Improved Route Discovery Technique for Multicast Routing in Mobile Ad hoc Network

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Abstract— **The Mobile Ad hoc Networks (MANETs) are self-organizing networks with dynamic topology. Flooding and Expanding Ring Search are two commonly used methods to search an interested node in Mobile Ad hoc Networks. Flooding is not suitable for large networks. In this paper, to take advantage of route discovery process based on conventional expanding ring search and to reduce broadcast overheads, we propose modified route discovery process for Improved Multicast Routing Protocol (IMRP). Because of reduction in broadcast overheads, protocol saves battery resources and promises better reliability and prolonged average lifetime for the network. The paper utilizes goodput, end-to-end delay, packet delivery fraction and residual energy under different scenarios that involve different parameters each time to examine and compare the behavior of IMRP with known Multicast Ad-hoc On-demand Distance Vector (MAODV) routing protocol. Our experimental results show that IMRP gives good results compared to MAODV**.

Index Terms—**Multicast, Mobile Ad Hoc Network, Shared Tree, Routing**

I. INTRODUCTION

A Mobile Ad hoc Network (MANET) is an infrastructure-less and continuously self-configuring network of different mobile devices connected without use of any types of wires. Each mobile device/node in a MANET is free to move anywhere and in any direction independently and will therefore change its connection links to other devices/nodes very frequently. Because of this reason MANETs has become one of the most prevalent areas of research in the recent years.

The Mobile Ad-Hoc Networks (MANETs) offer a very wide range of possible applications, extending from emergency situations to military use [1]. Being totally infrastructure-less, they are easy to deploy, with low cost and preparation time. However, as a result of their own nature, the most challenging issue that they face is the routing process. Extensive work has been done on this area and a multitude of protocols have been developed to support this demanding procedure. They are mainly categorized to pro-active and re-active based on the timing they choose to create the paths to the possible destinations. The former maintain routing tables that they update periodically and because of that it generates overhead traffic to keep the routing tables up-to-date, while the latter discover the path to the destination “on-demand”. In on demand routing protocol, the network nodes need routes whenever there is a requirement or when an already established route becomes invalid. The differences in their features result to significant variations on their performances under similar conditions. By examining these variations it is concluded that the utilization of the appropriate routing protocols, basically depends on the characteristic and purpose of deployment of the particular network.

Most on demand protocols use broadcast flooding to search destination node. In broadcast flooding, the search node broadcasts its query, which is then rebroadcast by all intermediate nodes that receive the query from the source node or any other node that subsequently broadcasts the query. Broadcast flooding is guaranteed to find the shortest path to the destination when one exists, but it is highly inefficient in terms of broadcast overheads. All nodes that are connected to the sender receive, process, and broadcast the query, even if they are very far from the path from the sender to its destination node. It increases the cost to the network, such as power and bandwidth consumption. A solution of this broadcast flooding is expanding ring search (ERS) [3], [2], [4], [5]. In ERS, the search node assigns a query a time-to-live (TTL) value and broadcasts it to all of its neighbors. The TTL value defines the maximum number of links the query traverses along any path from the sender node. Each node that receives a query decrements the TTL value and rebroadcasts the query if the TTL value is greater than one. If the destination is not found, the sender node sends a new query with a larger TTL value which is increased by TTL_INCREMENT value, thus expanding the search extent[7], [8], [9] . The underlying paradigm which is known as controlled flooding-is common to many search techniques. If ERS designed properly, the expected costs of such techniques are less than the cost of full flooding [10], [11]. The advantage of expanding ring search is easy to implementation [6], but it has its own fundamental deficiency. The ERS method has the following limitations. If the destination node is far from the sender node, then the sender node has to broadcast multiple RREQ messages. Consequently, intermediate nodes have to receive and process this message repeatedly. This leads to more consumption of energy and routing overhead [10].

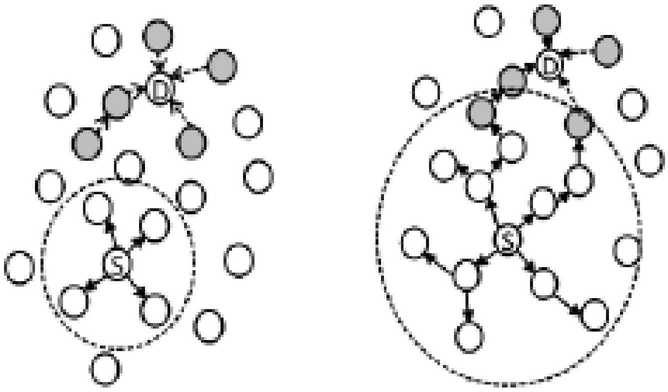

Figure 1: An example of Expanding Ring Search method

In figure 1, we consider that the node S wants to send a message to the node D. It has to find the route to D based on the Expanding Ring Search method. First of all, the node S broadcasts the query by RREQ (Route Request) message with TTL set to be N. For simplicity, we set N =1 for this example. It means, the radius of Ring Search is one-hop neighbor. Because the node D is not in the Ring Search, and there is no nodes in the ring knowing the information about D. Consequently, the route to D is not found. In the second searching, TTL is increased by 2 (K = 2 in this scenario). The node S continues broadcasting the RREQ message with radius of ring search of 2. In this case, no way to D is found. Finally, TTL is set to a "limited value". The RREQ message is broadcasted to entire network. D receives the RREQ message. Then it will reply to the node S by sending a RREP (Route REPLY) message indicating the route to D.

II. Proposed Work

The objective of this work is to find out the better route search methodology based on ERS and also to compare the performance of suggested approach with very known on demand multicast routing protocol-MAODV for different parameters. The analysis has been done through simulation using Network Simulator, NS-2.26.

Routing protocol is the main factor which affect the performance of wireless networks. And whenever node want to send the same information to multiple nodes at that moment instead of sending information to all nodes individually, multicasting is used. MAODV is one of the popular multicast routing protocol for wireless networks. MAODV provides loop freedom for all routes through the use of sequence numbers. In this paper to develop IMRP, ERS based route searching methodology which is used by MAODV is modified.

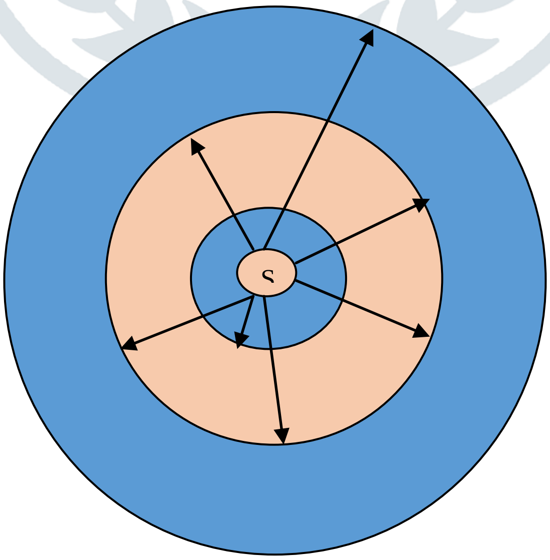

Figure 2: Expanding Ring Search method used in IMRP

As per ERS algorithm, during route discovery process, the TTL value determines the maximum number of nodes that the RREQ can go through. In IMRP, when source node wants to send information to its group members then initially it will start forwarding process with TTL=TTL_START value. Based on that source node broadcast the message. Then after source node reinitialize the RREQ with TTL value which is increased by TTL_INCREMENT value. Then after source node unicast the RREQ message based on the current TTL value. Then again TTL value is incremented by TTL_INCREMENT value. Now source node broadcast the RREQ message with updated TTL value. In this way every time ring will be generated based on TTL value. This process of increasing the TTL value and unicasting/broadcasting the RREQ message continues until the TTL_THRESHOLD value is reached. Beyond that RREQ message will be broadcasted across the entire network till it cross the RREQ_RETRIES value.

In Figure 2, When S node start its route discovery process then, it will start discovery process with unicasting the RREQ with TTL=TTL_START value to furthest node entry from its neighbor table. If destination is not found then it resend the RREQ with broadcasting with TTL=TTL_previous + TTL_INCREMENT value. And still destination is not found then repeat the process with unicasting, and then broadcasting until the TTL_THRESHOLD value is reached.

III. PERFORMANCE EVALUATION

In this section, performance of proposed IMRP is evaluated via simulation. The performance of IMRP is compared with the known multicast routing protocol MAODV.

Simulation Environment

For the simulation of the IMRP, NS-2.26 simulator has been used. Data traffic was generated using constant bit rate (CBR) UDP traffic with 10, 15, 20, 25 and 30 network size with one sender and 2 mobile nodes acting as receivers in the multicast group. All wireless mobile nodes are randomly distributed in a square of 500m x500m. The nodes use the IEEE 802.11 radio and MAC model provided by the CMU extensions. Each simulation executes for 200 seconds. The number of mobile nodes which defines the network size also is varied from 10 to 30 nodes to see the effect of the network size on the performance on the system performance.

Performance Metrics

The metrics used for performance evaluation were: (i) Residual Energy (ii) Goodput (iii) Packet delivery fraction — 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. (iv) 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.

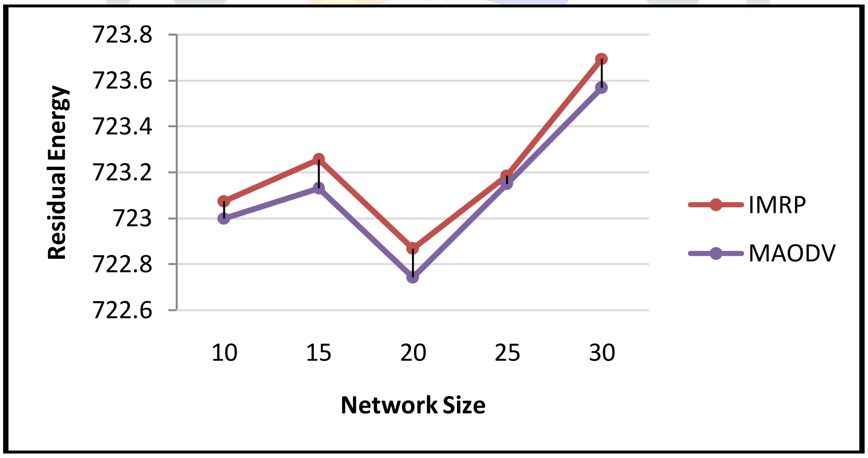

Figure 3: Residual Energy for various Network Size

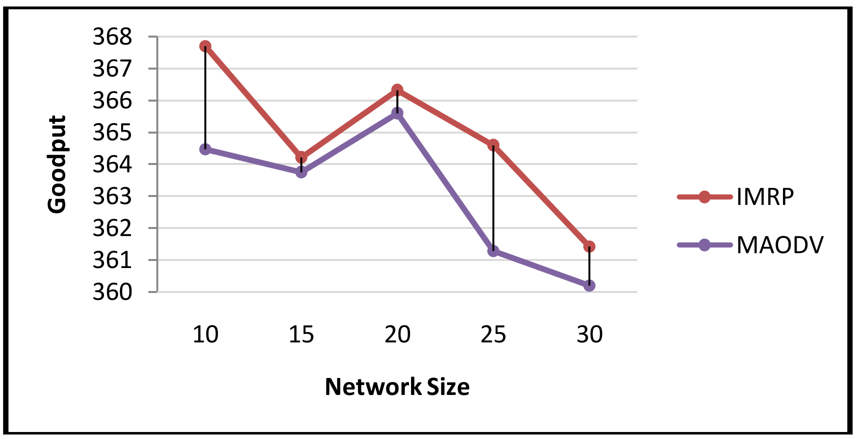

Figure 4: Goodput for various Network Size

Figures compare the performance of IMRP with that of MAODV as a function of network size. Comparison of residual energy is shown in fig. 3, goodput in fig. 4, packet delivery fraction in fig. 5 and end-to-end delay in fig. 6.

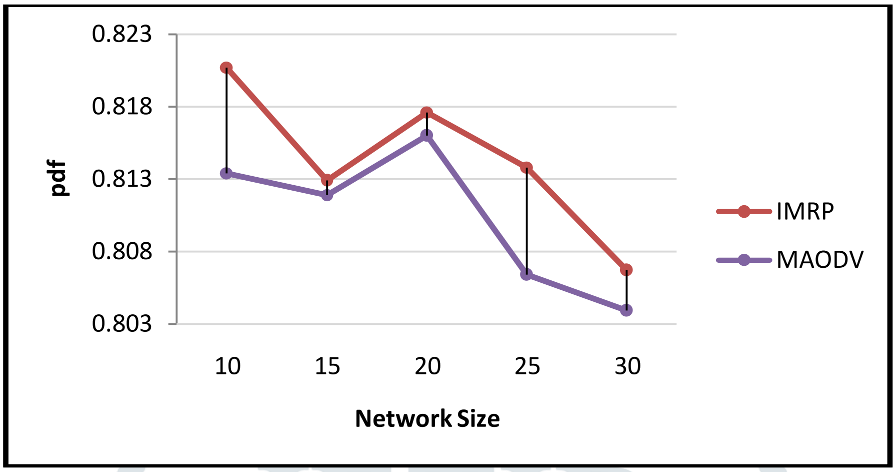

Figure 5: Packet Delivery Fraction for various Network Size

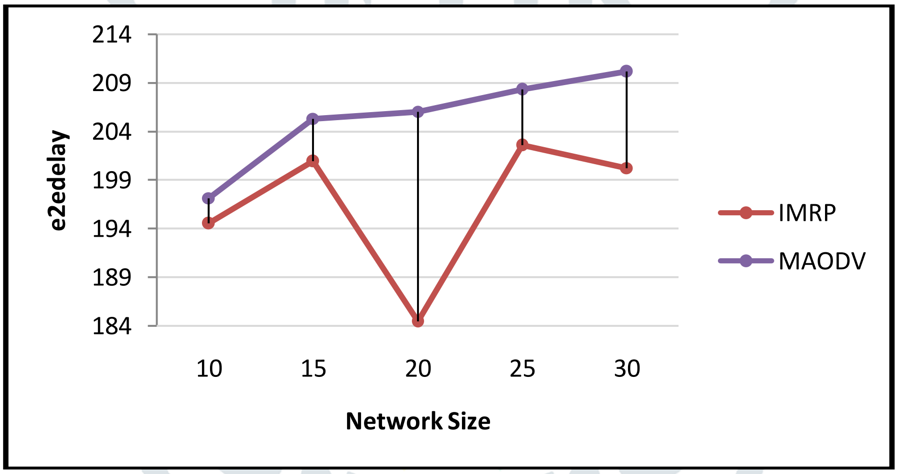

Figure 6: End To End Delay for various Network Size

IV. CONCLUSION AND FUTURE WORK

The Improved Multicast Routing Protocol is compared with other shared tree multicast routing i.e. MAODV. Comparison was made on various parameters like Residual Energy, Goodput, Packet Delivery Fraction and End-to-End Delay for varied Network Size. IMRP facilitates reduction in overhead due to modifying the packet forwarding methodology. Because of modifying the ERS algorithm in IMRP, required control packets during route discovery process can be reduced and it also affects residual energy of the network. Energy consumption of node during receiving and forwarding the packets can be reduced by using unicasting/multicasting the RREQ during route discovery process and this reduction in overhead will also reduce the mobile node resources like power and network resources like wireless link bandwidth. Effect of node speed on the performance of IMRP will be discussed in future work.

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