IDENTIFIABLE ROUTE RETRIEVAL FOR MULTICASTING IN MANETS

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***Abstract*—** In modern days, Mobile ad hoc networks (MANETs) are used widely for applications that need mobility while routing, more significantly for emergency and military operations. Routing information to nodes without a permanent infrastructure and with dynamically changing infrastructure is one of the greatest challenges. Multicasting is a more frequent requirement for such protection operations, which adds on to the level of difficulty while routing. In order to overcome this problem, the two protocols exist in the literature providing different solutions to delivering data to various destinations at mobility. However, these strategies are either of better complexity or the cost is high. In this paper, we propose Identifiable Route Retrieval for Multicasting (IR2M) in MANETs to use the route familiarity of nodes efficiently to construct routes to destinations. The performance of this algorithm is analyzed using the simulations in the network simulator.

***Keywords*—**Ad hoc network, multicasting, node selection, Quality-of-Service (QoS)

1. Introduction

Mobile ad hoc networks are made up of movable nodes that are able to dynamically form a network and communicate information across the network. The requirement for multicasting in such networks is largely found in military, disaster recovery and emergency operations. To cater to these requirements, the nodes need to efficiently perform multicasting in the network. Multicasting is the process of delivering information from a single source to multiple nodes in the network that are all located at different positions, all at once. Hence an efficient routing algorithm that can reliably deliver information to the destinations without much computation is a definite requirement.

A number of multicasting protocols have evolved to perform multicasting in the network. Beginning with Multicast-Ad hoc On Demand Distance Vector routing [1], which was first proposed by Royer and Perkins in 1999, a good number of protocols have evolved. These protocols are majorly classified into two main categories based on the route construction and retrieval mechanism. The two categories are Mesh based and Tree based multicasting protocols. In both cases, the retrieval of routes from the nodes is essential.

In this paper, we propose a strategy for retrieval of routes based on familiarity that can use its previous information to provide multicasting routes to destinations with lesser time complexity when compared to Route Driven Gossip (RDG) protocol used for MANET multicasting. The remaining sections of this paper include related works, architecture of the proposed system, simulation results and discussion followed by the conclusion.

2. Related Work

A brief analysis of some of the existing protocols is presented in this section. Multicasting operation is performed when a node is able to transmit information to multiple destinations.

A AODV

Perkins and Royer Ad hoc On-demand Distance Vector routing Protocol (AODV) [1] is one of the earliest protocols used for communication in mobile ad hoc networks. The algorithm uses the distance vector routing to find the most recent shortest path using the route reply messages obtained as a consequence of the route request messages sent by a source in the network. AODV protocols still remains as one of the most successful protocols for routing in some network types. But due to the growing demand in other aspects, the protocol has been enhanced by many researches to suit various applications.

B Dynamic Source Routing

Dynamic Source Routing is one of the most popular reactive protocols after AODV which was proposed by Johnson and Waltz (1996, 2001) [2]. This is one of the most relevant protocols pertaining to the IR2M proposed here, as it uses the memory of the past from to perform multicasting in the network. The nodes perform route discovery and route maintenance; however, the obtained routes are not only from the current availability of routes (RREP messages only) but will help retrieve some of the recently used routes from the cache memory. The main disadvantage of this protocol is that sometimes the routes obtained from the cache are timed-out and will produce link breakages, a little more frequent in mobile ad hoc networks.

C Multicast Operation of AODV

The Multicast operation of AODV (MAODV) [3] was again proposed by Perkins C.E to send information to multiple nodes in the network. This protocol forms a multicast tree from which the routes are retrieved by multicast grouped members for communication. Similar to AODV, this performs operations like route discovery and route maintenance. The major disadvantage of this protocol however is the lack of reliability during multicasting.

D On-Demand Multicast Routing Protocol

The On-Demand Multicast Routing Protocol (ODMRP) [4] uses an on-demand multicast-mesh to build routes during communication in the network. Every node that wishes to obtain a route from this mesh broadcasts a Join message and is added to the table. The node becomes a member of the multicast mesh.

E Differential Destination Multicasting

Differential Destination Multicasting (DDM) [5] was proposed by Ji L. in 2001. Unlike multicast AODV, the source is given the full authority to know and control membership of the nodes in groups instead of distributing the control to all other nodes. Apart from that variable-length destination headers that are differentially encoded are inserted in data packets

which are used in combination with unicast routing tables to relay multicast packets towards multicast receivers. This approach not only provides the routing choice to the source but also provides a stateless mode option. This is one of the most successful approaches for multicasting to small groups among scalable network sizes with dynamic topology. The only disadvantage of this protocol is that the nodes do not perform dynamic familiarity check.

3. Proposed Work

The main objective of the proposed method is to use Identifiable routes for routing performance in the Mobile Ad hoc Network. Familiar and cached routes are retrieved in order to send data to the corresponding destinations as required by the routing processes in the network. The Identifiable Route Retrieval in Multicasting (IR2M) is proposed with an aim to control overhead and promote the routing performance while multicasting.

A Identifiable Route Retrieval in Multicasting

Route formation and retrieval is based on the familiarity factor in a network. Generally the multicast routes are obtained from the routing trees or routing meshes formed. These are generally formed depending on the node locality, availability of the nodes for communication and the routing cost.

Familiarity generally refers to the fact that there is a trail of previous memory about a path or any information. Just like how any Identifiable route can be traced back using partial information, in this paper, the familiarity of a route or data is retrieved from the cache memory if any and then added into the mesh or the tree instead of new mesh formation process and route establishment process. This means that the route discovery messages terminate at regions where there already exist routes to the multicasting destinations.

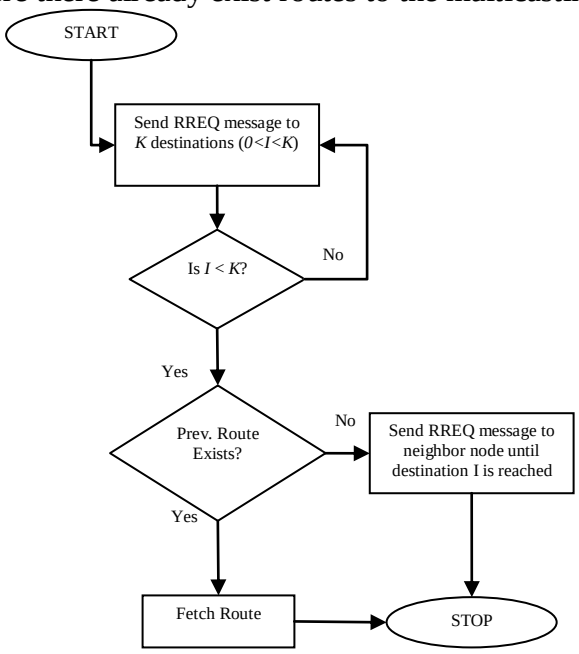

Fig.1 Route Discovery in FRRM

Algorithm:

Set S source

```
Set D1 to DN as Destinations
Broadcast {sourceID, destinationIDs in RREQ} {
    For (Destinations 1 to N) {
        While {node != Destination) {
            If {familiar route exists} {
                Do not broadcast RREQ
                Fetch route;
            }
            Else {
                Broadcast RREQ
            }
        }
    }
}
```

The above algorithm describes the new route discovery process that takes place just before forming either meshes or trees. The routes available in the cache memory are fetched and used for multicasting.

Figure 1 shows the flow of the route discovery process. Initially route request messages are sent and reply messages are obtained from various nodes before forming either the multicast mesh or the multicast tree. Route replies are provided from the cache memory if any available routes are familiar to the node. Using this information multicast trees or meshes can be formed.

This method induces the problem of the nodes retrieving familiar but outdated routes for routing. This problem is called as the stale route cache problem. In this paper, we also provide a solution to avoid this stale route cache problem. The algorithm to solve this problem follows.

```
Set cache(i) = cache memory of node i at time tk
Set t = current_instant
If {previous route exists} {
      //Estimate Rate of topology change
       RTC = ∑ change of RSS/time
        if {t-tk < f(RTC)} {
            retrieve route (i,t)
        }
}
```

The stale routes are filtered using a function that records the rate at which a topology changes. The topology change rate is estimated by the change in RSS of the neighboring nodes over time. This factor clearly indicates the rate at which the nodes are moving inside the network. Only if the timestamp of the routes available in the cache memory satisfy the condition $t-t_k<f(RTC)$the nodes are considered for routing.

The technique reduces the number of outdated routes from including into the current routes. Hence the performance of the FRRM is improved to a good extent which is discussed in the following section.

4. Performance Analysis

We have used NS2 simulator to show the simulation results of the proposed FRRM protocol. The random waypoint mobility model is used for the communication between 50

nodes in the network that are distributed in an area of 1000m×1000m. Each node is capable of independently moving within the specified area.. The specifications of the simulation environment and the processes involved are shown in the Table 1 below.

TABLE I. SIMULATION PARAMETERS

Parameter	Value
Simulator	NS2 (Ver. 2.28)
Simulation Time	20 ms
Number of nodes	50
Routing protocol	AODV
Traffic model	CBR
Simulation Area	1000×1000
Transmission range	250m
Channel Type	Wireless Phy
Antenna Type	Omni Antenna

A. Packet Delivery Rate

The packet delivery rate is defined as the rate at which the destination received the data packets. The rate is calculated based on the number of data packets received per time. Higher the packet received rate aggrades the performance of the network as shown in Fig. 2. The delivery rate of FRRM is clearly greater than that of the DDM used for comparison.

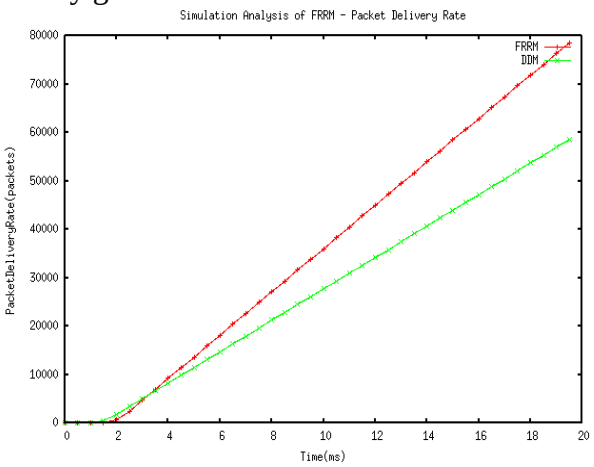

Fig. 2 Packet Delivery Rate

B. Throughput

Fig.3. shows the amount of throughput in the network. The network throughput is used to judge the efficiency of the network. IR2M has greater throughput than the DDM scheme.

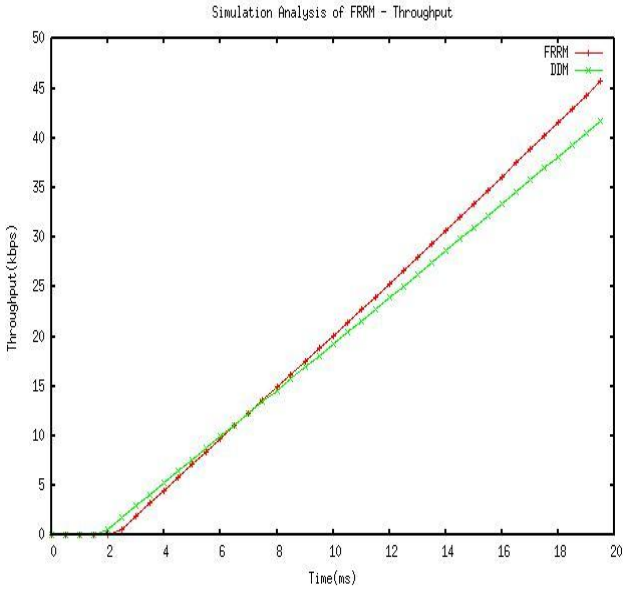

Fig. 3 Throughput

C. Packet Loss

Packet Loss rate of both the IR2M and the DDM are compared to check the rate at which packets are dropped by mobile nodes in the network. The plot for the packet loss ratio is shown in the figure 4 below. It is hence proved that the loss ratio is greater for DDM when compared with the IR2M protocol.

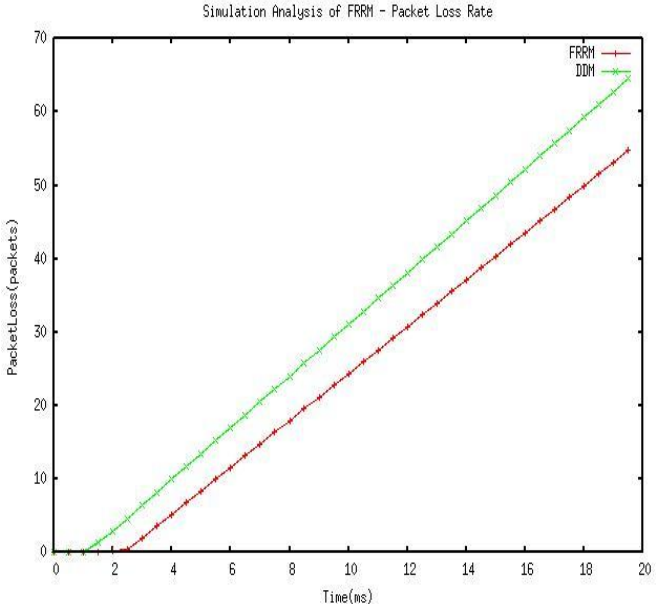

Fig. 4 Packet Loss

D. Delay

Packet Loss ratio of both the IR2M and the DDM are compared to check the rate at which packets are dropped by mobile nodes in the network. The plot for the packet loss ratio is

shown in the figure 5 below. It is hence proved that the loss ratio is greater for DDM when compared with the IR2M protocol.

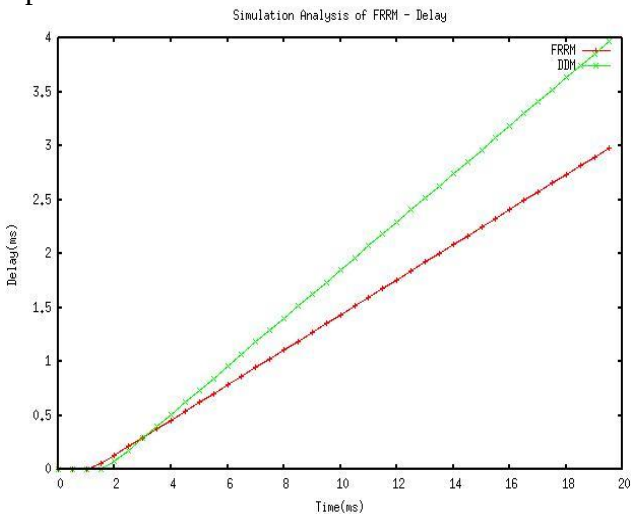

Fig. 5 Delay

From the above graphs it can be found that IR2M performs better than DDM protocol. Although in the initial stages of the simulation there is the DDM performing better, along the simulation time we can see that IR2M performs much better.

5. Conclusion

A Identifiable Route Retrieval for Multicasting (IR2M) was proposed, simulated and analyzed in this paper. IR2M proposes that a check in the cache routes before using them for routing (either through multicast mesh or tree formation) is can improve the network performance. The Differential Destination Multicasting protocol was used as a comparison baseline to perform multicasting. From the analysis, it can be that the IR2M can improve the reliability and communication performance to a good extent.

In future this protocol can be extended to suit hybrid networks and hence the multicasting can be brought to a close-to-ideal endeavor.

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