Performance Analysis Of Zone Based Efficient Multicast Routing Protocol For Multicasting Over MANET

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ABSTRACT

Group communication in Mobile Adhoc Network is achieved using an efficient method called multicasting. Efficient, secured and scalable multicasting in MANET is a challenging approach, due to dynamic topology of the MANET. So here we propose a novel Scalable and Efficient Multicast Routing Protocol (SEMRP).It is a zone based multicast routing protocol, where a zone based bidirectional tree is constructed to achieve efficient group membership management and multicast packet delivery. The position information of nodes is used in zone construction, multicast tree creation and multicast data delivery which reduce the route searching overhead and tree structure maintenance. The scalability and the efficiency of SEMRP are evaluated through simulations and quantitative analysis. Our simulation results show that SCMRP achieves better throughput and less packet loss as compared to DSDV routing protocol. And SCMRP is proved Scalable in both network size and group size.

Keywords

Mobile Adhoc Networks, Multicast, Routing, Cluster, Protocol.

1.INTRODUCTION

Mobile Adhoc Network (MANET) is a network of mobile nodes with dynamic topology, no proper infrastructure, absence of Centralized administration and communication is multihop wireless communication. Each node acts as host as well as router to assist in forwarding of data to other nodes which may not be related to it. Two broad classifications of routing protocols namely proactive and reactive routing protocols exist[2]. In proactive routing protocols each node maintains list of all other nodes and their routes by some sort of pre-processing function such as broadcasting a hello message, hence these protocols respond quickly to the network changes. When a packet arrives at a node, node verifies its routing table, and accordingly forwards the packet. In reactive routing protocols nodes do not maintain details of other nodes in the beginning, but the nodes build the routing table on demand, if a session has to be started then the path is setup between the source and the destination and then the packet is forwarded. Here the path-setup process is called as “Route Discovery”.

In some of the applications data need to be transmitted from one to many destination nodes. The service which allows this type of data delivery is called multicasting, but providing multicast service in MANET is a challenging approach as MANET has dynamic topology.

Table 1.1 characteristics and applications of MANET

Characteristics	• Less bandwidth • Dynamic topology • Limited energy • Lack of Security
Applications	• Military applications - Battlefields • Search and rescue operations • Multimedia applications • Teleconferences

In this work, proactive geographic routing protocol called a Scalable and Efficient Multicast Routing Protocol (SEMRP) is proposed. SEMRP uses virtual Zone based structure to provide efficient group membership management. This protocol scales to a larger group size as well as network size. Zone is formed around the zone leader with all other member nodes of the nodes one hop or N-hops away from zone leader.

The paper is organized into following sections, section 2 deals with some of the related work, section 3 gives the detailed study of proposed protocol, Simulation results in section 4, result analysis in section 5 and finally conclusion.

2. RELATED WORK

In this section, we introduce some of the conventional multicast protocols and zone supported forwarding approaches. Multicast Routing protocols can be categorized as shown in fig 2.1, based on the routes constructed for the members of the multicast group (Network topology) as in [4].

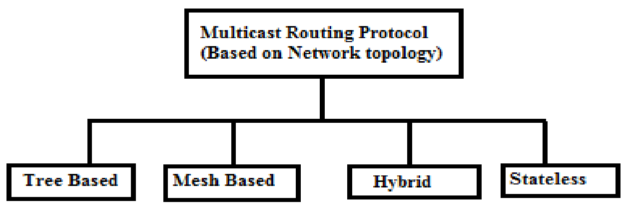

Fig. 2.1. Multicast Routing Protocols

Tree based multicasting protocols are both power and capacity efficient. In these types of protocols, single path is established between source and destination pair. Tree based approaches are further divided into two kinds, Source tree based and Shared tree based. In source tree based approach (MZRP [5], ODOMP [6], ADMR [7]]), each source constructs individual multicast tree, where the path between source and member of the multicast tree is not shortest. In shared tree based approach (MAODV [8], AMRIS [9]) only one multicast tree is constructed which include all the source nodes and members of all multicast groups. Shared tree based approach is less efficient, each node maintains more routing information, single point of failure cause major problems, since traffic is aggregated in the shared tree ,which gives it a low throughput. Whereas source tree based protocols provide better throughput since each source is responsible for single multicast tree, but has scalability problem. SEMRP is a source tree based protocol.

In mesh based protocols (FGMP [10], ODMRP [11], CAMP [12]), single mesh is constructed connecting the source to all the multicast group members, redundant paths in mesh structure provide more robustness and higher packet delivery ratio. But then introduce power inefficiency, capacity wastage and more overhead caused due to data packet duplication. In hybrid approach (AMRoute [13], ASTM [14], and OGHAM [15]) attempt to achieve both robustness and efficiency by combining tree based and mesh based approaches. Stateless multicast approach (DDM [16]) is useful if the multicast group is small. In an environment with frequent mobility, tree and mesh construction and maintenance introduce more overhead, the stateless approach is introduced to minimise this effect as in [17].

In zone based approaches, clusters of nodes are formed which make multicasting routing mechanism simple and efficient [18].Every cluster have cluster head or leader to which all other cluster nodes are connected either by single hop or multiple hops. In zone based approaches the routing strategies can be either intra-cluster (within a cluster) or inter-cluster (among the clusters).

3. SCALBLE AND EFFICIENT MULTICAST ROUTING PROTOCOL

3.1. Protocol overview

In SEMRP the reliable membership management and multicast data delivery is performed through two tier virtual zone based structure, the lower layer nodes in the network organize themselves into set of zones in reference to fixed origin as shown in fig.3.1. Among the member nodes of the zone, one node is elected as zone leader. At the upper layer zone leader acts as representative and lets the nodes of the zone to join and leave the multicast group. For Proper zone construction and group membership management, bidirectional tree construction and maintenance, multicast data delivery, the location information is integrated with design. Bidirectional tree allows bidirectional packet forwarding to reduce delay and forwarding overhead. The sources forwards the packets directly along the tree to both upstream root zone and downstream leaf zones instead of only forwarding it first to the root of the tree.

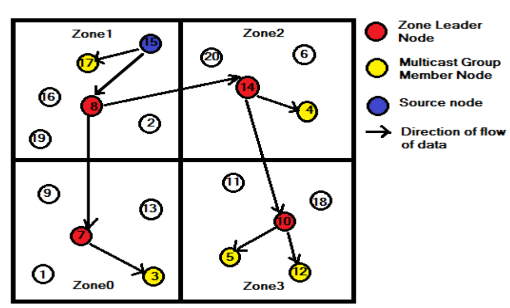

Fig .3.1 Zone Structure with bidirectional multicast tree and Multicast Group

3.2. Neighbour table generation and Zone leader Election

The election of zone leader with less overhead is mandatory for efficient zone structure maintenance. Location service is assumed to be part of the protocol design, every node is aware of its own position without the need of any external location service. This is useful in leader election. Every node constructs the neighbour table with no extra signalling. Position, Node ID, Flag information of the neighbouring node is recorded into every other node's neighbouring table upon receiving the Hello message for every minute. Zone Leaders Neighbour table include a extra field ZoneID, as it records all zone leaders information along with nodes information of same zone .

Table 3.2.1 Neighbour table of leader node Zone0

Node ID	Position	Flag	Zone ID
9	$(x_9 y_9)$	1	Zone0
18	$(x_{18} y_{18})$	1	Zone1
20	$(x_{20} y_{20})$	---	Zone0

Table 3.2.2 Neighbour table of ordinary node of Zone0

Node ID	Position	Flag
9	$(x_9 y_9)$	1
16	$(x_{16} y_{16})$	---
20	$(x_{20} y_{20})$	---

Zone leader is elected based on following criteria 1) if no other node in the same zone then the node announces itself as the leader. 2) If there are many nodes then, one which is near to the centre of the zone is elected as leader. 3) If more than one node is at the centre of the zone, then one which higher NodeID is elected as leader.

3.3. Zone Supported Geographic Forwarding

Communication process includes intrazone transmission and interzone transmission. As nodes in a zone are within each other's transmission range and each node knows every other node position in the zone, intrazone communication is possible. As source and destinations may be multiple hops away, geographic unicasting is used to ensure the reliable transmission, with packet forwarding guided by the position information of the destinations. To avoid the overhead incurred in tracking the exact location of the large number of destinations, location service used as part of Zone based membership management. Only NodeID is needed at the network tier, to forward the packet to the destination zone. At the destination zone the packet is forwarded to the specific node or broadcast based on type of the message.

3.4. Multicast tree construction and multicast session life cycle

Multicast session G_N is initiated by the source node X by flooding whole network with a message NEWSESSION (G_N, $ZoneID_X$), this message carries group name, and zone id of source node. When a node Y receives this message and is interested in this session, it will join the group. If Y did not receive NewSession message, then Y can query its neighbours to search the available groups. To join the group node Y send JOINREQ(Y, Pos_Y, G_N) to respective zone leader. And node maintains Membership table, with the entry (G_N, rootzone ID, isAck) , here isAck field confirm that the node is on the multicast tree. Zone leader will send updated NewSession message to the upstream zone towards the root zone. JOINREPLY message is sent to source of the JOINREQ. Then the isAck field of the membership table is set.

Every zone leader maintains Multicast Table to keep track of all groups and group members of that zone. This table has an entry for each group with the group ID, root zone ID, upstream zone ID, downstream zone list, downstream nodes list. From source to all Group members multicast tree is constructed. To end the session the source node floods ENDSESSION (G_N) message. Upon receiving this message all the nodes will remove an entry from their Membership tables and Multicast table.When a member node Y wants to leave the group G_N ,it sends the LEAVE(Y, G_N) message to its zone leader. If zone leader wants to leave the group it will send LEAVE (ZoneID,G_N) message to its upstream zone. All the entries related to these nodes are removed from multicast table. Source can forward the packets after the multicast tree is constructed. SEMRP uses the Bidirectional tree based strategy to forward the packets to upstream zone and downstream zones simultaneously to reduce the delay incurred in tree-based routing protocols.

3.5. Multicast data forwarding

Source and destinations may be far away from each other, group members may not be reached in one hop from source. When a source X wants to forward multicast packet to list of destinations (D1, D2, D3), it finds next hop node for each destination. X now inserts the next hop node and list of destinations associated with next hop node in the packet header and broadcasts the message. When a node receives this packet, keeps the packet if it is one among the next hop node, otherwise drops the packet.

This process continues until packet reaches to all the destinations.

For reliability, the packets are sent to the center of the destination zone although there may be no node located at the center position. There is no guarantee that the packet will be sent to the destination node correctly since the destination is a virtual reference point. This problem is neglected in previous geographic protocols that use region as destination. To avoid this problem zone forwarding mode is introduced in SEMRP protocol. In zone mode, the node selects as its next hop the neighbouring node whose zone is closer to the destination zone than its own zone. For this the distances of different zones to the destination zone are compared.

4.SIMULATION RESULT

SEMRP protocol is simulated using NS2 in an area of 1250m×1250m. The area is further divided into equal sized zones. Inter-zone communication is performed within zone with no extra overhead, Intra-zone communication is through the zone leaders. The empty zone scenario is also considered , where nodes of one zone are given more mobility and zone is made empty, so the further intra zone communication for such nodes will be through leader of new zone to which the node has moved.

Table 4 : configurations made for simulation set up

PARAMETERS	VALUES
Network Simulator	NS 2.34
Channel type	Wireless channel
Radio-propagation model	Two Ray Ground
Antenna type	Omni Antenna
Routing protocol	AODV, DSDV
MAC type	802.11
Traffic Type	CBR
Packet size	512
Max packet in Queue	50
Number of packets	Upto 100
Area covered	1250 X 1250

5. RESULT ANALYSIS

We compare the performance of SEMRP and DSDV with the variation on node density and multicast group size. The main focus is on the scalability and efficiency of the protocols, under the dynamic environment. And the performance metrics used for multicast performance evaluation are throughput and packet loss.

5.1. Effect of Node Density

Geographic routing protocols perform better in dense networks. The simulation is run with fixed group size of 10 and by varying the node density to 30, 40, 50, 60 and 70 nodes.

The SEMRP has better throughput when the network becomes more dense as compared to the DSDV as shown in Fig.4.1.1 Packet is dropped by the forwarding node if it doesn't find the neighbour node or the destination zone. And also packet drop increases with increase in the node density, compared to DSDV, SCMRP has less packet drop, as shown in the Fig.4.1.2.

Table 5.1.1 Throughput performance of SEMRP and DSDV by varying the node density

Node density	Number of Packets Received (kbps) In SEMRP	Number of Packets Received (kbps) In DSDV
30	101.72	53.73
40	98.46	54.05
50	108.41	52.10
60	109.41	54.83
70	109.70	60.02

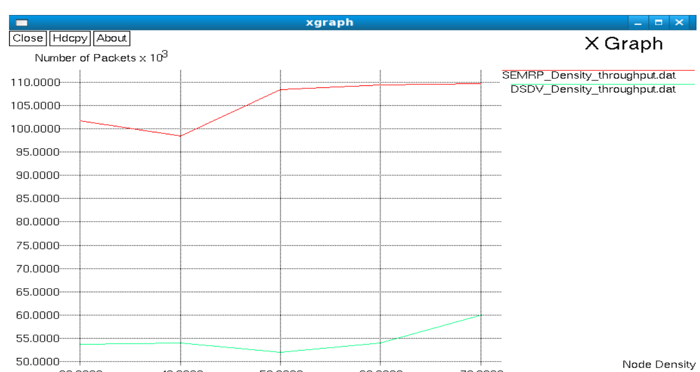

Fig 5.1.1 Throughput comparison by varying node density

Table 5.1.2 Packet drop in SEMRP and DSDV by varying the node density

Node Density	Number of Packets Dropped in SEMRP	Number of Packets Dropped in DSDV
30	23	111
40	46	105
50	37	112
60	46	126
70	50	145

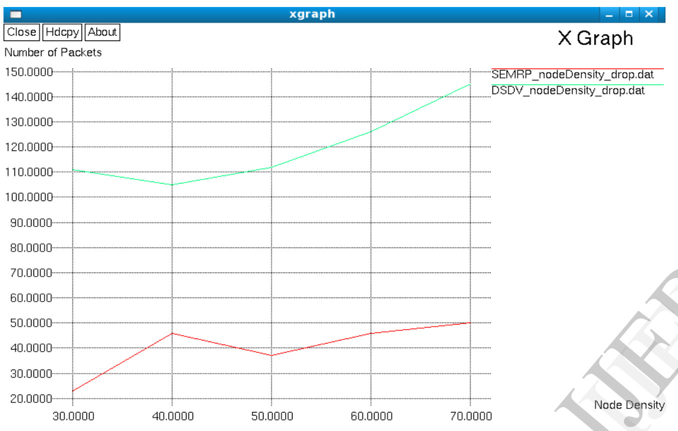

Fig. 5.1.2 Comparison of packet drop by varying the node density

5.2. Effect of Group Size

SEMRP can scale to a larger group size and performs well with different group sizes. The simulation is run with 50 nodes by varying the group size to 5,10,15,20 and 25.SEMRP has better throughput even with varying group sizes, where as DSDV performs poor even with smaller group sizes as shown in Fig.4.2.1. In SEMRP, larger group size results in temporary disconnections in the tree resulting into more packet loss. Packet drop in SEMRP is less as compared to DSDV as shown in Fig.4.2.2

Table 5.2.1 Throughput performance of SEMRP and DSDV by varying the group size

Group Size	Number of Packets Received (kbps) In SEMRP	Number of Packets Received (kbps) In DSDV
5	71.75	8.38
10	112.03	19.24
15	143.29	33.03
20	152.61	28.39
25	169.55	39.30

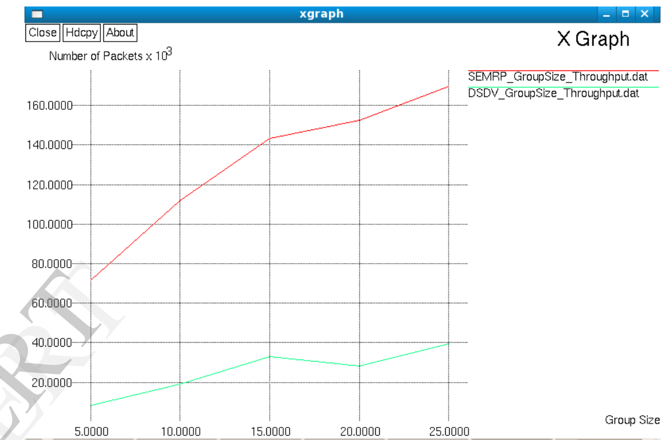

Fig. 5.2.1 Throughput comparison by varying the group size

Table 5.2.2 Packet drop in SCMRP and DSDV by varying the Group Size

Group Size	Number of packets dropped in SEMRP	Number of packets dropped in DSDV
5	21	84
10	57	99
15	62	122
20	83	149
25	111	194

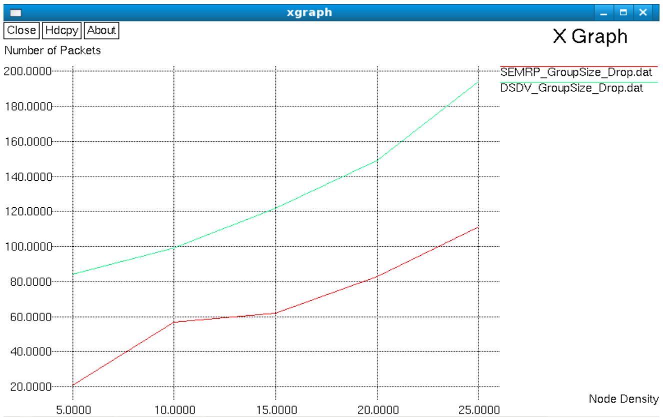

Fig. 5.2.2 Comparison of packet drop by varying the group size

6.CONCLUSION

Designing more scalable and efficient multicasting protocol over dynamic environment (MANET) is a challenging approach. In this paper Zone based Scalable and Efficient Multicast Routing Protocol (SEMRP) is proposed. Efficiency and scalability are achieved by constructing virtual zone based structure, position information is used for zone structure construction, packet forwarding, multicast tree construction and maintenance. A zone based bidirectional multicast tree is constructed for efficient multicast membership management and data delivery. SEMRP makes use of geographic forwarding for reliable multicast packet delivery.

Simulation results prove that compared to DSDV the SCMRP achieves better throughput and less packet loss and is scalable to both network size and group size. SEMRP can further be enhanced to provide security by placing an agent in each host to detect the intrusion by analyzing the incoming request and response messages and neighbour node activities.

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