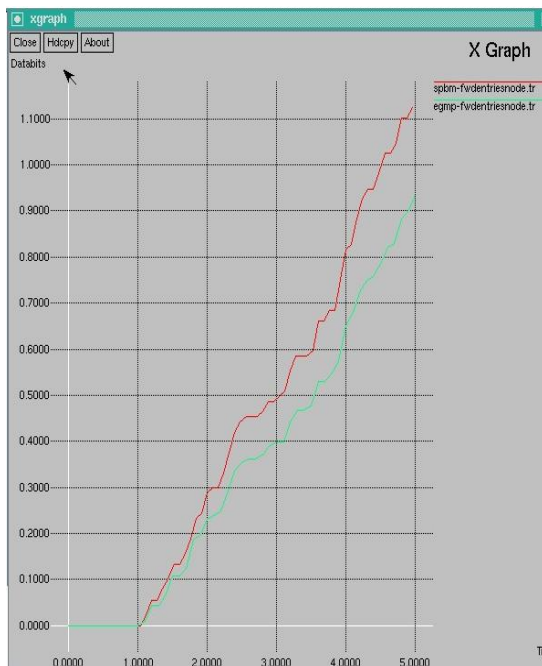SPBM. Figure 4, 5, 6 gives the comparison result EGMP and SPBM.

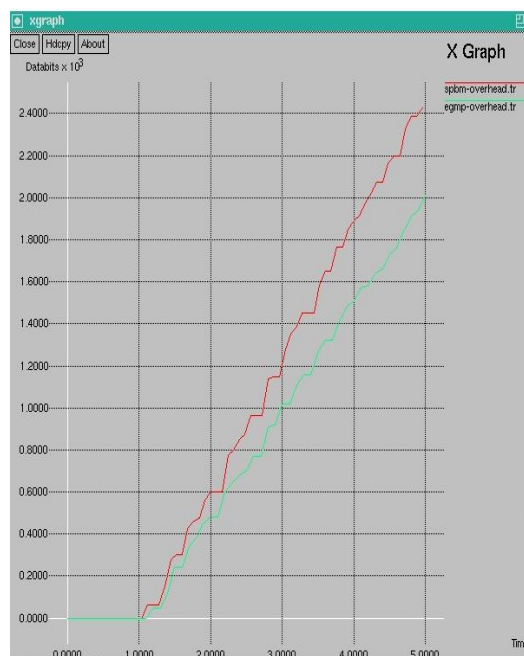Figure 4 : Comparison of control overhead between EGMP and SPBM

Figure 5 : Comparison of group joining delay between EGMP and SPBM

Figure 6 : Comparison of packet delivery ratio between EGMP and SPBM

4. PERFORMANCE EVALUATION
V. CONCLUSION

In this paper, we propose an efficient and scalable geographic multicast protocol, EGMP, for MANET. The scalability of EGMP 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. A zone-based bidirectional multicast tree is built at the upper tier for more efficient multicast membership management and data delivery, while the intra zone management is performed at the lower tier to realize the local membership management. The position information is used in the protocol to guide the zone structure building, multicast tree construction, maintenance, and multicast packet forwarding. Compared to conventional topology-based multicast protocols, the use of location information in EGMP significantly reduces the tree construction and maintenance overhead, and enables quicker tree structure adaptation to the network topology change. We also develop a scheme to handle the empty zone problem, which is challenging for the zone-based protocols. Additionally, EGMP makes use of geographic forwarding for reliable packet transmissions, and efficiently tracks the positions of multicast group members without resorting to an external location server. Our results indicate that geometric information can be used to more efficiently construct and maintain multicast structure, and to achieve more scalable and reliable multicast

transmissions in the presence of constant topology change of MANET. Our simulation results demonstrate that EGMP has 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 SPBM, EGMP has significantly lower control overhead, data transmission overhead, and multicast group joining delay.

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