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# Group Co-operative Schemes for Optimal Multicast Capacity-Delay Scaling in MANET

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**Abstract:** ***Mobile ad hoc networks (MANET) is a complex distributed systems that comprise wireless mobile nodes which, dynamically self organize into arbitrary Adhoc network topologies, allowing devices to seamlessly networked in areas with no preexisting communication infrastructure. The recent interest in the research community is to understand the capacity changes under delay constraints in mobile ad hoc networks. In this project, we are concentrating on capacity-delay scaling optimality for multicast traffic pattern for an i.i.d. mobility model in mobile ad hoc networks. With the assumption that n nodes move in a unit square, with each serving as a source that sends identical packets to k destinations, we propose four group schemes of which the achievable capacity and delay are analyzed:***

***(1) Non-cooperative non-redundancy scheme,***
***(2) Non-cooperative redundancy scheme,***
***(3) Cooperative non-redundancy scheme,***
***(4) Cooperative redundancy scheme.***

***With intelligent cooperation scheme, each destination acts equivalently as relay and helps other destinations get more opportunities of receiving packets with capacity sacrificed. The project work is design and implement the following group schemes and to simulate using NS2. The results are will be compared with using algorithms and without using algorithms to show the increase in the performance of the proposed algorithm.***

**Keywords:** MANET, capacity,delay,cooperation, redundancy.

## 1. Introduction

With the rapid development of communication technologies, wireless networks nowadays are increasingly becoming irreplaceable communication techniques for people's daily life.Lots of research efforts have been dedicated motivated by their promising applications towards the designing and building of wireless networks, such as mobile ad hoc network, satellite network, cellular network, Wi-Fi (or hotspot) network, wireless sensor network, etc.The mobile ad hoc network is of special interests to researchers among these wireless networks from both academia and industry due to its distinctive features.

Routing in mobile ad hoc networks and some fixed wireless networks use multiple-hop routing. Routing protocols for wireless network should be able to maintain paths to other nodes and must handle changes in paths due to mobility. However, most of the existing adhoc routing protocols do not consider the QoS problem. Although there are several existing surveys on multicast routing protocols over MANETs, they are either not up-to-date or mostly focus on the same technical trend, such as tree, mesh and hybrid-based multicast routing protocols. Compared to other survey work in the area, this paper provides a state-of-the-art technique for typical multicast routing protocols with popular adaptive methods for MANETs.

Routes in ad hoc networks are multihop because of the limited propagation range (250 meters in an open field) of wireless radios.Routes often get disconnected,since nodes in the network move freely and randomly . Routing protocols are thus responsible for maintaining and reconstructing the routes in a timely manner as well as establishing the durable routes. In addition, routing protocols are required to perform all the above tasks without generating excessive control message overhead.To deliver data packets,Control packets must be utilized efficiently and be generated only when necessary. Reducing the control overhead can make the routing protocol efficient in bandwidth and energy consumption.one of the most researched areas in the field of networking is Multipoint communications.Video conferencing applications, which requires multicast support are becoming more widespread as the technology and popularity of Internet grows.Network hosts work in groups to carry out a given task in a typical ad hoc environment. Therefore, multicast plays an important role in MANETs.

Multicast protocols used in static networks (e.g., Distance Vector Multicast Routing Protocol (DVMRP), Multicast Open Shortest Path First (MOSPF), Core Based Trees (CBT), and

Protocol Independent Multicast (PIM)) do not perform well in wireless ad hoc networks because multicast tree structures must be readjusted as connectivity changes since they are fragile also. Furthermore, A global routing substructure required by multicast trees such as distance vector or link state. The frequent exchange of routing vectors or link state tables, triggered by continuous topology changes.This yields excessive channel and processing overhead. Hence, the tree structures used in static networks must be modified, or a different topology between group members (i.e., mesh) need to be deployed for efficient multicasting in wireless mobile ad hoc networks.The typical points considered in multicast routing optimization are summarized as follows:

- Non-cooperative non-redundancy scheme, the multicast capacity can achieve $O(1/k)$ with expected delay $\Theta(n \log k)$.
- Non-cooperative redundancy scheme with $m$ relays, the multicast capacity can achieve $O(1/(km))$ with expected delay $\Theta((n \log k)/m)$. It guarantees a minimal expected delay of $\Theta(\log n)$ and previous works [3], [5] must tolerate a minimal delay of $\Theta(\sqrt{n})$.
- Cooperative non-redundancy scheme, the multicast capacity achieves $O(1/k)$ with delay $\Theta(\frac{n \log k}{k})$.
- The delay is much smaller than that of non-cooperative case and it gets smaller when there are more destinations in a multicast session, which counters our intuition. Optimal multicast capacity-delay tradeoff can be achieved in this scheme.

Cooperative redundancy scheme with $m$ relays, the achievable capacity is $O(1/km)$ with expected delay $\Theta(n \log k/(k + m))$.

An open question that still remains is: what is the optimal capacity-delay tradeoff in mobile ad hoc networks? Inequality (1) is clearly not optimal. The methodology of [4] is constructive in nature. Hence, inequality (2) is only a lower bound. The optimal capacity-delay tradeoff searching is important for two reasons. First, it will allow us to know where the fundamental limits (i.e., upper bounds) are, and how far existing schemes could possibly be improved. Secondly, as has happened in previous works [1, 3], a careful study of the upper bound is usually able to reveal the delicate tradeoffs which is inherent to the problem. A thorough and complete understanding of these tradeoffs will help us identify the possible points of inefficiency in existing schemes and provide directions for further improvement.

There have been several recent studies that attempt to address the relationship between the achievable capacity and the packet delay in mobile ad hoc networks. In the work by Neely and Modiano [3], it was shown that the maximum achievable per-node capacity of a mobile ad hoc network is bounded by O(1). The authors of [3] present a scheme that can achieve Θ (1) per-node capacity and incur Θ (n) delay, provided that the load is strictly less than the capacity in an i.i.d. mobility model. In [3], the authors formulate and prove a fundamental tradeoff between the capacity and delay.

## 2. Literature survey

A mobile ad hoc network (MANET) is a peer-to-peer network with fully self-organized mobile nodes.Mobile users randomly move around in such an autonomous network system and freely communicate to each other via wireless links without the aid of any pre-existing infrastructure or centralized administration. Therefore, any mobile objects including the vehicles,animals,and human beings could easily form a MANET as long as each object carries a wireless communication device.

Compared with the available wireless network architectures, including the satellite network, cellular network and Wi-Fi network, the mobile ad hoc network has lots of attractive advantages.First advantage is it incurs much lower establishment expenditure and maintenance cost than other wireless networks, as their is no infrastructure support or base station is required for the building of a MANET. Second advantage is is robust against the single point of failure, i.e., the death or diminishing of any particular network node will never affect the whole network performance. Finally,MANET can be rapidly deployed and flexibly reconfigured even in those geographically tough areas. Due to these specific features, the mobile ad hoc networks holds greater promise for a lot of future applications, such as the disaster relief, emergency response, daily information exchange,military troop communication,vehicular ad hoc network and pedestrian network etc. It is believed that the mobile ad hoc networks will become one of the most important and indispensable component among the next generation networks.

Perkins, D. D. and H. D. Hughes in their paper [7] “A Survey on QOS Support for MANETs”,highlights that the MANETs possess various unique properties which make them very different from traditional wired and even wireless systems. It is a significant technical challenge to provide reliable high-speed end-to-end communications in mobile ad hoc networks, due to their dynamic topology, distributed management and multihop connections. In addition, the actual throughput of wireless communications is often much less than the maximum radio transmission rate, due to the effects of multiple access,noise and interference conditions. Furthermore, these effects result in time-varying channel capacity, making it difficult to determine the aggregate bandwidth between two endpoints. Finally, resources such as energy, bandwidth, processing power and memory, which are relatively abundant in wired environments, are strictly limited and have to be preserved in mobile ad hoc networks. It is not an easy task to incorporate QoS to ad hoc multicast routing. Wireline QoS algorithms rely on the availability of precise state information, whereas in an ad hoc network this information is inherently imprecise. Nodes join, leave and rejoin the network at any place. Links appear or disappear at any time. Thus, protocols designed for wired networks are not appropriate for ad hoc networks due to their lack of adaptation to the unpredictable network topology and excessive overhead.

B. Quinn, K. Almeroth, mentioned in the RFC 3170 [8] describes the challenges involved with designing and implementing multicast applications. The document lists many multicast applications and derives unique multicast service requirements for various groups of applications. While many applications, such as audio/video distribution, can tolerate loss of data, many other applications cannot. In addition, even the loss-tolerant applications will suffer a performance penalty: an audio stream may experience a short gap or lower fidelity in the presence of loss. Among the loss-intolerant application categories are file distribution and caching, monitoring applications (stock prices, sensor readings, etc.), synchronized resources (directories, distributed databases, etc.), concurrent processing, collaboration/shared document editing, and online auctions.

Some of the loss-intolerant applications discussed in these documents are relevant in a MANET environment as well (such as the collaboration, caching, or monitoring applications). In addition, MANET-specific applications such as military command-and-control applications also require a high degree of reliability.

Many different protocols for multicasting have been proposed in recent years. Acharya and Badrinath [9] were among the first to address the issue of multicast communications in wireless networks. Subsequently many multicast protocols have been proposed and evaluated [10], [11], [12], [13].

M. Gerla and S. Lee explained that the On-Demand Multicast Routing Protocol (ODMRP) [10] falls into the category of on-demand protocols since group membership and multicast routes are established and updated by the source whenever it has data to send. Unlike the conventional multicast protocols which build a multicast tree (either source-specific or shared by the group), ODMRP is meshbased. It uses a subset of nodes, or *FG*, to forward packets via scoped flooding. ODMRP borrows the notion of the forwarding group from FGMP.

Similar to other reactive protocols, ODMRP consists of a request and a reply phase. When a multicast source has data to send but no route or group membership information is known, it piggybacks the data in a Join-Query packet.When neighbor node receives a unique Join-Query, it will records the upstream node ID in *message cache*, which can be used as the node's routing table, and re-broadcasts the packets.The side effect of this process is to build the reverse path to the source. When a Join-Query packet reaches the receiver, then it generates a Join-Table packet that is broadcast to its neighbors. This Join-Table packet contains the multicast group address,the sequence of source address, next hop address pairs, and also a count of the number of pairs. Whenever a node receives a Join-Table, it checks if the next node address of one of the entries matches its own address. If it matches, the node realizes that it is on the path to the source and thus becomes a part of the forwarding group for that source by setting its *FG flag*.Then it broadcasts its own Join-Table, which contains the matched entries.Next hop IP address can be obtained from the message cache. This process constructs (or updates) the routes from sources to receivers and builds the forwarding group.

Membership and route information is updated by periodically (every Join-Query-Refresh interval) sending Join-Query packets. Nodes only forward (non-duplicate) data packet if they belong to the forwarding group or if they are multicast group members. By having FG nodes flood data packets, ODMRP is more immune to link/node failures (e.g., due to node mobility).

E. Royer and C. Perkins in their paper [11] explains the MAODV as, MAODV is an example of a tree-based multicast routing protocol (Fig2 illustrates MAODV tree formation). Similar to the ODMRP,MAODV also creates routes on-demand. Route discovery is based on a route request Rreq and route reply Rrep cycle.Suppose when a multicast source requires a route to a multicast group, it broadcasts a Rreq packet with join flag set and the destination address set to the multicast group address.

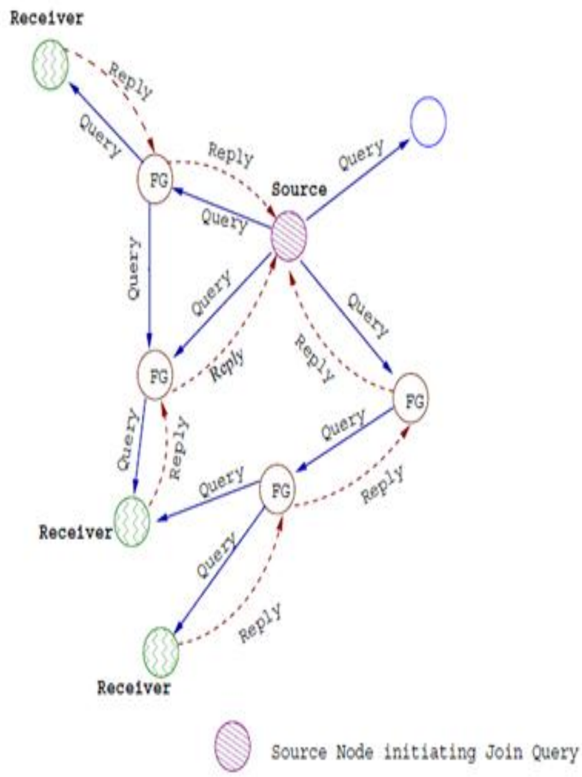


**Fig1:** Mesh Formation in ODMRP.

Member of the multicast tree with a current route to the destination responds to the request with a Rrep packet and non members rebroadcast the Rreq packet. Each node on receiving the Rreq packets,updates its route table and records the sequence number and next hop information for the source node. This information is used to unicast the Rrep back to the source.When the source node receives multiple replies for its route request it chooses the route having the freshest sequence number or the least hop count. It then sends a (Mact)multicast activation message which is used to activate the path from the source to the node sending the reply.

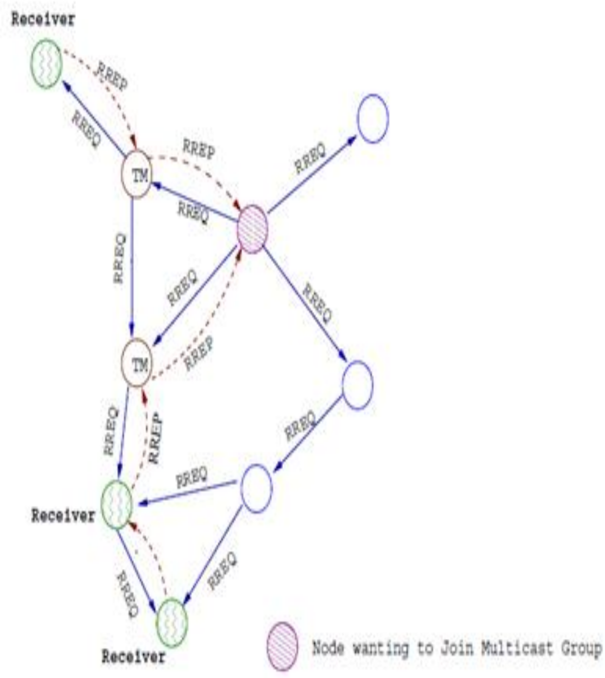


**Fig2:** Tree Creation in MAODV.

If a source node does not receive a Mact message within a certain period, it broadcasts another Rreq . After a certain number of retries (Rreq-Retries ), the source assumes that there are no other members of the tree that can be reached and declares itself the *Group Leader*.It is the responsibility of group leader for periodically broadcasting group hello (Grp-Hello ) messages to maintain group connectivity. Nodes also periodically broadcast Hello messages with *time-to-live = 1* to maintain local connectivity.

## 3. Proposed system

The key motivation behind the design of Multicast Routing Protocol (MRP) is the reduction of the routing load. High routing load usually has a significant performance impact in low bandwidth wireless links. Hence this routing protocol is a highly desirable feature of any routing protocol for ad hoc networks. In mobile scenario, mesh-based protocols have been claimed to outperform tree based protocols. The MRP creates a mesh of nodes which forward multicast packets via flooding, thus providing path redundancy. This doesn't maintain route information permanently. It uses a soft sate approach in group maintenance. Member nodes are refreshed as needed and do not sent explicit leave messages.

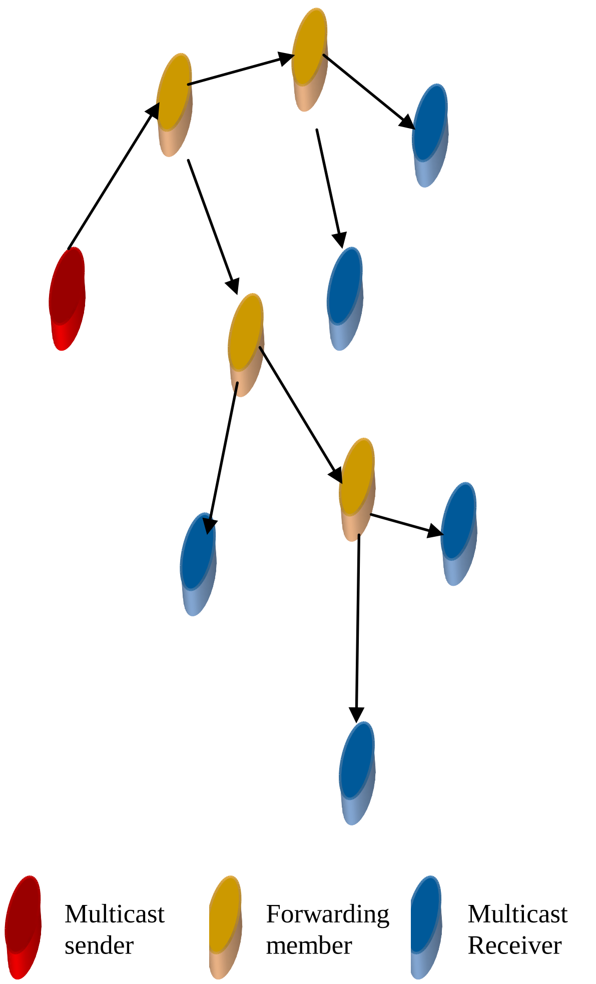


**Fig. 3.1:** Path selection for the finding the route to destination.

In this architecture, group membership and multicast routes are established and updated by the source demand. This is shown in the figure 3.1, it uses request phase and a reply phase for establishing the route for the destination. When the multicast sources have data to send, but do not have the routing or membership information, they flood a JOIN QUERY packet. When a node receives a non-duplicate JOIN QUERY it stores the upstream node ID and rebroadcasts the packet.The receiver creates a JOIN REPLY and broadcasts to the neighbors, when the JOIN QUERY packet reaches a multicast receiver. When a node receives JOIN REPLY it checks if the next node ID of one of the entries matches its own ID. If it matches, the node realizes that it is on the path to the source and thus is part of the forwarding group. It then broadcasts its own JOIN REPLY built upon the matched entries.Forwarding group propagates The JOIN REPLY to member until it reaches the receivers and builds a mesh of nodes called forwarding group.Multicast senders will refresh the membership information and update the routes by sending JOIN QUERY periodically.

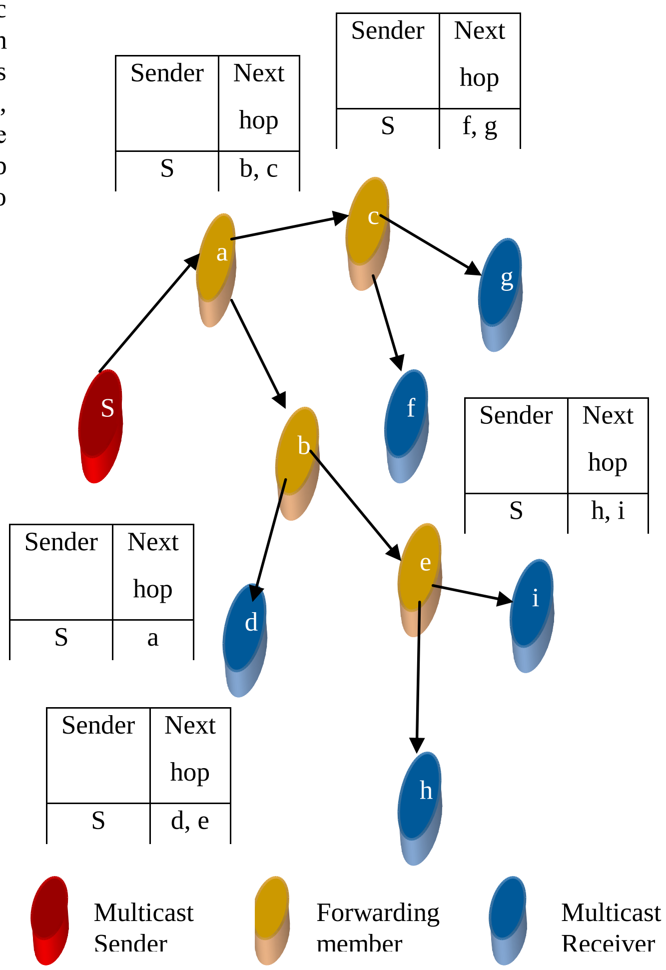


**Fig. 3.2:** Multicast tables maintained in each node of MRP.

MRP protocol can make use of unicast technique to send multicast data packet form the sender nodes toward the receivers in the multicasting group. To carry multicast data via scoped flooding it uses forwarding group concept. The source, in MRP, establishes and maintains group membership. If source wishes to send the packets to a multicast group but has no route to that group, it simply broadcasts JOIN_DATA control packet to the entire network. When an intermediate node receives the JOIN_DATA packet it stores source address and sequence number in its cache to detect duplicate. It performs necessary routing table updates for reverse path back to the source.

A multicast receiver constructs a JOIN_TABLE upon getting JOIN_DATA packet and broadcasts it to its neighbors.The node resolves whether it is on the way to the source,when it receives JOIN_TABLE by consulting the earlier cached data. Considering matched entry this node builds new join table and broadcasts it. In this way JOIN_TABLE is propagated with the help of forwarding group members and ultimately it reaches to the multicast source.To carry multicast data,a multicast table is built on each node .

# 4. Conclusion

This paper, try to provide the optimal capacity delay tradeoff, which is much better than [5] in cell partitioned network, which guarantees a distributed scheme. Specifically, considering a MANET composed of *n* nodes and each initiates a multicast session along with the source sending identical messages to its *k* destinations. Note that each node acts as source in one session and destinations in other sessions. First assumption is that all nodes will move according to a two dimensional *i.i.d.* mobility model in the MANET. The second assumption is regarding the Cell partitioned approach to build the network. In addition, the introduction and development of the new concept of cooperation schemes of the grouped destination to improve the performance of multicast network. Cooperation means destinations of the same multicast session can relay packets for each other. Previous works [5], [7] do not consider such mechanism and will illustrate that it helps to achieve the optimal multicast capacity delay tradeoffs in MANET.

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