Efficient Multicast Routing Protocol Using Limited Flooding For Efficient Route Discovery

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Abstract— **We present an efficient route discovery mechanism to enhance the performance and multicast efficiency of On-Demand Multicast Routing Protocol (ODMRP). The framework is called limited flooding ODMRP, improves multicasting mechanism by efficiently managing flooding mechanism based on delay characteristics of the contributing nodes. Only the nodes that satisfy the delay requirements can flood the Join-Query messages is the algorithm. The Limited Flooding ODMRP algorithm compares with original ODMRP and RODMRP with respect to Average End to End Delay, Packet Overhead and Packet Delivery Ratio, Energy consumed, Number of alive nodes, Number of dead nodes. Simulation results reveal that limited flooding ODMRP performs better under various simulation scenarios as compared to original ODMRP and RODMRP.**

Index Terms— **Mobile Ad hoc networks, Routing protocol, Multicasting, ODMRP, R-ODMRP, Limited flooding ODMRP.**

I. INTRODUCTION

Mobile ad hoc networks (MANETs) have been recognized as one of the most evolving research areas among the emerging wireless technologies. MANETs are a class of wireless communication networks without a fixed infrastructure. The MANET concept has basically evolved to tackle the disaster situations like tsunami, earthquake, terrorist activities, battlefields, land- slides, etc [1]. Later, the concept has been extended to include applications such as online education, gaming, business, etc. Several applications in MANETs need group communication to manage the situations.

The MANET nodes do not provide reliable services and QoS (Quality of Service) guarantees as compared to other wireless networks such as Global System for Mobile communication (GSM) and Code Division Multiple Access (CDMA). The main sources of unreliability in MANETs are due to limited battery capacity, limited memory and processing power, varying channel conditions, less stability under unpredictable and high mobility of nodes. Routing is extremely challenging in MANETs as due to frequent change in position of nodes even the efficient nodes may become unusable or inefficient. Several routing protocols have been specifically designed for ad hoc networks and they can be mainly classified as proactive and reactive.

In the proactive routing protocols the routes are established in advance [2, 3]. This results in considerable overhead especially when the topology changes frequently. This is highly inefficient when updating routes that hardly carry any traffic. The routing table must be updated regularly. Although this kind of an approach leads to less packet transfer delay between nodes but at the same time it leads to a large control overhead especially in MANETs where nodes are changing their position constantly.

The most suitable and popular routing protocols for ad hoc networks are reactive or on demand protocols. Here, the routes between communicating nodes are established only when the need arises [4]. The control overhead is considerably reduced as the route record of all nodes need not be maintained. In a resource constrained environment this proves very beneficial. Some of the prominent reactive routing protocols are Dynamic Source Routing (DSR), Ad Hoc On Demand Distance Vector (AODV), On-demand Multicast Routing Protocol (ODMRP).

In the present system, the ODMR algorithm is responsible for finding the candidate list which is neighbor list and each of their neighbors.Candidate nodes are neighboring nodes which are invloved in routing . From each of the neighbor to the destination node the route is found out and then the route with the Lowest Time Delay is chosen as the best route. The Range ODMR algorithm also works in a similar fashion as that of ODMR but the number of candidates will be equal to the number of neighbors. The Disadvantages of the present system are :(1)The number of Routes Discovered is really very huge.(2)The End to End Delay is very high.(3)The energy consumed is very high.

II. RELATED WORK

This section provides a general overview on multicasting trends and previous frameworks introduced in research community. Several multicast routing protocols with unique features have been proposed for MANETs in the literature. We briefly point out the strategies used to establish multicast routing by analyzing these multicast mechanisms.

A Manet consists of dynamic collection of low power nodes with quickly changing multi-hop topologies that usually composed of relatively low bandwidth wireless link. These constraints make multicasting in mobile ad hoc networks challenging [5].

The general solutions to solve these problems are to avoid global flooding and advertising, construction of routes on demand and dynamically maintain memberships, etc. All protocols have their own advantages and disadvantages. One constructs multicast trees to reduce end-to-end latency while other builds mesh to ensure robustness. Some protocols create overlay networks and use unicast routing to forward to optimize either total energy consumption or system lifetime of the multicast tree.

The simulation and analysis of the performance of existing proactive and reactive multicast routing protocols over WMNs is done [6]. Three prominent multicast routing protocols are selected for performance comparison; they are On Demand Multicast Routing Protocol (ODMRP), Multicast Ad hoc On Demand Distance Vector (MAODV) Protocol and Multicast Open Shortest Path First (MOSPF). Among them, MOSPF is a proactive routing protocol while MAODV and ODMRP are reactive multicast routing protocols. The analysis and investigations are carried out on the acquired simulation results of three prominent multicast routing protocols, ODMRP, MAODV and MOSPF. Mesh based (ODMRP) shows better performance than tree based (MAODV) routing protocol.

Patch ODMRP extends the ODMRP (on-demand multicast routing protocol) [7], which is a mesh-based multicast routing protocol proposed for ad-hoc networks. In ODMRP, the nodes that are on the shortest paths between the multicast group members are selected as forwarding group (FG) nodes, and form a forwarding mesh for the multicast group. The ODMRP reconfigures the forwarding mesh periodically to adapt it to the node movements. When the number of sources in the multicast group is small, usually the forwarding mesh is formed sparsely and it can be very vulnerable to mobility.

The performance of multicast routing protocols in wireless mobile ad hoc networks is analyzed [8]. A conclusion is that, in a mobile scenario, mesh based protocols outperformed tree-based protocols. The availability of alternate routes provided robustness to mobility. AM Route performed well under no mobility, but it suffered from loops and inefficient trees even for low mobility. AMRIS was effective in a light traffic environment with no mobility, but its performance was susceptible to traffic load and mobility. CAMP showed better performance when compared to tree protocols, but with mobility, excessive control overhead caused congestion and collisions that resulted in performance degradation. ODMRP was very effective and efficient in most of our simulation scenarios.

ODMRP (on-demand multicast routing protocol) [9] is a popular multicast protocol for wireless ad hoc networks. The strengths of ODMRP are simplicity, high packet delivery ratio, and non-dependency on a specific unicast protocol -ODMRP-based wireless multicast protocol named RODMRP offers more reliable forwarding paths in face of node and network failures.

A subset of the nodes that are not on forwarding paths rebroadcast received packets to nodes in their neighborhoods to overcome perceived node failures. This rebroadcasting creates redundant forwarding paths to circumvent failed areas in the network. Each node makes this forwarding decision probabilistically. Our simulation results indicate that RODMRP improves packet delivery ratio with minimal overheads, while retaining the original strengths of ODMRP.

On demand multicast routing protocol (ODMRP) is a multicast routing protocol for mobile ad hoc networks [10]. Its efficiency, simplicity, and robustness to mobility renders it one of the most widely used MANET multicast protocols. At the heart of the ODMRP's robustness is the periodic route refreshing. ODMRP rebuilds the data forwarding "mesh" on a fixed short interval. The route refresh interval has critical impact on protocol overhead and thus efficiency. In this paper, we present an enhancement of ODMRP with refresh rate dynamically adapted to the environment. An additional enhancement is "unified" local recovery and receiver joining. On joining or upon detection of a broken route, a node performs an expanding ring search to graft to the forwarding mesh. Simulation results show that the enhanced ODMRP (E-ODMRP) reduces overhead by up to 90% yet keeping similar packet delivery ratio compared to the original ODMRP.

In mesh-based multicast ad hoc routing protocols by reducing the number of forwarding nodes we reduce the packet overhead [11]. We show that minimizing the number of forwarding nodes is equivalent to the problem of finding the minimal cost multicast tree. In addition, we demonstrate the problem to be NP-complete by a transformation to the Steiner tree problem. We propose a distributed heuristic algorithm based on the epidemic propagation of the number of forwarding nodes. Our simulation results show that the proposed heuristic, when implemented into ODMRP, is able to offer similar performance results and a lower average latency while improving the forwarding efficiency in around a 40-50% with respect to the original ODMRP.

III. PROPOSED WORK

In this section the proposed MULTICAST routing algorithm which is Limited Flooding ODMRP is discussed. The forward node which is picked will be based on the bandwidth and the queue size. The route discovery algorithm will have the lowest end to end delay and low energy consumed because the algorithm does not require any candidate lists and single path route discovery is obtained.

Implementation of proposed protocol.

Limited Flooding Based ODMRP

The limited flooding ODMRP has features which enhances its efficiency in reaching the destination with the minimum time factor : (1)The source node employs carrier sense multiple access with collision avoidance protocol (CDMA/CA) to avoid packet collision with other nodes that simultaneously occupy the wireless link resources. (2)When a node has data to send, it senses the physical medium. If the medium is idle, the packets are injected into the network; otherwise, it waits until the medium gets idle and then it counts down a certain period of time called back-off time before sending a data packet.(3) Duration of back- off time is exponentially distributed and is determined by a pseudo-random integer distributed in $[0W_{i-1}]$ range. Where W_i is the contention window of the i^{th} back off slot. (4)When the back-off time expires, the source node listens to the transmission link. If the medium is idle, it sends the packets to the neighboring nodes. (5) The nodes lie within area $2r$, where *r* is the radius of a circle centered at the source node called interference nodes. A node can successfully transmit data within the network when none of the interfering nodes concurrently transmit packet. (6)The duration of time a wireless channel is available for data transmission for an arbitrary node with number of interfering nodes is given by

$$d_{FreeChannel} = 1 - \frac{\phi 4 \pi r^2 m}{bw}$$

$Where,$

$\phi = Number\ of\ interfering nodes$

$r = radius\ of\ area\ covered by transmitting\ node$

$m = packet\ size\ of\ data\ to\ be\ send$

$bw = bandwidth between the\ nodes$

(7)The time the channel is free is given by

$$T_{servicetime} = \varsigma + \frac{m}{bw}$$

$Where,$

$\varsigma = back\ off\ delay$

$m = packet\ size$

$bw = bandwidth$

(8)The service time is given by

$$T_{servicetime} = \varsigma + \frac{m}{bw}$$

$Where,$

$\varsigma = back\ off\ delay$

$m = packet\ size$

$bw = bandwidth$

(9)The single hop delay to transmit a packet from node a to its neighboring nodes is
Given

$$d_a = \frac{k}{\mu} + \frac{\varsigma + \frac{m}{bw}}{1 - \frac{\phi 4 \pi r^2 m}{bw}}$$

$Where,$

$\phi = Number\ of\ interfering nodes$

$r = radius\ of\ area\ covered by transmitting\ node$

$m = packet\ size\ of\ data\ to\ be\ send$

$bw = bandwidth\ between the\ nodes$

$\varsigma = back\ off\ delay$

$k = Maximum\ Queue\ Size$

$\mu = packet\ exit\ rate$

Fig.1 shows the working procedure of limited flooding algorithm and the steps involved in executing protocol is (1)Source Node, Multiple Destination Nodes & Transmission Range acts like input.(2)The Source Node will first find a set of neighbor nodes.(3)If the neighbor nodes have one of the destination node then stop the process.(4)find the delay based on bandwidth and queue size (5) compute the new queue size (6) pick the neighbor node which has low queue size time is chosen as forward node.(7)The process is repeated until destination is reached.

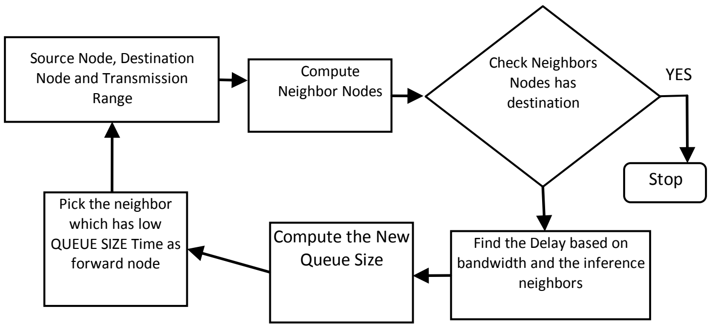

Fig.1: The limited flooding ODMRP.

IV. PERFORMANCE EVALUATION

In this section we compare the performance of proposed method and the original ODMRP and RODMRP under various simulation scenarios.

Simulation Setup

The simulation environment used is based on MATLAB. The simulated environment consists of nodes being deployed in an area of 100m x 100 m area. A single source and multiple destinations need to be chosen. The transmission range, Energy required for generation as well as transmission is chosen. The attenuation factor is selected from the range 0.1 to 1.

Effect of End to End Delay

End to End Delay is the time taken for the RREQ to go from the source node to destination node and then send back the RRPLY from destination node to source node.

$$EE_{delay} = t_{stop} - t_{start}$$

Where

t_{stop} = The time when RREP ...

t_{start} = The time when RREQ ...

Fig.2 shows the end to end delay of nodes per rounds. Limited Flooding ODMRP uses lower end to end delay when compared to the original ODMRP and RODMRP.

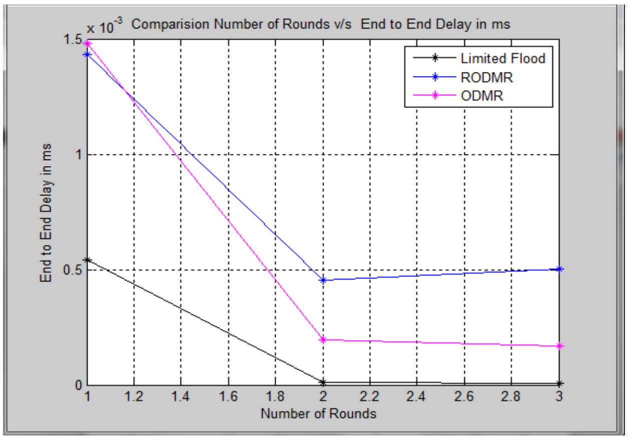

Fig.2: End to End delay v/s Number of rounds

Effect of Number of Hops

The Number of intermediate links from the source node to destination node is called Number of Hops.Fig.3 shows the hop count per rounds in routing process. The limited flooding ODMRP uses less hop count when compared to ODMRP and RODMRP. Thus we infer that intermediate links involved in limited flooding ODMRP are less increasing efficiency.

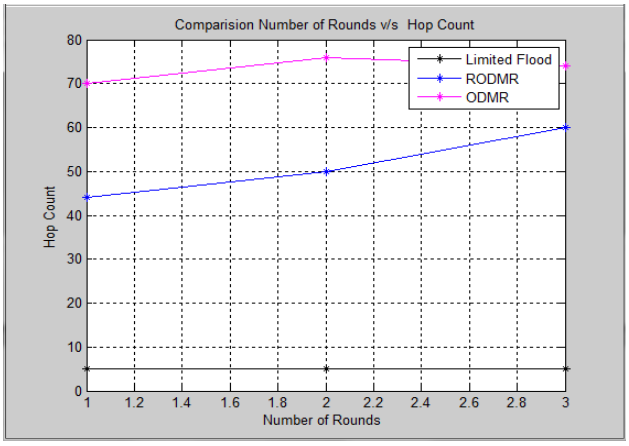

Fig.3: Hop count v/s Number of rounds

Effect of Energy Consumption

The energy wasted for delivering the packets from the source node to destination node. The total energy consumption is given as follows

$$TE = \sum_{i=1}^{l} E_i$$

Where

l = number of links

E_i = Energy consumed by the i^{th} link

The energy consumed by the i^{th} link given by

$$E_c = 2E_{tx} + E_{amp} d^{\gamma}$$

E_{tx} = energy required for data transmission

E_{amp} = energy required for data generat...

d = distance between two intermediate node

γ = environment factor

$0.1 \leq \gamma \leq 1$

The Standard environment factor

Fig.4 shows energy consumed per rounds. The limited flooding ODMRP uses less energy consumption when compared to ODMRP and RODMRP. Since limited flooding uses less energy it leads to performance increase.

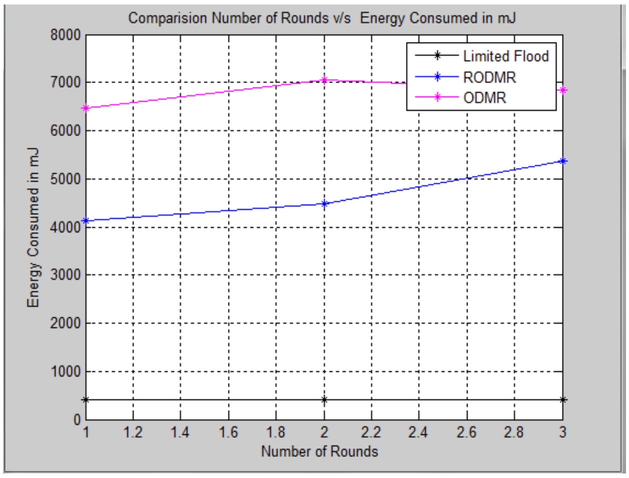

Fig.4 Energy consumed v/s number of rounds.

Effect of Number of Alive Nodes

The count of number of nodes which has the battery power greater than equal to B/4 where B is the initial Battery Power

Fig.5 shows the number of alive nodes involved per rounds. In the limited flooding protocol there are maximum alive nodes, whereas RODMRP has more alive nodes when compared to ODMRP. Thus it proves that battery power is not consumed much in limited flooding and is consumed to maximum in ODMRP which degrades the efficiency of protocol.

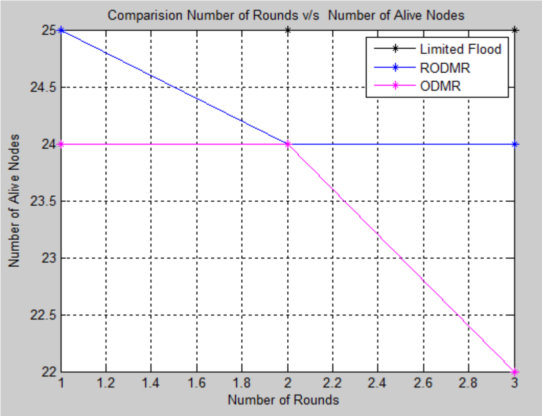

Fig.5: Number of alive nodes v/s number of rounds.

Effect of Number of Dead Nodes

The count of number of nodes which has the battery power less than B/4 where B is the initial Battery Power. Fig.6 shows the number of dead nodes present per round in routing process. ODMRP has maximum dead nodes when compared to RODMRP. In limited flooding ODMRP there are no dead nodes present.

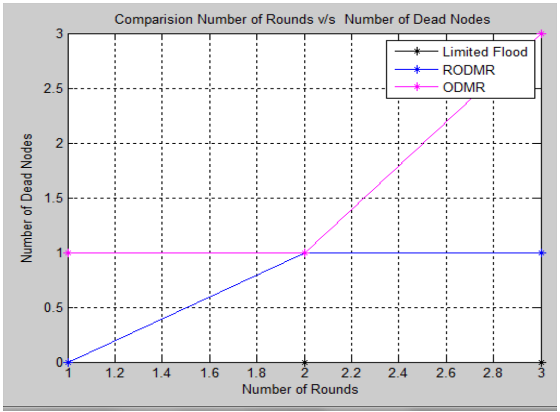

Fig.6: Number of dead nodes v/s number of rounds.

Effect of Routing Overhead

The routing overhead is defined as the ratio of the number of control packets to the number of data packets. Fig.7 shows the comparison of three protocols w.r.t packet overhead ratio parameter per round. The packet overhead is less in case of limited flooding protocol when compared to ODMRP and RODMRP. Thus lesser the overhead lesser will be the multicast traffic involved which enhances the performances.

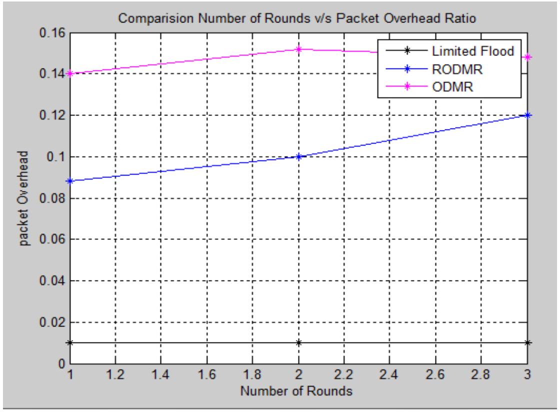

Fig.7: Packet overhead v/s number of rounds.

Effect of Packet Delivery ratio

Fig.8 shows the comparison of three protocols w.r.t packet delivery ratio parameter versus number of rounds executed. The limited flooding provides highest packet delivery ratio when compared to original ODMRP and RODMRP. Having the higher packet delivery ratio it increases the performance of protocol.

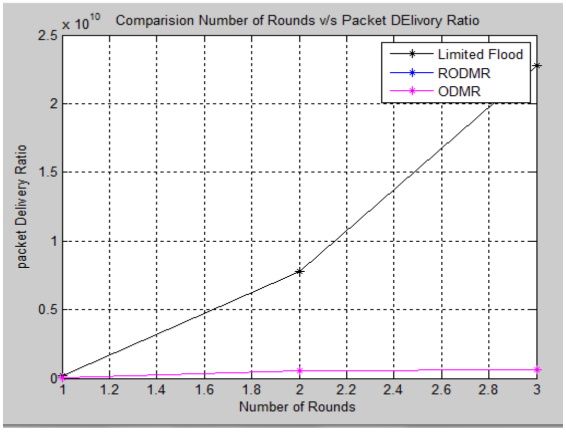

Fig.8: Packet delivery ratio v/s number of rounds.

V. CONCLUSION AND FUTURE WORK

In this project an overview of ODMR, Range ODMR and Limited Flooding routing concepts are presented, a new localized Limited Flooding routing algorithm was proposed. The performance of the proposed algorithms are compared against other existing algorithms namely ODMR and Range ODMR w.r.t parameters end to end delay, number of hops, energy consumption, number of alive nodes, number of dead nodes, routing overhead, packet delivery ratio.

Simulation experiments reveal that our methodology results in some improvement in packet overhead in highly congested scenarios. The simulation reveals that the Limited flooding ODMRP performs better in terms of packet overhead, especially under intense traffic load and the higher performance results in terms of delivery, overhead, and end-to-end delay than ODMRP and RODMRP for most scenarios.

In future work, we can improve The Limited Flooding Algorithm by taking into consideration the residual energy of nodes there by increasing the lifetime and A recovery mechanism can be used in order to recover if any dead nodes occurred in the network.

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