Modified Multicast Cellular Aggregated Location Management

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Abstract
The wireless ad-hoc network operates without an access point. When this infrastructure less network provides the mobility of nodes we call it MANET. Various protocols are proposed for MANET's, some of which provides multicast services. Today, the application of multicasting can be seen in defense area, multiple user games and natural calamity operations. The internal working of protocols can be different but the goal of all the protocols are same i.e. reliable and efficient multicast packet delivery. The route of the Multicast packet transfer become sensitive with respect to mobility. In order to, enhance the efficiency and reliability, the MPRs (multi point relays) selection mechanism along with multicasting in CALM is used. So, to transfer the data packets i.e. multicast packets, from the source to group members we have proposed an approach that builds multicast delivery routes using multi point relays.

Keywords
Multicasting; Cellular Aggregated Location Management; Location Service; Multi-Cast Tree

I. Introduction

The mobile ad-hoc network is an autonomous collection of two or more wireless nodes. These nodes might be dynamic in nature and they can communicate with each other either directly within communication range or by the multi-hop data forwarding operation if they are not directly within same communication range. The wireless ad-hoc network works without any support of central administration and infrastructure and consists of wireless devices which have capability of networking. A MANET is an autonomous collection of mobile users that communicate over relatively bandwidth constrained wireless links. [1][12]. Due to mobility of nodes the location will vary with respect to time. As a result of which unicast routing protocols turns out to be inappropriate for increasing no. of receivers.

Therefore, a different routing protocol named as MRP (Multicast Routing Protocol) is preferred. Multicasting has its applications in different fields such as defence area, audio and video conferencing, natural calamities, multi-player games and integration with cellular systems. Apparently because of certain limitations in Mobile Ad hoc Networks, number of obstructions need to be taken into account during designing of multicast routing protocols. As in MANET, the nodes in the network are mobile and topology changes dynamically [1]. The second issue is the reliability of the multicasting protocol, the multicasting protocol also need to make sure that the multicast traffic has reached all the member of the intended tree structure [12]. The third issue is the bandwidth consumption while transmitting the multicast traffic, the multicast protocols need to take into the account the bandwidth consumption while transmitting the multicast traffic [1][13] also due to ever increasing applications of mobile ad hoc network, the traditional functionalities of multicasting will soon be outdated and thus needs to be extended to incorporate new feature in order to keep up with demands of modern ad hoc routing.

A. Routing information update mechanism

First presented routing protocols were topology based in which that find route from source to destination according to the metrics of the network links. These are of two types of topology based routing protocol, reactive protocol such as DSR and AODV [3] [6] and proactive protocols such as DSDV [4][6] and FSR, the topology based methods have scalability problem, as the network size grows the overhead increases. The solution to the scalability problem is the location based protocols in which the network node maintains geographic locations and uses the information to route packets. In the traditional location based protocols such as LAR [16], the node floods location query packets over the entire network in order to find the position of the destination node. Due to flooding technique these type of protocols cannot be applied to the large scale networks. Thus a location based scheme CALM [2] was developed that can reduce network overhead for location management.

B. Traditional CALM

CALM or Cellular Aggregated Location Management is a location management scheme, it decreases the location management overhead in a network while covering the disadvantages of the aforementioned routing protocols. In this method a circular network interface is assumed which is divided into various sectors and cylinders which are equal in size. Nodes reside in the areas which are created from the intersection of the sectors and cylinders, any node residing in a particular area cannot go outside of that area. Each area has a single node which will act as the server for all the nodes residing in that particular area , This node will be responsible for answering the location queries of the other nodes in its area.

For location update these nodes will forward update packages along their respective cylinder in both clockwise and anti-clockwise direction. All the intermediate server nodes will record the contents of the packet and will enter the locations of the nodes residing in their area to the update packets, the update packets will traverse the cylinder (in both clockwise and anti-clockwise way) eventually returning to the initial location server that transmitted the packet, thus every location server will be updated in this process. In Fig. 1 we see that s2 is the server node that sends the update packets in clockwise and anti-clockwise direction.

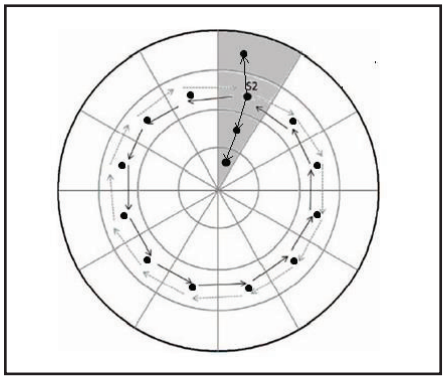

Fig. 1: CALM Location Query Process

For location query the nodes residing in a particular area will request the location server of that area for the position of the destination node, if the location sever does not have the destination of the node then it will sent the query packets towards the circumference and the center of the network interface. If any intermediate server node has the position of the destination node then it will reply with the position otherwise it will just transmit the message to the direction from which it originally came from. Once the position of the destination node is found, the source node will transmit a route request packet to the area of the destination node through the unicast table that is maintained by each node. The destination node replies with a reply packet along the same path thus a path is established for packet transmission. It uses single hopping for packet transmission. The destination node replies with a reply packet along the same path thus a path is established for packet transmission. It uses single hopping for packet transmission.

C. Multicasting Mechanism in Routing Protocols

In protocols such as MAODV [7] [14], the multicasting is accomplished by maintaining a multicast table. Such table is maintained by all the nodes in a network. The multicast table is responsible for the identification of the corresponding node; the identity can be group leader, group member or router. Multicast table also maintains the next hop for each multicast tree structure. Thus every node in traditional multicast algorithms maintain two table ,one is unicast routing table while another is the multicast routing table for multicast traffic. Although widely used, this implementation of multicasting poses some limitation such as lack of functionality to transmit multicast traffic between non-member sender and a group member. Even if the aforementioned limitation is overcome, the non-member source would still transmit the multicast traffic individually towards the each group member for the intended group resulting in the wastage of bandwidth.

II. Modified Multicast Cellular Aggregated Location Management Routing Protocol (MMCALM)

To overcome aforementioned limitations, a new protocol is implemented which applies modified multicasting on CALM location management scheme. In MM-CALM routing protocol, we defined a tree structure to demonstrate each multicast group composed of group members and routers thus each multicast tree has group members, a group leader and routers (which acts as the intermediate node for transferring the packets along the path). For the implementation each node in the network will contain two more tables along with unicast table. These tables are multicast and group leader table. The multicast table lists the next hop for each multicast tree structure. It also maintains the identity (group leader, group member or router) for its corresponding node. Each and every next hop can be either downstream or upstream, if the next hop is in proximity of the group leader, then the direction would be upstream, otherwise the direction would be downstream. The group leader table records the currently known multicast group address along with their group leaders.

These tables will be updated using CALM location updating procedure in which each server node will fetch the location as well the information about the group and group leaders in its area and pass it to the update packages that are traversing along a particular cylinder.

A. Route Discovery and Maintenance for reaching a multicast tree

Using the Modified Multicast CALM routing protocol the non-tree member nodes of a network can also send out multicast traffic to multicast node in the network, this is achieved by two things i.e. establishing a route from the data source to the member node and After receiving the data the tree member transmits the packet to every member of its group. We borrow the mechanism of node discovery and route establishment from CALM .The data source initiates a RREQ packet and transmits it to the group leader through group table. The group table or any intermediate node replies with the RREP packet thus establishing a path to the group leader, during the multicast packet forwarding each node checks whether it is the part of multicast tree, if not , it will look into the unicast table for the next hop. If the node is a tree member then it will look into the multicast routing table to send the packet to other nodes. Once the multicast traffic reaches the group leader, it is broadcasted to all the nodes in the tree structure. Thus every node in the tree structure receives the multicast traffic from the group leader who itself received it using unicast propagation.

B. Multicast Tree Construction

For the formation of multicast tree structure the following algorithm is followed.

1. A node must be a member of tree, if it is not then to join the multicast group, the node has to send a Route Request (RREQ) along with a join flag (RREQ-J) to the tree.
2. The node turns as a member of the tree by making its entry in the Multicast Group Table. This is done before sending out RREQ-J. Also, if a node already present in is not a member and wants to become a part of it, then it has to update records of its Multicast Route Table that is, changing its role from a router to a group member.
3. The non-member node unicasts an RREQ-J packet towards the intended group leader.
4. The packets are sent as a response by sending RREP to requesting nodes that has highest sequence number and lowest hop count.
5. The tree is finally formed when the receiving node selects the RREP packet with the minimum distance, and then to confirm the route the node sends the MACT.

In a case of link breakage, the downstream node is responsible for broadcasting the RREQ packet, the node that will send the response will be the one with hop count less than or equal to specified value in RREQ. If upstream node does not respond to the RREQ packet, multicast tree will collapse and receiver itself forms a multicast group on its own. In order to improve the bandwidth issues the concept of broadcasting is used to multicast the packet. Since there are no feedbacks it is impossible to know about whether the neighbors received the packets or not.

C. Tree Maintainence

To ensure whether the group is active or not, the leader sends a Hello message in the network. On receiving a GRPH message, nodes update their Group Leader Table so as to replace the old with the new leader and the path in the direction of the leader. The multicast traffic is broadcasted. The broken link cannot be detected easily (the MAC layer detection). Instead, for link maintenance, Neighbors- Hello messages are used and sent periodically to the next node. If a reply does not come after certain amount of time then the link is considered to be broken. On detection of a broken

link, the downstream node removes that next hop from node's Multicast Route Table, and later to establish a new branch it turns as the source node that passes Route Request-J. Both the Route Request-J sent here and the one that is used for the non-member node to make it a part of the multicast group, are different as in this to remove the previous branch and its personal downstream nodes replying to the RREQ-J, first it is broadcasted and affixed with an additional and useful details of the node's hop count to the leader. The tree member on collecting a Route Request-J with add-ons, checks its personal hop count to the leader. To make a reply to Route Request-J the members are supposed to have equal or minimum hop count. The rest procedure is similar to the approach used for an outside node that is willing to become a part of the tree.

III. Simulations

For implementation, performance evaluation and simulation of the above mentioned protocol the Linux based simulation tool NS2 is used. NS2 is an acronym used for Network Simulator Version 2 which is an open-source event-driven simulator designed for the research purpose in computer networks domain.

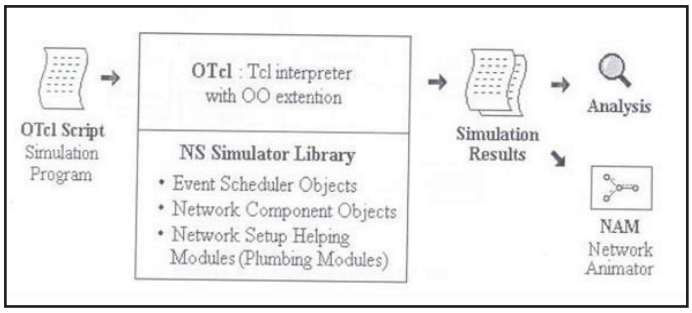

Fig. 2: Simulation Process Using NS-2

The realization of ad hoc networks in real time systems is infeasible since it is complex, costly and dangerous the practical implementation would act as a bottleneck for performance evaluation and testing, hence a network simulator is a practical approach to our protocol. The below mentioned features are of NS2 which gives plausible explanation on our choice of simulator used for the project.

The protocols CALM, MMCALM are simulated by using network (NS2) simulator for the testing the architecture designed in CALM along with modified multicast feature, for comparison of parameters - Packet Delivery Ratio, Average end to end delay and Throughput.

A. Scalability

Comparatively the results of the cellular aggregated location management is better and the reason is aggregation, it is much more scalable than AODV, DSR and other routing protocols which means that the network overhead is independent of the size of the network. Since the modified multicasting is applied to CALM the resulting protocol MM-CALM is much more scalable than the other multicasting routing protocols.

B. Packet Delivery Ratio

Since the no. of update data packets transferred in MM-CALM is lower in comparison with the different protocols the MAC layer knock is much lesser resulting in more packet delivery ratio as compared to standard protocols. Most of the packet delivery failure is due to outdated location information or query failures as opposed to other scalable routing protocols in which there is high probability transmission failure due to flooding.

C. Multicasting

The multicasting for MM-CALM is different from other traditional multicasting protocol because in MM-CALM the nonmember nodes can also send multicast traffic to other multicast members which will reduce the congestion in network.

D. Bandwidth

The source node sends the multicast traffic to the group leader through unicasting and the group leader broadcast the message along the tree structure, since unicasting is used to transmit the multicast traffic to the group leader, a lot of bandwidth is saved.

IV. Conclusion and Future Work

In our paper, we have presented an extension to CALM to which we call as MM-CALM, a scalable location management service with improved traffic loading for routing in ad hoc networks. MM-CALM is better than other standard routing protocols in terms of scalability since it uses "Synchronized

Aggregation" technique. Multicasting applied to MM-CALM is unique and different as compared to traditional multicasting techniques such as MAODV. Multicasting in MM-CALM allows the non-member node to send multicast traffic to the group member nodes in a tree structure , this along with the aggregation technique gives MM-CALM extended multicasting functionalities along with better scalability, packet delivery ratio, end-to-end delay, and throughput as compared to other multicasting routing protocols.

Further work can be done in future by applying security protocol to the multicast groups as well as the multicast traffic.

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