International Journal of Advance Research in Science and Engineering
Vol. No. 5, Issue No. 07 , July 2016
www.ijarse.com
IJARSE
ISSN 2319 - 8354

AN EFFICIENT MULTICAST ROUTING PROTOCOL TO IMPROVE PERFORMANCE METRICES IN MANET

Prashant Sharma[1], Dr. Jayant Shekhar[2]

Prof & Director Department of Computer Science

Subharti Institute of Technology & Engg. Meerut UP (India)

ABSTRACT

A vital and vital issue for multicast versatile specially appointed systems (MANETs) is directing convention plan i.e. a noteworthy specialized test because of the dynamism of the system. Versatile Ad-Hoc Network (MANET) is an element, multi-bounce and self-ruling system made out of light remote portable hubs. A considerable measure of control messages are required to manufacture ideal multicast trees and keeping up gathering enrollment because of the dynamism of MANETs. Because of these overheads we devour more prominent vitality resourses of portable hubs and system resourses like remote connections transfer speed . This paper displays a compelling multicast steering convention for MANET with minimum control overhead. The convention builds shared multicast tree utilizing the physical position of the hubs for the multicast sessions. To get the physical area of the hubs we utilize the idea of appropriated area administration , which viably diminishes the overheads for course looking and shared multicast tree maintenance.In this convention we utilize the idea of little covered zones around every hub for dynamic topology support with in the zone. To interest for a current multicast tree outside the zone, obliged directional sending is utilized which guarantee a decent decrease in overhead in contrast with system wide flooding for pursuit method.The convention utilizes neighborhood availability procedure and defensive course reconfiguration on the premise of the present status of the hubs are being proposed which diminishes the overhead, power and transmission capacity prerequisite and attempt to expand the execution and unwavering quality.

I. INTRODUCTION

A manet consists of a collection of mobile hosts forming a dynamic multi-hop independent network [1] without the participation of any centralized access point or static infrastructure. Using multicast instead of sending through multiple unicasts not only minimizes link consumption, but also reduces sender and router processing, communication costs and delivery delay [2]. Group communication is important in Mobile Ad Hoc Networks (MANET). Many ad hoc network applications which require close association of the member nodes depends on group communication. In addition, many routing protocols for wireless MANETs need a broadcast/multicast as a communication primitive to update their states and maintain the routes between nodes [3].Multicast protocols can be categorized in tree based and mesh based protocols. Multicast network structures are fragile therefore need to be readjusted and repaired continuously as the connectivity changes. Multicast protocols have to produce multi-hop routes under bandwidth shortage, limited battery power and dynamic topology due to nodes' random mobility. Even in wired networks, building optimal multicast trees and maintaining group membership information is challenging which becomes predominantly puzzling in mobile ad hoc networks. The proposed convention, a compelling multicast steering convention for MANET with slightest control overhead, called EMPIM utilizes the idea of proactive zone and builds a common bi-directional multicast tree with move down root for its directing operations. Zone building, multicast tree development and multicast parcel sending relies on upon the area data acquired utilizing a disseminated area service GLS, which viably decreases the overheads for course searching and shared multicast tree support. To hunt down an existing multicast tree outside the zone, obliged directional sending is utilized which guarantee a decent lessening in overhead in contrast with system wide flooding for inquiry process. Execution and unwavering quality in terms of reduced overhead, less consumption of power and data transfer capacity is mproved using the neighborhood availability strategy what's more, defensive course reconfiguration on the premise of the present status of the hubs. These procedures likewise guarantee great decrease in idleness if there should arise an occurrence of connection breakages and counteractive action of the system from part. Whatever is left of the paper is composed as takes after: Section 2 depicts tree based multicast conventions arrangement for MANET furthermore highlights the issues lie in the current multicast steering protocols. The proposed viable multicast routing convention for MANET with slightest control overhead is talked about in Segment 3.Section 4 examinations the performance of EMPIM in correlation with other shared-tree based multicast convention MAODV. At last, area 5 condenses the investigation of the work in conclusion.

II. MULTICAST PROTOCOLS FOR MANETS

The greater part of the multicast conventions proposed for versatile specially appointed systems can be extensively ordered into two sorts, to be specific tree-based multicast and lattice - based multicast. Multicast network does not perform well as far as vitality effectiveness because of intemperate overhead as it relies on upon telecast flooding inside the cross section. Then again tree structure is known for its effectiveness in using the system asset ideally which is the inspiration driving the choice of tree based multicast. A tree based multicast directing convention can be either a source-tree or a common tree based convention. Numerous source-tree based steering trees directed at various wellsprings of the multicast session are utilized to convey information bundles in a source-tree based multicast directing convention while a mutual multicast tree for the entire multicast gathering is utilized to convey information parcels in a common tree based multicast directing convention. Source-tree based multicast cause intemperate overhead to remake an extensive number of source trees in the event of profoundly versatile hubs [4], while shared tree multicast has lower control overhead since it needs to keep up just a solitary shared tree for all multicast sources and hence is more adaptable [5].

2.1 Comparison of Multicast Protocols

Ad hoc Multicast Routing (AMRoute) [6] and Lightweight Adaptive Multicast (LAM) [7] are tree based protocols, in which a shared tree is constructed for the delivery of multicast packets to the entire multicast group. In AMRoute protocol a bi-directional shared multicast tree is created involving only the group members. The tree links are created as unicast tunnels between the tree members. The problem with AMRoute is that it depends heavily on an underlying unicast protocol for creating these unicast tunnels. The LAM protocol depends on Temporally-Ordered Routing Algorithm (TORA) [8] for route finding ability and cannot operate independently. An advantage of LAM is that, it reduces the amount of control overhead generated for route finding, due to its tight coupling with TORA. CAMP [9] and On-Demand Multicast Routing Protocol (ODMRP) [10] are well-known examples of mesh-based multicast routing protocols. They enhance the robustness by providing redundant paths between the source and destination pairs. The mesh is created at the cost of higher forwarding overhead. CAMP illustrates a proactive mesh based protocol. On the other hand, in ODMRP, the mesh is created using the forwarding group concept and a reactive approach is followed to keep the forwarding group current [4].

The main disadvantage with mesh based protocols is the excessive overhead incurred in keeping the forwarding group current and in the global flooding of the JOINREQUEST packets. Even the shared tree approach has some other drawbacks:

(i) Due to shared tree structure these protocols have the disadvantage of their dependency on a core node to maintain group information and to create multicast tree, thus have a central point of failure.

(ii) Due to node mobility the tree structure is fragile and thus, need updation. To compensate this problem and to optimize the multicast tree, multicast protocols for MANETs usually employ control packets to periodically refresh the network structure [11], which causes increments in the overhead and power consumption.

(iii) Every multicast routing protocol is having some or the other problem, hence suitable to specific kind of environment.

To improve the problem of dependency on a core node, a back up root node along with the primary root node is used. To reduce overhead and power requirement, the constrained directional forwarding in the direction of the target using its location information employed in the protocol. To make an environment independent protocol, a hybrid approach is the need of the protocol. Moreover, the location advantage of the nodes can further improve the performance of the protocol manifolds. Based on this view we have designed a new multicast routing protocol named A Novel Multicast Routing Protocol to Improve QOS in Manet (EMPIM).

III. PROPOSED PROTOCOL EMPIM

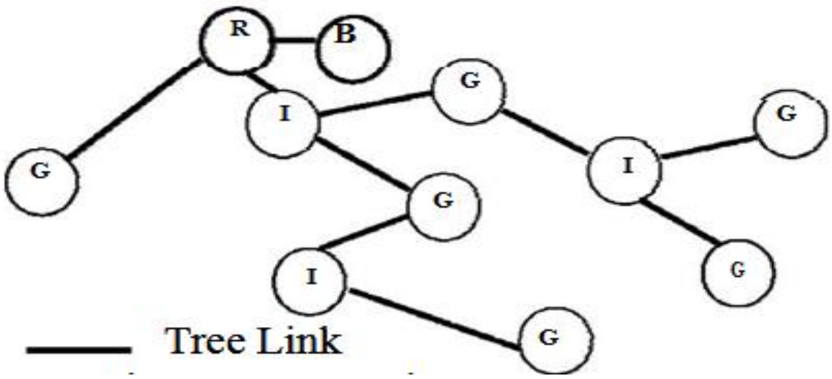
This section introduces a new multicast protocol, Effective Multicast Routing Protocol for MANET with Least Control Overhead, which follows a hybrid approach using the grid location service to gather the physical location of the nodes. Use of backup root node provides support in case of primary root node failure. The

International Journal of Advance Research in Science and Engineering
Vol. No. 5, Issue No. 07 , July 2016
www.ijarse.com
IJARSE
ISSN 2319 - 8354

protocol reduces the total energy consumption as well as improves the performance than a conventional shared tree based protocol by reducing the overhead.

3.1 Shared Multicast Tree with Backup Root

In case of shared multicast tree the protocol dependency on a root node to maintain the group information burdens the root node. Due to this shared tree multicast is particularly not suitable from energy balancing point of view because the root of the tree takes on more responsibility for routing, consumes more battery energy, and stops working earlier than other nodes. This leads to reduced network lifetime [12] and the whole multicast tree is disconnected into a number of partitions which consumes a lot of wireless bandwidth for reconstructing the multicast tree from all these partitions. To alleviate this problem, EMPIM creates the shared multicast tree with backup root node as an alternative to the primary root node. Creation of a backup root node enhances the performance of the multicast tree and also lessens the load on the primary root node. In case of primary root node failure the backup root node takes over, therefore, reduces the dependency on a single root node. This facilitates a great reduction in tree maintenance and tree re-construction overhead. Selection of backup root node is done from the neighbor nodes of the primary root node on the basis of stability, battery status and quality. A non-tree member node with slow movement and more power status is chosen to be the backup root node. If the root node does not found any neighbor node with the required criterion then the selection process is delayed by some random time and after that the backup root node search process starts again. The selection process may lead to slight delay but improves overall efficiency of the protocol by selecting a suitable node as backup node. Selecting a suitable node as backup root node not only serves the purpose of standby root node but also defer the early possibility of searching the backup root node again in case of power failure or movement of the existing backup root node.



R Primary Root node

B Backup root node

G Group members

I Intermediate nodes

Fig :1 Shared Multicast Tree with Backup Root

Figure 1 shows an example of a multicast tree. The tree consists of a primary root node (R), backup root node (B), three intermediate nodes (I), six member nodes of a multicast group, and nine tree links. A multicast packet is delivered from the root node R to all the six group members. Using the zone routing every tree member unicasts the multicast packet only to the neighbor tree members, thus saves a lot many transmissions otherwise required in case of broadcasts.

3.2 Zone Routing

A steering zone is characterized for every hub independently, and the zones of neighboring hubs cover. A k-jump directing zone of hub S can be characterized as an associated topological subgraph, on which hub S knows about the course to some other hub [13]. The hubs of a zone are isolated into fringe hubs and inside hubs. Outskirt hubs are hubs which are precisely k bounces far from the hub being referred to. The hubs which are not as much as k bounces away are inside hubs. In fig. 2, the hubs G, D and M are outskirt hubs and rest all are inside hubs and the hub N, 4 jumps far from S, is outside the steering zone. However hub L is inside the zone, following the most brief way up to L with length 3 is not exactly the greatest steering zone bounces.

To deal with the overhead, the proactive degree is diminished to a little zone around every hub in the EMPIM convention. As the zone range is essentially littler than the system sweep, the expense of taking in the zones' topologies is a little division of the cost required by a worldwide proactive instrument. Zone directing is additionally much less expensive (as far as control movement and blockage) and speedier than a worldwide receptive course revelation component, as the quantity of hubs questioned in the process is little [4]. A greater proactive zone can be chosen for similarly stable topology where the overhauls of topology are done on topology change as it were. In a constrained zone, every hub keeps up a proactive unicast course to each other hub. In the proposed convention the steering is at first settled with proactively prospected courses inside the zone and afterward outside the zone, utilizing diffused directing towards the tree individuals. Thusly, course demands can be all the more productively performed without misusing the flooding in the system.

3.3 EMPIM's Modified Data Structures

GLS speaks to a completely circulated and adaptable area administration in the accompanying behavior: No hub is a bottleneck as obligation of keeping up the area administration is spread uniformly over every one of the hubs. Disappointment of a hub does not influence the reachability to numerous different hubs. Neighborhood correspondence fulfills the inquiries for the areas of the close-by hubs which likewise permit operation notwithstanding system allotments. The correspondence cost and per-hub stockpiling of the area administration develop as a little capacity of aggregate number of hubs [17]. GLS utilizes various hubs as ―location servers‖ circulated all through the system, which gives area data to different hubs. Albeit every hub can go about as an area hub, EMPIM favors a hub rich in assets like memory and similarly stable to be area hub. Keeping in mind the end goal to encourage the area benefit, every hub has a few information structures notwithstanding those required for the directing calculation. The information structures utilized as a part of EMPIM are altered ones and notwithstanding the current ones to enhance the execution of the steering.

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ISSN 2319 - 8354

The second information structure that every hub keeps up is the ―scorecard‖ of different hubs as appeared. This is a table where every passage contains the IP of a hub and a score demonstrating how ― good‖ the hub is at giving area data to the hubs outside its zone. Passages are made in the sliding request of the score qualities and just of those hubs having a score esteem more than a limit sth. These hubs speak to the area servers. A little esteem score demonstrates an awful area hub in giving area data to different hubs, while a high esteem for the score shows that the hub stores more hubs' areas. It might be introduced relative to the accessible size of the hub's area table. At the point when the hub answers a source hub's solicitation, score is expanded and when the hub moves more than dth separation from its unique place, its entrance is expelled from the scorecard table. Score is diminished after some time through a score rot component. At the point when the score diminishes than sth, the passage will be expelled from the table. The purpose behind this score decrement is to keep hubs from consuming vitality that once in a while give areas, regardless of the fact that they have huge limits.

At the point when a source hub needs the area of an objective outside, it counsels its scorecard and sends a MGREQ solicitation to the most astounding scoring area hub. On the off chance that a reaction is not heard after a specific measure of time, the hub's score is diminished and the source hub asks the following most noteworthy scoring hub. At the point when a reaction is gotten, the source hub expands the hub's score. The sum by which a score is expanded ought to reflect to what extent a hub takes to answer a solicitation, and how a la mode the area data got from the hub is.Besides LT and scorecard, with the end goal of steering data every hub keeps up Multicast Tree Table (MTT) as appeared and Request Table (RT) as appeared. Every section of multicast tree table contains the multicast bunch IP address, multicast bunch pioneer IP address, jump check to multicast bunch pioneer, next bounces and timestamp. This table has sections for every one of those multicast gatherings of which gathering the hub is a part. The Next Hops field is a connected rundown of structures, each of which contains the accompanying fields:

- Next Hop IP Address
- Link Direction
- Activated Flag

For the purpose of finding the distance d between two nodes equation (1) is used and slope θ made by a line joining the source node and peripheral node with the line from source to member node is calculated using (2).

$$\mathbf{d = \sqrt{[(a2 - a1)^2 + (b2 - b1)^2]} \ldots\ (3.1)}$$

$$\boldsymbol{\theta = \tan^{-1} \frac{(b2 - b1)}{(a2 - a1)} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3.2)}$$

where (a1,b1) and (a2,b2) are the locations of two mobile nodes.

A multicast group request packet MGREQ, shown in fig. 5, is broadcasted by a node within its zone in search of an existing multicast group. This packet contains the IP and location of the request node, IP of the multicast group, join-flag and a timestamp. A location reply packet MGRPL as shown in fig. 6 is sent in response to a MGREQ packet by a tree member node. The MGRPL packet contains the IP and location of the multicast group tree member, the IP and location of the request node, and a timestamp.

3.4 Shared Tree Creation

EMPIM maintains a bi-directional shared multicast tree for each multicast group, consisting of the members of the multicast group and several routers. Each multicast group has a unique multicast group address (IP) [18] and a group leader. The group member that first constructs the tree is designated as the group leader or the primary root of the tree [19]. EMPIM algorithm searches the multicast group tree member in the zone of the intermediate node. It searches the possibility of tree member by searching the multicast group IP in the multicast tree table and request table of each neighbor node in the zone. In case of no match found with in the zone it repeats the search outside the zone.

3.4.1 Searching the existing multicast group in zone -

Proactive topological routing operates within the k-hop routing zone. A request node, that wants to join the multicast group, will first look for the existing tree of the multicast group. The node broadcasts a MGREQ packet with multicast group IP and join flag set within its k-hop routing zone (TTL=k). All nodes of the zone search the multicast group IP in their multicast tree table. A node having a matched entry replies back MGRPL unicastly to the request node by putting its own IP, latitude and longitude in the multicast tree member IP (TM_IP), latitude (TM_LAT) and longitude (TM_LNGT) fields of the MGRPL through the reverse route maintained during the traversing of MGREQ packet. In case of no entry matches in the multicast tree table of all the neighbor nodes, the request node searches the tree existence outside the zone.

3.4.2 Searching the existing multicast group outside zone

To find the possibility of the group outside the zone, the multicast IP of the MGREQ packet is searched in the request table of the zonal nodes. If any entry of the request table matches, then the node unicasts MGRPL to the request node by putting the IP, latitude and longitude of the matched entry node in the multicast tree member IP, latitude and longitude fields of the MGRPL. The matched entry node, in the request table, indicates a node that had requested for the multicast group in the past and hence actually the tree member node outside the zone.

In case of no entry matches in the multicast tree table and the request table of the nodes in the zone, the node finally checks its scorecard and sends the MGREQ packet to the highest scoring node of its scorecard. It waits for a certain amount of time and in case of no response it sends the packet to the next highest scoring node. Continuing in this way it enquires from all the nodes of the scorecard. Still in case of no success, the request node sends a small signal to its border nodes like to forward the cached copy of the MGREQ to all the border nodes of their respective zones in search of the multicast group in the whole network like D, G, J, L and M as shown in fig. 2. In case of no border nodes, signal is sent to the nodes with k-1 hop like C, F, I and K in fig. 7 and to all possible nodes in case of sparse network. The border nodes then broadcast the MGREQ packet to all the nodes in their zone. These nodes further search the multicast group IP in their multicast tree table and request table until the network diameter is not reached. A node having a matched entry in either table replies MGRPL back unicastly to the request node.

3.4.3 Confirm the Join Process

After receiving the MGRPL the request node broadcasts a stop search signal to all nodes in its zone and sends the GRAFT message to confirm the join process following the forward route to the node from which it received the MGRPL message. The GRAFT message will activate the tree link between the request node and the node which sent the MGRPL message and this way the request node becomes the tree member. Request node also updates its request table and multicast tree table.

3.4.4 Creating a new Tree for a new Multicast Group -

Once the whole network is traced (TTL equals Network_Diameter) in search of multicast group and still no MGRPL is received by the request node, it assumes that the requested multicast group does not exist. It then declares itself the leader of the multicast group and becomes the primary root of the tree and broadcasts this information to all nodes within its zone.

3.5 Shared Tree Preventive Modification

The robustness of the multicast tree is adversely affected with the time if individual links are repaired only when broken. Over a period of time due to high mobility of the nodes the overall structure of the tree would be far from optimal, hence making the tree susceptible to even more link breakages. In EMPIM, the tree is updated regularly and also the preventive maintenance is done which kept the tree robust.

3.5.1. Tree Modification

In order to maintain the tree structure even when nodes move, group members periodically send tree_update requests to the backup root node to lessen the load on the primary root node. The multicast tree can be updated using the path information included in the tree_update request messages. If any change is found in the path the back up root node sends an update message to the primary root node to notify about the change so that the changes in the topology also reflect in the tree structure. Tree_update need to be initiated by leaf nodes only as each uplink next hop puts its own uplink on the tree update message, therefore contains all uplinks as it travels towards backup root node. The period must be carefully chosen to balance the overhead associated with tree update and the delay caused by the tree not being timely updated when nodes move [6, 18, 20].

3.5.2 Preventive Maintenance

Preventive approach is being used for tree reconstruction prior to link breakages in case the tree member wants to leave the tree or its power resource is going to deplete.

A non-leaf node wishing to move out of the multicast tree, will broadcast an alarm message with TTL value 1 to its neighbors before sending the Leave message. It then compares the distance of nodes in its LT and passes all of its routing information to a nearest node which is not a tree member. New links are attached on the tree from the upstream node and downstream nodes of the leaving node to the newly found neighbor node. The downstream node sends tree_update to the backup root node. All the future transmissions follow the path with newly discovered link. In case of leaf node or a normal network node, the node simply sends the leave message to its one hop neighbor nodes. All the neighbor nodes receiving the alarm packet from any node also remove the related entry from their LT and also from request table, if the entry with IP of leaving node exists there. In case of primary root mobility, the primary root sends the alarm message to back up root notifying it to take the control of the tree and passes its all routing information to the back up root. Upon receiving the alarm message, the back up root updates its downstream next hops to the downstream next hops of the primary root node. It also selects a new back up root for its replacement after it resumes as primary root node.

In case of the exhaustion of the battery power of a tree member node, link is repaired prior to its breakage. The battery power of the nodes in the multicast tree is examined periodically (frequency of examination is doubled in case of primary root node) and if the

power source of a node goes below a threshold value, a new link is discovered prior to its failure, and the links to this node are deleted from the multicast tree. New link is searched in the same way as in case of leaving the tree process.

The latency in finding new route in case of nodes failure is reduced by reconfiguring the routes using preventive approach before the failure of the node.

3.5.3 Tree Repair

When a link breakage is detected, the downstream node of the break (node farther away from the group leader) initiates to repair the link by broadcasting a MGREQ-J within the zone. Only a tree node with lesser hop count to the leader (that is nearer to the group leader) may respond to this MGREQ. If the node receives a reply it then grafts a new branch using GRAFT message up to the node which sent the MGRPL.

IV. PERFORMANCE COMPARISON

4.1 Simulation Testing

For the simulation of the protocol NS-2.26 simulator has been used. The nodes use the IEEE 802.11 radio and MAC model provided by the CMU extensions. The nodes are placed at uniformly random locations in a square universe. We generate 50 mobile hosts moving randomly within a flat square (1000m X 1000m) area. The model is configured with 100 pixels radio transmission power and 2 Mb/s basic data rate as a sample case. Two Ray Ground mobility model with node speed of 10m/s was used for the simulation. Each simulation was run for 900 simulated seconds. Data traffic was generated using constant bit rate (CBR) UDP traffic sources with 5, 10, 15, 20 and 25 mobile nodes acting as receivers in the multicast group. The node chooses a random destination and moves toward it with a constant speed chosen uniformly between zero and a maximum speed (10 m/s).

4.2 Performance Metrics

The metrics used for performance evaluation were:

(i) Consumption of power of the nodes in the network.

(ii) Average end-to-end delay of data packets - this includes all possible delays caused by buffering during route discovery, queuing delay at the interface, retransmission delays at the MAC, propagation and transfer times.

(iii) Packet delivery ratio — the ratio obtained by dividing the number of data packets correctly received by the destination by the number of data packets originated by the source.

PDR= Packets Received / Packets Sent

4.3 Overhead

This includes control overhead required for tree re-construction, maintenance and route search process.

Figures compare the performance of EMPIM with that of MAODV as a function of no. of receivers.Comparison of energy consumption is shown in fig. 9, end-to-end delay in fig. 10,delivery ratio in fig. 11 and overhead generated of EMPIM and MAODV protocols is shown in fig. 12.

In all respects the EMPIM outperforms MAODV due to the constrained directional forwarding in the direction of the target only instead of exploiting the broadcast in the whole network. Location information obtained through grid location service is very useful in this regard.

V. CONCLUSION

The Effective Multicast Routing Protocol for MANET with Least Control Overhead is compared with other shared tree multicast protocol i.e. MAODV. Comparison was made on various parameters like Energy Consumption, Packet Delivery Ratio, Delay, and Throughput.

EMPIM eliminates the drawbacks even of the shared tree protocols. It reduces the delay problem due to directional diffused forwarding routing and also the network partition problem when a link error occurs due to the failure of primary root. Due to the physical location of the nodes obtained through GLS the route finding process becomes faster, therefore the packets are delivered on a fast pace.

Backup root also facilitates reduction in overhead in case of EMPIM otherwise required for tree reconstruction and tree maintenance. This result in improved packet delivery ratio and energy balance compared to the conventional shared tree multicast (STM) due to preventive maintenance and also because of support from the backup root in case of primary root failure.

Scalability is achieved due to the shared tree multicast routing protocol as single tree maintenance for all group members is easier than the maintenance of number of trees in case of source based multicast routing protocol.

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