VIRTUAL ZONE BASED MULTICAST OVER MOBILE AD –HOC NETWORK

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Abstract - A Mobile Ad-hoc network (MANET) is composed of mobile nodes without using the infrastructure. There are several virtual architectures used in the protocol without the need of maintaining state information for more robust and scalable membership management. In this paper, we propose a Robust and Scalable Geographic Multicast protocol (RSGM). Both the control messages and data packets are forwarded along efficient tree-like paths, but there is no need to explicitly create and actively maintain a tree structure. To avoid periodic flooding of the source information throughout the network, a well-organized source tracking mechanism is designed. We are analyzing the protocols RSGM, SPBM and ODMRP with the performance metrics such as packet delivery ratio, control overhead, average path length and average joining delay by varying moving speed, node density, group size and network ranges.

Index Terms - Multicast routing, Protocol, Zone structure, Position, Tree-based, Mesh-based, RSGM, SPBM, ODMR, MANET.

I. INTRODUCTION

In MANET, wireless devices could self-configure and form a network with a random topology. Such a network may operate in a standalone fashion or may be connected to the larger Internet. Multicasting is the transmission of the datagram to a group of hosts identified by a single destination address and hence is intended for group-oriented computing [7]. Multicasting techniques can be considered as an efficient way to deliver packets from the source to any number of client nodes [II]. The applications in MANET include military, emergency applications, and small sensor devices located in animals and other strategic locations that collectively monitor habitats and environmental conditions [I]. Many efforts have been made to develop multicast protocols for MANETs. These include conventional tree-based Protocols and mesh-based protocols. There is a big challenge to support reliable and scalable multicast in a MANET with these topology-based schemes, as it is difficult to manage group membership, and maintain multicast paths with constant network topology changes.

II. RELATED WORK

A mobile ad-hoc network (MANET) is a self-configuring network of mobile routers (and associated hosts) connected by wireless links. Multicast Routing Protocols such as tree-based and mesh-based are analyzed. Multicast Operation of Ad-hoc On-demand Distance Vector (MAODV) [2] is a reactive tree-based multicast routing protocol. However, it is very difficult to maintain the tree structure in mobile ad hoc networks, and the tree connection is easy to break and the transmission is not reliable. ODMRP is a mesh-based protocol and applies on-demand procedures to build routes. This protocol uses soft state to maintain multicast group memberships [3]. In this paper, we proposed a protocol called Robust and Scalable Geographic Multicast Protocol (RSGM). RSGM [5] is a zone-based routing scheme using position information. The zones are defined as geographic squares. RSGM can be scalable to both the group size and the network size. We are comparing this protocol with ODMRP and SPBM. The performance metrics such as packet delivery ratio, control overhead, average path length and average joining delay is compared by varying speed, node density, group size and network range.

III. ROBUST AND SCALABLE GEOGRAPHIC MULTICAST PROTOCOL (RSGM)

In this paper, we discuss the RSGM protocol that supports two-tier membership management and forwarding structure. At the lower tier, a zone structure is built based on position information and a leader is elected on demand when a zone has group members. A leader manages the group membership and collects the positions of the member nodes in its zone. At the upper tier, the leaders of the member zones report the zone membership to the sources directly along a virtual reverse-tree-based structure. If a leader is unaware of the position or addresses of the source, it could obtain the information from the source home. With the knowledge of the member zones, a source forwards data packets to the zones. After the packets arrive at a member zone, the leader of the zone will further forward the packets to the local members in the zone along the virtual tree rooted at the leader. Many issues need to be addressed to make the protocol fully functional and robust. The issues related to zone management include the strategy for electing a zone leader on-demand and maintaining the zone leader during mobility, the handling of the empty-zone problem, the scheme for Source-Home construction and maintenance, and the need to reduce packet loss during node moving across zones.

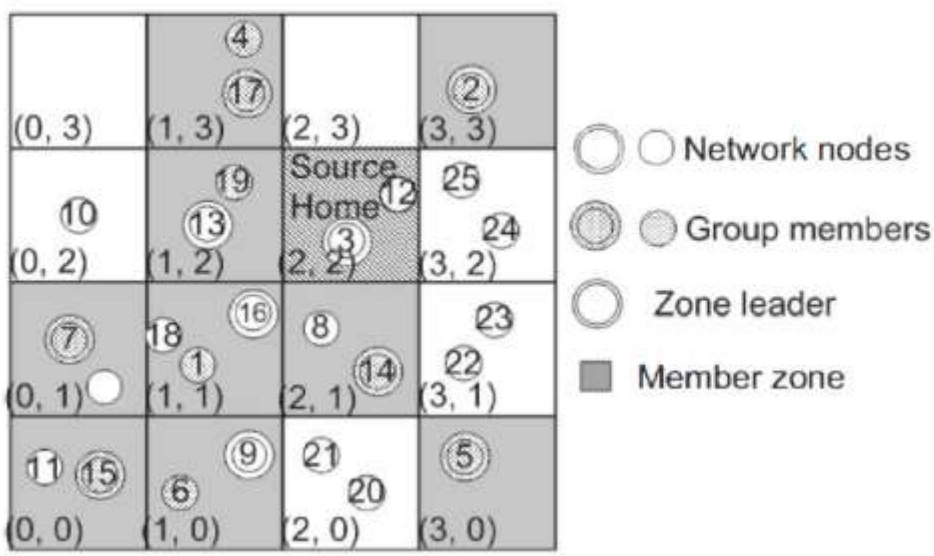

Fig I A Reference Zone Structure

Some of the notations to be used are pos: A mobile node's position coordinates (x, y). zone: The network terrain is divided into square zones. We will study the impact of zone size on the performance of the protocol.

Group TD: The address of a multicast group.

A. Zone Construction and Maintenance: Tn RSGM, the zone structure is virtual and calculated based on a reference point. Therefore, the construction of the zone structure does not depend on the shape of the network region, and it is very simple to locate and maintain a zone. Virtual zones are used as references for the nodes to find their zone positions in the network domain. The zone is set relative to a virtual origin located at (xo, Yo), which is set at the network initialization stage as one of the network parameters. The length of a side of the zoning square is defined as zone size. Each zone is identified by a zone TD (zTD). A node can calculate its zTD (a, b) from its pos (x, y) as follows: a= [X-Xo] b = [y-yo] zone_size ' zone_size For simplicity, we assume all zone TDs are positive. A zone TD will help locate a zone, and a packet destined to a zone will be forwarded toward its centre. The center position (xc,Yc) of a zone with zTD (a,b) can be calculated as: Xcenter = Xo + (a + 0.5) x zone_size Ycenter = Yo + (b + 0.5) x zone_size)

B. Zone Leader Election: A leader will be elected in a zone only when the zone has group members in it. When a multicast group member M just moves into a new zone, if the zone leader (zLdr) is unknown, M queries a neighbour node in the zone for zLdr [1] [4]. When failing to get zLdr information, M will announce itself as zLdr by flooding a LEADER message into the zone. In the case that two leaders exist in a zone, e. g., due to the slight time difference of leader queries and announcements, the one with larger ID will win as zLdr.

A zLdr floods a LEADER in its zone every time interval Interval refresh to announce its leadership until the zone no longer has any members. [f no LEADER message is received longer than 2 x Tntval refresh, a member node will wait a random period and then announce itself as zLdr when no other node announces the leadership.

IV. PERFORMANCE EVALUATION

Tn this paper, we are evaluating the following performance metrics of protocols such as RSGM, SPBM and ODMRP by using network simulators. The simulations were run with 400 nodes randomly distributed in the area of 2,400 m x 2,400 m.

A. Packet delivery ratio: The ratio of the number of packets received and the number of packets expected to be received. So the ratio is the total number of received packets over the multiplication of the group size and the number of originated packets.
B. Normalized control overhead: The total number of control message transmissions divided by the total number of received data packets.
C. Average path length: The average number of hops traversed by each delivered data packet.
D. Joining delay: The average time interval between a member joining a group and its first receiving of the data packet from that group.

V. SIMULATION RESULTS

The performance metrics such as packet delivery ratio, control overhead, average path length and joining delay of RSGM, ODMRP, SPBM is compared with the variation of moving speed, node density, group size and network range.

A. Packet Delivery Ratio Vs Speed: RSGM has high packet delivery ratio when compared with SPBM and ODMRP (Fig.2). RSGM keeps a stable and over 98 percent delivery ratio under all the mobility cases.

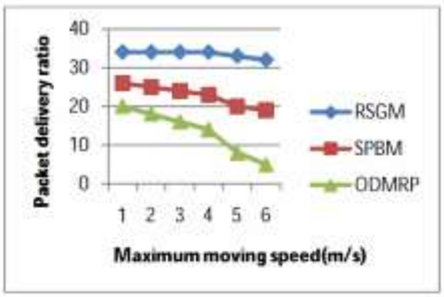

Fig.2 Packet delivery ratio

B. Control overhead Vs Speed: The control overhead of RSGM and ODMRP is lower when compared with SPBM at different moving speeds (Fig.3).

Fig.3 Normalized control overhead

C. Path length Vs Speed: The average path length of SPBM and RSGM perform much better than ODMRP (Fig.4).

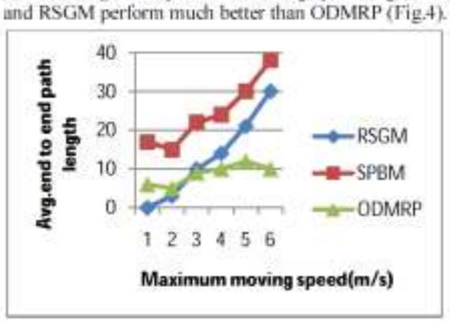

Fig.4 Average path length

D. Delay Vs Speed: In RSGM, when a node wants to join a group, it will start the joining process immediately, and the nodes can join the multicast group very quickly as shown in Fig.5.

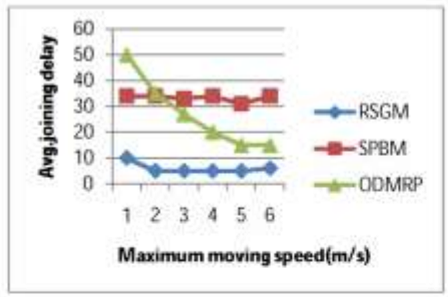

Fig.5 Average joining delay

E. Packet Delivery Ratio Vs Node density: RSGM keeps a higher packet delivery ratio when compared with SPBM and ODMRP as the node density increases (Fig.6).

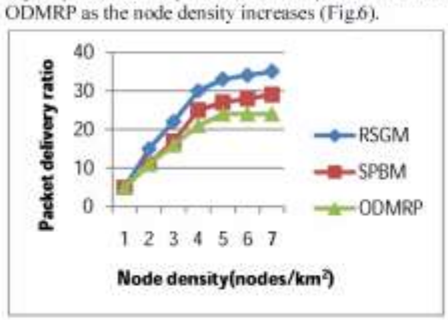

Fig.6 Packet delivery ratio

F. Control overhead Vs Node density: The control overhead of RSGM and ODMRP is much better when compared with SPBM when the node density increases (Fig.7).

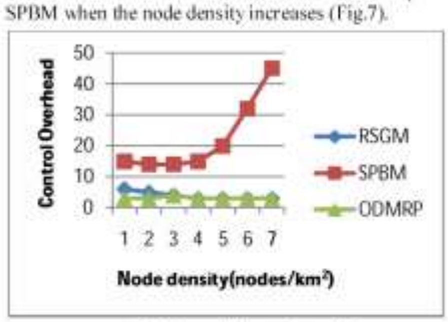

Fig.7 Normalized control overhead

G. Path length Vs Node density: The geometric protocols such as RSGM and SPBM have longer transmission paths in a sparse network due to the more frequent use of recovery forwarding of the underlying geometric unicast protocol (Fig.8).

VI. CONCLUSIONS

In this paper, we have analyzed a robust and scalable geographic multicast protocol (RSGM) for MANET. In RSGM, both data packets and control messages are transmitted along efficient tree-like paths without the need for explicitly creating and maintaining a tree structure. Scalable membership management is achieved through a virtual-zone-based two-tier infrastructure. In our simulation results, RSGM has much higher packet delivery ratio and lower control overhead, average path length and average joining delay when compared with SPBM and ODMRP by varying moving speeds, node densities, group sizes and network ranges.

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