

Stateless Multicast Protocol for Ad- Hoc Networks

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Abstract— Multicast routing protocols based on creation of a multicast tree (or mesh), which requires the individual nodes to maintain state information. In dynamic networks with bursty traffic, where long periods of silence are expected between the bursts of data, this multicast state maintenance adds a large amount of communication, processing, and memory overhead for no benefit to the application. In this paper we have developed a stateless receiver-based multicast protocol that simply uses a list of the multicast destination members addresses (sinks), embedded in packet headers, to enable receivers to decide the best way to forward the multicast traffic. Proposed protocol, exploits the knowledge of the geographic locations of the nodes to remove the need for costly state maintenance which makes it ideally suitable for dynamic networks. We propose advancement to the RBMulticast protocol by adding ETX metric for selection of forwarder for the packet from source to destination. Earlier protocols have used number of hop as a metric for transmission of packet from source to destination. The ETX metric make RBMulticast protocol as high throughput and energy efficient protocol by reducing number of transmission required for a single packet. We implement this protocol using java, and show the increased throughput and effectiveness of modified RBMulticast.

Keywords— Wireless networks, Stateless Routing, Multicasting, ETX metric.

I. INTRODUCTION

Applications require data delivery to multiple destination. In such applications use of multicasting is ideally suited. These applications range from member-based TV/Video broadcasting to push media such as headlines, weather, and sports, from file distribution and caching to monitoring of information such as stock prices, sensors, and security. Providing robust multicast routing in such dynamic network environments is an important design challenge for supporting these applications. In this proposed system, we work on a Receiver-Based Multicast protocol that is RBMulticast, in which the packet routing, splitting packets into multiple routes and the medium access of individual nodes depends on the location information of multicast destination nodes[1].

RBMulticast includes a list of the multicast members in the packet header, which prevents the overhead of building and maintaining a multicast tree at intermediate sensor nodes, because all the necessary information for routing the packet is included within the packet header. In proposed system we does not require any state information such as neighbor wake-up time or any operations such as time

synchronization. Proposed protocol does not require tree creation or maintenance or neighbor table maintenance.

RBMulticast is a receiver-based protocol, which means the packet transmission can be decided by the potential receivers of the packet in distributed manner. Receiver based routing approach does not require routing tables. Proposed protocol can be compared to proactive and reactive routing protocols where the route is decided using the latest available information. RBMulticast, receivers contend for the channel based on their potential contribution toward forwarding the packet [2], which is inspired by the cross-layer protocol XLM [2], a receiver based unicast protocol designed for wireless sensor networks [2].

Proposed RBMulticast, the multicast routing uses the concepts of virtual node and multicast region for forwarding packets closer to the multicast destination members. It also determines when packets should be split into separate routes to finally reach the multicast members.

As mentioned in [4],[5],[6],[7],[8],[9] existing multicast protocols for WSNs and MANETs generally use a tree to connect the multicast members.

The ETX Metric:

The ETX of a link is the predicted number of data transmissions required to send a packet over that link, including retransmissions [7]. The ETX of a route is the sum of the ETX for each link in the route. For example, the ETX of a three-hop route with perfect links is three; the ETX of a one-hop route with a 50% delivery ratio is two [2][8].

II. RELATED WORKS

In location-based approaches to multicast routing, nodes obtain location information by default as an application requirement. Multicast algorithms rely on routing tables maintained at intermediate nodes for building and maintaining the multicast tree. Receiver-based communication is an opportunistic way of thinking about protocol design in that decisions are not required to be made at the sender side but instead are made at the receiver side.

ExOR [1] uses the ETX to choose a candidate forwarder set. It can provide better performances over existing routing protocols. But there are still some problems in ExOR. After a transmission, all candidates with lower priority have to wait for the forwarding of the candidate with higher priority in order. It is not an efficient way to do the spatial reuse. Also multicast is not implemented.

The algorithm is designed to transmit packets of the Internet Protocol, In order to enable the maximum number of other services. Digital radios are widely replaced with wire line internet services for portable devices. New specialized integrated circuits are widely available at low cost.

Source broadcasts the batch of the packets. When the timers at the intermediate nodes expires, nodes further from the final destination node retransmits the packets which are yet not retransmitted by the nodes closer to the destination. To support this basic scheme, the intermediate radios set the timer to transmission time that the closer radios will need to transmit the packet. The transmission time is calculated based on the probabilities of a correct transmission from each intermediate radio and the number of packets present in the batch.

Takahashi-Matsuyama heuristic can be used to incrementally build a Steiner tree for multicast routing [10], [11]. The multicast algorithms rely on routing tables maintained at intermediate nodes for building and maintaining the multicast tree [12], [13].

The multicast algorithms rely on routing tables maintained at intermediate nodes for building and maintaining the multicast tree [12], [13]. In location-based approaches to multicast routing [14], [15], [16], nodes obtain location information by default as an application requirement. If location information is known, multicast routing is possible based solely on location information without building any external tree structure. PBM [17] weights the number of next-hop neighbor nodes and total geographic distance from the current node to all destination nodes and compares this to a predefined threshold to decide whether or not the packet should be split.

PBM is a generalization of Greedy-Face-Greedy (GFG) [18] routing to operate over multiple destinations.

GMR [19] selects neighbors based on a cost over progress framework integrated with greedy neighbor selection. Geocast [20] delivers multicast packets by restricted flooding. Nodes forward multicast packets only if they are in the Forwarding Zone calculated at runtime from global knowledge of location information.

Drawback of existing system:

1. There is no clear declaration of selection of the intermediate node for packet forwarding.
2. Existing work uses the criteria of distance to select the next forwarding node.
3. No security related discussion in existing work.

III.PROBLEM STATEMENT

The existing multicast routing protocols rely on various tree structures, in which the intermediate nodes need to maintain tree states or routing states for packet delivery. Maintaining state information is costly in multicast routing protocols. In our proposed system, we implement stateless multicast protocol for ad hoc networks, in which it uses geographic location information to route multicast packet and it also uses the ETX metric for forwarding the packet from one node to another node. We also considered the candidate

selection. It uses RBMulticast Header for send and receive packet. The RBMulticast header maintains list of destination nodes, which prevents the overhead of building and maintaining a multicast tree at intermediate sensor nodes.

IV.PROPOSED WORK

RBMULTICAST PROTOCOL

1.RBMulticast Overview :-

When a user initiates a request to send (RTS) a packet to a multicast group, data are passed down to the RBMulticast module in the protocol stack. Once the RBMulticast module gets this packet, it retrieves the group list from its group table, assigns the group nodes to the multicast regions based on their locations, and using these locations, calculates a "virtual node" location for each multicast region. RBMulticast replicates the packet for each multicast region that contains one or more multicast members and appends a header consisting of a list of destination nodes (multicast members) in that region, Time to Live (TTL) value, and a checksum value. The destination of a replicated packet is the "virtual node" of the corresponding multicast region, which can be determined in several e.g., as the geometric mean of the locations of all the multicast members in that multicast region. In the end, all packets for all multicast regions are inserted in the MAC queue, and are then broadcasted to the neighborhood.

Before broadcasting packet to the neighboring nodes forwarding node completes the process of selection of next. Before Neighbouring nodes forwarding node completes the process of selection of next.

The **node closest to the virtual node and having low ETX value** will take responsibility for forwarding the packet. The procedure for transmitting packets is summarized in pseudocode in Algorithm 1.

Algorithm 1. RBMulticast Send

Require: Packet output from upper layer

Ensure: Packets inserted to MAC queue

- 1: Get group list N from group table
- 2: for node n in group list N do
- 3: for multicast region r in 4 quadrants regions R do
- 4: if $n \in r$ then
- 5: Add n into $r.list$
- 6: end if
- 7: end for
- 8: end for
- 9: for $r \in R$ do
- 10: if $r.list$ is non-empty then
- 11: Duplicate a new packet p
- 12: Add RBMulticast header ($TTL, checksum, r.list$) to p
- 13: Insert p to MAC queue
- 14: end if
- 15: end for

After a node receives a multicast packet, it then retrieves the destination node list from the RBMulticast packet header. If this node is inside the destination list, it removes itself from the list and passes a copy of the packet to the upper layers in the protocol stack. Algorithm 2

Algorithm 2. RBMulticast Receive

Require: Packet input from lower layer

Ensure: Forwarded packets inserted to MAC queue

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1: Calculate checksum. Drop packet if error detected
2: Drop packet if not in Forwarding zone
3: Get destination list  $D$  from packet header
4: for node  $d$  in destination list  $D$  do
5:   if I am  $d$  then
6:     Duplicate the packet and input to upper layer
7:     Remove  $d$  from list  $D$ 
8:   end if
9: end for
10: if  $TTL$  in header = 0 then
11:   Drop the packet
12:   return
13: end if
14: for  $d \in D$  do
15:   for multicast region  $r$  in 4 quadrants regions  $R \in$ 
16:     if  $d \in r$  then
17:       Add  $d$  into  $r.list$ 
18:     end if
19:   end for
20: end for
21: for  $r \in R$  do
22:   if  $r.list$  is non-empty then
23:     Duplicate a new packet  $p$ 
24:     Add RBMulticast header ( $TTL - 1$ ,
25:       checksum,  $r.list$ ) to  $p$ 
26:     Insert  $p$  to MAC queue
27:   end if
28: end for

```

Fig. 1 gives an example of how RBMulticast is employed .The two multicast regions, the southwest and northwest quadrants, contain only one multicast member each, and thus a packet is sent directly to these multicast destinations. The northeast multicast region has three multicast members, and thus a single packet is sent to the virtual node located at the geometric mean of the locations of the multicast members (dotted circle with label 3 in the figure).

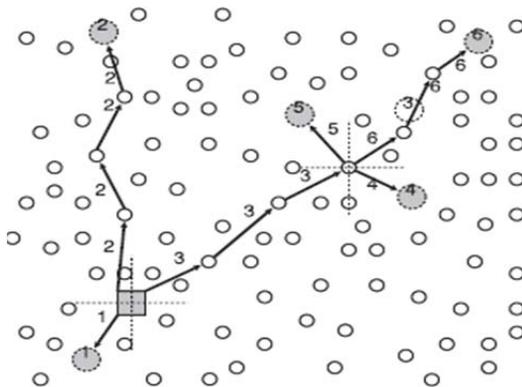


Fig1.RBMulticast Overview

2.Multicast Regions:-

Once a node receives a multicast packet (from the application layer or from a previous hop node), it divides the network into multicast regions, and it will split off a copy of the packet to each region that contains one or more multicast members. We show two possible divisions of the network into multicast regions in following Figs. a and b

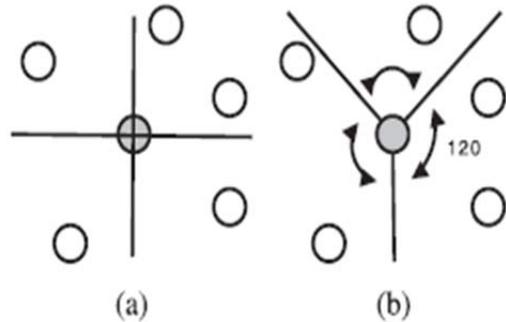


Fig1.Multicast Regions

3.Packet splitting:-

In Algorithms 1 and 2, we describe the RBMulticast method that splits packets at relay nodes for which the multicast destinations reside in different regions. This method is used in the protocol description due to its simplicity. In a variation of this method, namely, RBM-V, the packets are instead split off at the neighbor nodes of the virtual node, which delays splitting the packets compared to the former method.

Virtual Node :

we assume no knowledge of neighbor nodes and no routing tables, we assign a “virtual node” located at the **geographic mean of the multicast members for each multicast region**. This virtual node is used as an imaginary destination for the multicast packet in that region. The virtual nodes are not necessarily reachable or even physically exist as illustrated in Fig. 1. The idea behind this is that even if a virtual node does not exist, we can still find a route using the assumed receiver-based MAC protocol to get the packet closer to the location of the virtual node. On the other hand, when using the nearest multicast node as the destination, all node addresses physically exist and virtual nodes are not necessary.

4.Geographic Mean i.e. location of Virtual Node:-

$$X = \frac{\sum_{i=1}^n X_i}{n} \quad Y = \frac{\sum_{i=1}^n Y_i}{n}$$

(X,Y) Represent the location of virtual node.
 X_i = x co-ordinate of location of node i.
 Y_i = y co-ordinate of location of node i.
 n = Total no. of multicast destination in a region.

5.Etx calculation:-

We also retain the ETX metric in this paper, a state-of-the-art routing metric proposed by De Couto et al. A link's ETX metric measures the expected number of transmissions (including retransmissions) required to send a single packet across the link. Let P_f and P_r denote the loss probability of the link in the forward and reverse directions, respectively.

Each node measures loss rate of its links to and from its neighbours (i.e., Pf and Pr) by broadcasting one probe packet every second and counting the number of probes received in the last 10 seconds.

Then, the link's ETX [4] metric is calculated as:

$$ETX = 1/(1-pf).(1-pr).$$

6.Candidate selection

Prior to broadcasting a packet to the neighboring nodes , a node in the network calculates the ETX metric using above mentioned method. When the regions are created and a separate multicast destination lists are generated then candidate selection process is done. In candidate selection process firstly the nodes are which are closer to the virtual node and in the range of current forwarding node are selected. These nodes are added to the temporary list $TCri$, which is the list belonging to the region ri , Now the nodes in the $TCri$, prioritized according to the closeness of the nodes to the virtual node. Nodes which are closer to the virtual node are given the higher priority. After sorting a list, Nodes are again sorted using their ETX values, Nodes with low ETX value and closer to the destination are given higher priority and nodes with higher ETX are given low priority.

Algorithm; Candidate selection

Input : Neighboring nodes, ETX.

Output: actual Candidate list ACri.

```
// Get the neighbor list
Nlist= neighborlist();
For each i=1 to N //N=number of neighbor nodes
    //Cal distance from virtual node
    DVi = GetDistFrmVN();
    // Add node to temporary list
    TCri = TCri U i ;
End for;
// Sort list according to the DVi

STCri = sort(TCri);

// Sort List according to the ETX values
// to get actual candidate list

ACri = sort(STCri)
```

V.CONCLUSION

In this paper, we presented a new stateless multicast protocol for ad hoc networks called Receiver-Based Multicast. RBMulticast uses geographic location information to route multicast packets, where nodes divide the network into geographic “multicast regions” and split off packets depending on the locations of the multicast members. RBMulticast stores a destination list inside the packet header; this destination list provides information on all multicast members to which this packet is targeted. Thus, there is no need for a multicast tree and therefore no tree state is stored at the intermediate node.

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