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EFFICIENT SCALABLE AND ROBUST ZONE STRUCTURED MULTICAST ROUTING PROTOCOL FOR MANET

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ABSTRACT

Routing problems have become highly challenging because of the popularity of mobile devices. A rising amount of interest and importance has sparked among groups which support and communicate through Mobile Ad Hoc networks or MANET. Exchanging messages among a set of army soldiers on duty and communications between firemen during a disaster are examples of the above technology. With a one-to-many or many-to-many transmission pattern, multicast is an efficient method to realize group communications. Group communications are important in MANETs. Multicast is an efficient method to implement group communications. It is challenging to implement efficient and scalable multicast in MANET due to the difficulty in group membership management and multicast packet forwarding over a dynamic topology. A novel Efficient Geographic Multicast Protocol (EGMP) is proposed. EGMP 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 of information guides the zone structure building, multicast tree construction, and multicast packet forwarding, which efficiently reduces the overhead for route searching and tree structure maintenance.

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KEY WORDS

Geographic Routing, Wireless Networks, Mobile Ad Hoc Networks, Multicasting, Protocol.

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INTRODUCTION

The main aim of MANET is to extend mobility into the area of autonomous, mobile and wireless domains where set of nodes form network routing infrastructure in an adhoc fashion [1]. In a MANET, a group of mobile terminals work together to perform a particular task and hence it plays an important role in such networks [2]. Through wireless hosts MANET communicates with each other in absence of a fixed infrastructure. Hops are connected to each other through designed routes among two hosts within a network. With the rapid growth of demand in group communications the multicast technology in MANET has attracted a lot of attention [3]. Here mobile nodes are bounded to any centralized control like base stations or mobile switching centers. Limited transmission ranges affect wireless technologies and related network interfaces, and this is a reason why multi hops are needed for a single node to exchange data with another across a network. In this case, each mobile node operates as a host and as a router, forwarding packets to other mobile networks through its nodes which do not exist directly within wireless transmission range. Every nodal member participates in an ad hoc routing function that allows it to discover multihop paths through network to any other node.

Multicasting is proposed for group-oriented computing where the member of a host group is dynamic that means hosts may join or leave groups at any time. Members of host groups do not face any form of location or number restriction. A host may be a member of more than one group at a time and it doesn't have to be a member of group to send packets to the members in the group [4].

RELATED WORK

Multicast routing protocol can be classified based on the type of routing structure they construct that are: First tree-based multicast routing protocol builds a tree-type multicast delivery structure for a multicast request. Second mesh based routing protocol builds a mesh structure for performing a multicast task. In general, these types of protocols are resilient to network dynamics with certain sacrifice in forwarding efficiency [3]. It is a well-organized way of delivering content to a large group of receivers by using a tree structure embedded in the network. Building a multicast tree is called multicast routing that is used extensively to support many multicast application like teleconferencing and remote diagnosis [5,13]. It is an efficient way to transmit packets from one point or multi-points to multi-points that utilizes wireless channel bandwidth reasonably and reduces consumption of power [6].

Xia Deng et al., [1] have proposed a multicast routing protocol called CMRP (A Combined Multicast Routing Protocol) that considers three factors while selecting the routing path such as path's expiration time, the number of non-forwarding nodes, and the hop path. In order to meet user requirements, each component has an adjustable weight. They have showed that combination of these three factors achieve good performance in terms of data delivery ratio and energy consumption efficiency. The drawback of this paper is that the proposed protocol is not efficient to control the routing overhead and unable to handle traffic load.

Shigang Chena et al., [5] have proposed a scalable QoS multicast routing protocol (SoMR) that supports all three types of QoS requirement. SoMR is scalable due to small communication overhead. It achieves satisfactory tradeoff between routing performance and routing overhead by carefully selecting subgraphs in network aimed to search for path which are capable of supporting needs of QoS. This automatically tunes the scope based on the current network conditions. An early-warning mechanism helps to detect and route around the long-delay paths in the network. The operations of SoMR are completely decentralized. They rely only on the local state are stored at each router. The drawback of this paper is that they have not considered the throughput metrics and energy efficiency.

Neng-Chung Wang et al., [10] have proposed a power-aware dual-tree-based multicast routing protocol (PDTMRP) for mobile ad hoc networks (MANETs). Nodes described in the above scheme are classified randomly into two kinds: group-0 and group-1. In order toachieve the required load balance, two multicast trees (tree- 0 for group-0 and tree-1 for group-1) are constructed. In this scheme, load balance is used to improve the lifetime of a network. In the route discovery, this scheme not only solves the stability routing problem, but also achieves the load balance of data transmission. Thus, controlling overhead route constructions and the required number of route reconstructions are proportionately decreased. The packet delivery ratio and the control overhead of the proposed scheme outperform that of MAODV and RMAODV. Moreover, the traffic load can be balanced and the network lifetime can be prolonged. This proposed scheme has a major drawback which is that they have not considered about the delay metrics in their proposed protocol.

Chia-Cheng Hu et al., [14] have proposed distinct strategy to select stable Backbone Hosts (BH). Extra or remaining connection time period between two neighbors is calculated through Global Positioning Systems (GPS), and with its aid a long lasting and stable BHs from a selected set of hosts. Additionally,new multicast protocols are proposed according to selected set of stable BHs to select stable multicast routes. A stable route is a route that is available for a longer time. Simulation results show that the proposed protocol has shorter transmission latency, shorter more stable multicast routes, lower overhead, more stable attachment of multicast members to BHs, and higher receiving data packet ratios than other existing two-tier multicast protocols. The future work includes study of the link quality for different application of ad hoc networks.

X. Xiang et al., [15] have proposed a novel Efficient Geographic Multicast Protocol (EGMP) which utilize virtually enhanced base structures to add scalable and efficient group management membership. Network wide bidirectional trees are constructed to achieve mre through its zone-based efficiency in managing membership and systems for multicast deliveries. Positional information is often used as a guideline for building zone structures, constructing multicast trees, and forwarding multicast packet, all of which effectively reduces overheadroute searches and tree structure maintenance. Several strategies was proposed to improve the efficiency of the protocol, for example, introducing the concept of zone depth for building an optimal tree structure and integrating the location search of group members with the hierarchical group membership management. Finally, they have designed a scheme to handle empty zone problem faced by most routing protocols using a zone structure. The scalability and the efficiency of EGMP are evaluated through simulations and quantitative analysis. The results demonstrate that EGMP achieves a high packet delivery ratio, and low control overhead and multicast group joining delay under all test scenarios, and is scalable to both group size and network size. The proposed scheme has a major drawback which is that they have not considered about efficient utilization of bandwidth to improve QoS in the multicast routing.

THE IIOAB JOURNAL
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EXISTING PROTOCOL AND ITS PERFORMANCE

The following sections will try to illustrate some of the basic EGMP protocols briefly. Sction A will provide an overview ofall the protocols and required definitions to be used in the rest of the paper. Sections B and C, present the designs for construction of zone structure and the zone-based geographic forwarding.

OVERVIEW OF PROTOCOLSP

EGMP is a method which promotes scalability, reliable forms of managing membership and multicast forwarding established through using a structural two-tier virtual zone. At the lower layer, in reference to a predetermined virtual origin, nodes in the network are self-organizes by themselves into a set of zones, from which the elected leader of the zone manages local group memberships. The upper layers of leadership serves as a representative to join or leave multicast groups in its zone. Due to this model of functioning, a multicast tree of network-wide zone was created. For efficient and reliable management, location information is integrated with the design and used to guide the zone construction, group membership management, Maintenance, multicast tree constructions, and forwarding packets. This zone-based tree is sharable among groups of multicast sources.

Some notations used are:

- Zone: In this the network terrain is divided into square.
- Zone size, the length of a side of the zone square transmission range of the mobile nodes.
- To reduce intra zone management overhead, the intra zone nodes can communicate directly with each other without any intermediate relays.
- Zone ID: This is used for the identification of a zone. A node can calculate its zone ID (a, b) from its position
- Zone Forwarder. A zone forwarder is elected in each zone for managing the local zone group membership and taking part in the upper tier multicast routing.

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

NEIGHBOR TABLE GENERATION AND ZONE LEADER ELECTION

Neighboring tables are constructed through nodes without the need for extra signaling. When receiving a beacon from a neighbor, a node records the node ID, position, and flag contained in the message in its neighbor table. The zone ID of sending node can be calculated from its position. Failures in routing can be avoided by updating topology information and removing entries which have not been refreshed for a long period of time. Corresponding neighbors or TimeoutNT are unreachably detected by MAC layer protocols. The election of zone leaders through cooperative nodal systems is responsible for maintaining the consistancy of the zone. A node sends a beacon announcing its existence once a node appears in the network. Then, it waits for an Intvalmax period for the beacons from other nodes. Every Intvalmin node checks its neighbor table and determine its zone leader under different cases: 1) the neighbor table contains no other nodes in the same zone; it will announce itself as a potential leader. 2) Flags of every node existent in one zone are unset, which indicates that no node can announce leadership of the zone .If the node is closer to the zone center than other nodes, it will announce its leadership role through signal messages between leadership flagsets. 3) When inmore than a single node in one zone has selected a leader flags set, the highest node membership ID is selected. 4) But only one node in a zone can have a flag set, and this node is selected as the leader.

CONSTRUCTING MULTICAST TREES

The section presents creation of multicast trees along with its maintenance schemes. Thus, instead of connecting each group present in EGMP, the member directly connect to the tree, and this tree is formed after guided location information in the granularity of zone, which can significantly reduce overhead the tree management. A control message can be sent immediately based on setting destination locations, without having to incur high overhead charges and delay in finding paths, which enables quick group joining and leaving. In the following description, except when explicitly indicated, we use G, S, and M, respectively, to represent a multicast group, a source of G and a member of G.

MULTICASTING ROUTE OPTIMIZATION AND MAINTENANCE

It is crucial to maintain connection modes in dynamic networks and this requires adjusting the structure of the tree based on topological changes which optimize multicast routing. In the zone structure, some zones are empty due to the movement of nodes between different zones which is critical to handle the empty zone problem. Comparing the connections of individual nodes, however, there is a much lower rate of zone membership change and hence a much lower overhead in maintaining trees which are zone-based. Disconnected zones can effectivelexstablish reconnections to the tree due to the guided location constructions. Additionally, zones can be partitioned among multiple clusters based on the effects of fading and signal blocking.

PERFORMANCE EVALUATION

Periodically, multicast sources broadcast Join-Query messages to an entire network. Intermediary nodes storage source ID and sequence numbers, after updating the routing table with the required node ID (i.e., backward learning) and from the received details messages can be traced back to the source. A receiver creates and broadcasts a Join Reply to its neighbors, with the next hop node ID field that are filled by extracting information from its routing table. Matching ID neighbor nodes of the message realize the paths to the source and become a part of the forwarding group. It then broadcasted 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. **[Table -1]** lists the simulation parameters of EGMP with beacon interval 200sec. The simulations for ODMRP are based on the codes carried with the simulator, with the parameters set as in [9].

Table: 1. Parameter Values for EGMP Simulations

Parameter	Value
r(zone size)	75 m
Intval min	2 sec
Intval max	4 sec
Intval active	3 sec
Timeout NT	3 sec

Several bugs in the GloMoSim codes were fixed to prevent forwarding group node from sending any form of JOIN TABLES. This impacts and improves the delivery ratio by doubling its capabilities and reducing controlling overhead ODMRP. Additionally, we implemented SPBM in GloMoSim according to [20] and then two codes can provide the authors with similarly required parameter settings but it should be noted that square sizes is set as 150 mto assist nodes in a square which are inbetween each transmission range. Quad-trees transform according to the number of levels which is based accordingly to the square size and the network size used. For packet forwarding in SPBM [20], the square center is used as the destination position, which improves the delivery ratio. Also improves the stateless multicast protocol which allows it a better scalability to group size. Contrastly, EGMP uses a location-aware approach for more reliable membership management and packet transmissions, and supports a scalability of both group size and network size.

AN EFFICIENT SCALABLE AND ROBUST ZONE STRUCTURED MULTICAST PROTOCOL FOR MANET

Work on a Receiver-Based Multicast protocol, RBMulticast, which is a stateless cross layer multicast protocol where packet routing is extended, splitting packets into multiple routes, and the medium access of individual nodes rely solely on the location information of multicast destination nodes. Multicast members are included in a list of RBM multicast packet header locations and this can prevent building and maintaining overhead multicast trees set at intermediate sensor nodes and due to the above important routing information, the packet is included within the packet header. Additionally, the medium access method employed does not require any state information such as neighbor wake-up time or any a priori operations such as time synchronization. Tree creation,

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maintenance or neighbor table maintenance is not required. It makes RBMulticast as the least state of any multicast routing protocol. It is ideally suited for dynamic networks. In RBMulticast the following two techniques instead of two tier zone structures are proposed.

NODE LIFETIME PREDICTION ALGORITHM

Consider, two nodes having the same residual energy level. Among that an active node quickly consumes energy that is used in many data-forwarding paths which shortens its lifespan than when a node remains in inactive node. The lifetime of node is based on its current residual energy and its past activity solution that does not need to calculate the predicted node lifetime from each data packet. Ei, represents current residual energy i, is exponentially used to weigh moving average and estimate energy draining rates evi, and this is the rate of energy depletion. Ei which is obtained easily online from instrumental battery management techniques, and evi is thus a statistical value which is obtained through recent history. The estimated energy drain rate in the nth period is evin, and evi(n−1) is the estimated energy drain rate in the previous (n − 1)th period, α denotes the coefficient that reflects the relation between evin and evin−1,from which its constant value is estimted to be within the range of [0, 1].

LINK LIFETIME- PREDICTION ALGORITHM

When the minimum node lifetime in a route from 2 nodes of stable connection within the communication range of each other, then connection lifetime may last longer, and they cannot be a bottleneck in the route to which they belong. Unstable connections can also have the capability to model the flexibility and mobility of nodes which exist in shorter periods of its unstable nature. Nodes can move at a constant speed towards the same direction in a short period. It is easy to measure the distance between nodes Ni and Ni−1 by applying Global- Positioning-System- based location information. Transmitted packages are forwarded with the same power level owned by a receiver and can measure the strength of a received signal power especially when receiving packages. Then the distance is calculated by directly applying the radio propagation model to it. If the received signal power strength is lower than a threshold value, then this link as an unstable state and then calculate the connection time.

LLT prediction algorithm requires only two sample packets, and implements piggyback information on route-request (RREQ) and route-reply (RREP) packets during a route-discovery procedure with no other control message overhead, and thus, it does not increase time complexity.

RESULTS AND DISCUSSIONS

After the above subject of variability in moving speed of EGMP andits needed node density, the paper proceeds to investigate scalability of three protocols by modifying group and network size. We focus on the studies of the scalability and efficiency of the protocol under the dynamic environment and also in consideration with the energy and power utilization of nodes.. After evaluating the proposed algorithm, performance metrics are utilized in the simulations for performance comparison.

Packet arrival rate: The ratio of the number of received data packets to the number of total data packets sent by the source.

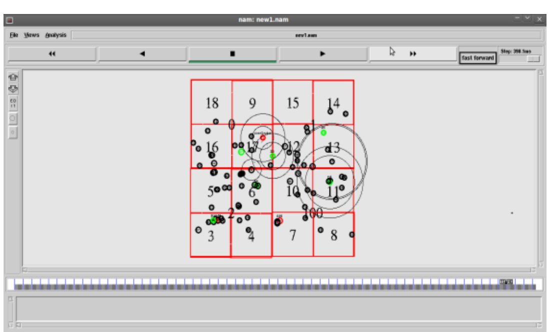

Fig:1.Packet from source is delivered to the destinations.

THE IIOAB JOURNAL
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Xgraph: The xgraph shows the packet delivery ratio.

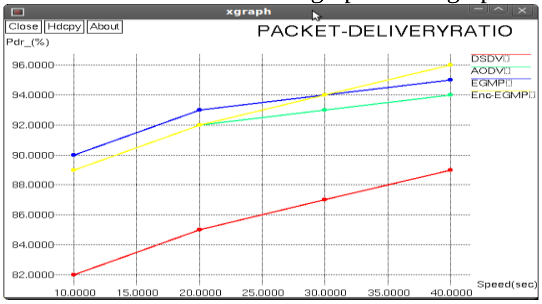

Fig: 2. The packet delivery ratio.

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Average end-to-end delay: The average time elapsed for delivering a data packet within a successful transmission.

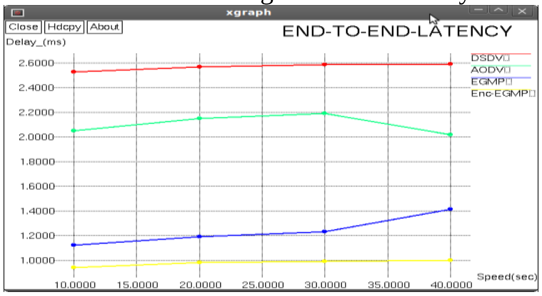

Fig: 3. End to End latency

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Energy consumption: The calculation of energy consumption for the entire network includes the transmission energy consumption for both the data and control packets.

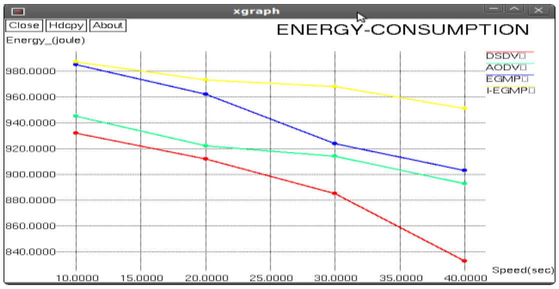

Fig:4. Energy Consumption

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Throughput: The throughput for the entire data transmission from source to destination is increased when compared to the existing protocol.

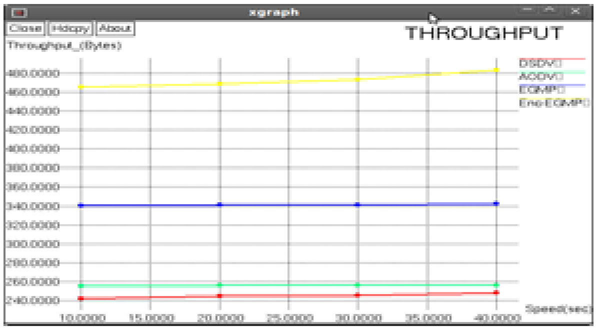

Fig: 5.Increase Throughput

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Collision rate: The average Collision rate for the entire data transmission from source to destination is much controlled and reduced when compared to the existing protocol.

Communication overhead: The average number of transmitted control bytes per second, including both the data packet header and the control packets.

CONCLUSION

Achieving stability of zone structure relies on underneath geographic unicast routing for reliable packet transmissions. We build a zone-based bidirectional multicast tree at the upper tier to achieve more efficient multicast membership management and delivery, and use a zone structure at the lower tier to realize the local management of membership. The research has also created a scheme which can handle problems of encountering empty zones which can challenge zone-based protocols. The position information is used in the protocol to guide the zone structure building, multicast tree construction and multicast packet forwarding. As compared to traditional multicast protocols, our scheme allows the use of location information to reduce the overhead in tree structure maintenance and can adapt to the topology change more quickly. Results shows that the throughput for the entire data transmission from source to destination is increased and the average time elapsed for delivering a data packet within a successful transmission when compared to the existing protocol. Future work should involve multicast routing protocols that aim at providing reliability, QoS guarantees, security, and so on. Hence, transmitting Multicast systems are more effective when compared to supported groups unicasted from group communication applications and thus this aspect is important for development of future networks.

CONFLICT OF INTEREST

The authors declare no conflict of interests.

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The authors report no financial interests or potential conflicts of interest.

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