A Comparative and Performance Study of On Demand Multicast Routing Protocols for Ad Hoc Networks

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ABSTRACT

The advent of universal computing and proliferation of portable computing devices have raised the importance of mobile and wireless networking. In wireless and mobile networking Multicast has great impact since it has overcomes the overheads of the unicast routing. Multicast can efficiently supports applications of different varieties that are characterized by a close degree of collaboration typical for many ad hoc applications. This article investigates the two prominent MANET multicasts routing for ad hoc network protocols On Demand Multicast Routing Protocol (ODMRP) and Multicast Operation Of Ad Hoc on Demand Distance Vector (MAODV) Protocol. MAODV fabricate and maintains a multicast tree based on the hard state, whereas ODMRP does the multicast operation based on the soft state by constructing the forwarding group. Our analysis shows that ODMRP is better than MAODV in packet delivery ratio but it has higher overheads.

Keywords*: routing protocol, wireless networks, ad hoc network, MAODV, ODMRP*

1. Introduction

The use of multicasting with the network has many benefits. Multicasting reduces the communication cost for applications that sending the same data to many recipients Instead of sending via multiple unicast, multicast reduces the channel bandwidth, sender and router processing and delivery delay. In addition multicast gives robust communication whereby the receiver address is unknown or modifiable without the knowledge of the source within the wireless environment. It is very difficult to reduce the transmission overhead and power consumption [6]. But to an extent multicast can utilize the wireless link efficiently by exploiting the inherent nature of the broadcast property. However, besides the issues for any ad-hoc routing protocol listed in MANET group, wireless mobile multicasting faces several key challenges, such as multicast group members move, thus precluding the use of a fixed multicast topology. Transient loops may form during tree reconfiguration. As well, tree reconfiguration schemes should be simple to keep channel overhead low. Most of the existing multicast routing protocols, such as DVMRP (Distance- Vector Multicast Routing protocol)[3] and FGMP (Forwarding Group Multicast Protocol)[4] require periodical transmission of control packets in order to maintain multicast group membership and multicast routes, thereby wasting a lot of bandwidth. But MAODV and ODMRP try to minimize the communicating overhead by invoking the route discovery process on-demand.

The rest of the paper is organized as follows. Section 2 presents an overview of the multicast protocols we simulate. Section 3 presents the qualitative comparison of both

MAODV and ODMRP. The Simulation environment and performance analysis is described in section 4. Finally concluding remarks are made in section 5.

2. Multicast Protocols for Mobile Ad Hoc Networks

There are many multicast routing protocols for wireless Ad hoc networks. In this paper, we focus our attention and discussion on MAODV [1] and ODMRP [2].

2.1 Multicast Operation of Ad Hoc On-Demand Distance Vector Routing Protocol (MAODV)

MAODV is an extension of AODV (Ad-hoc On-Demand Distance Vector) to support multicasting and it builds multicast trees on demand to connect group members. Route discovery in MAODV follows a route request/route reply discovery cycle. As nodes join the group, a multicast tree composed of group members is created. Multicast group membership is dynamic and group members are routers in the multicast tree. Link breakage is repaired by downstream node broadcasting a route request message. The control of a multicast tree is distributed so there is no single point of failure. One big advantage claimed is that since AODV offers both unicast and multicast communication, route information when searching for a multicast route can also increase unicast routing knowledge and vice-versa.

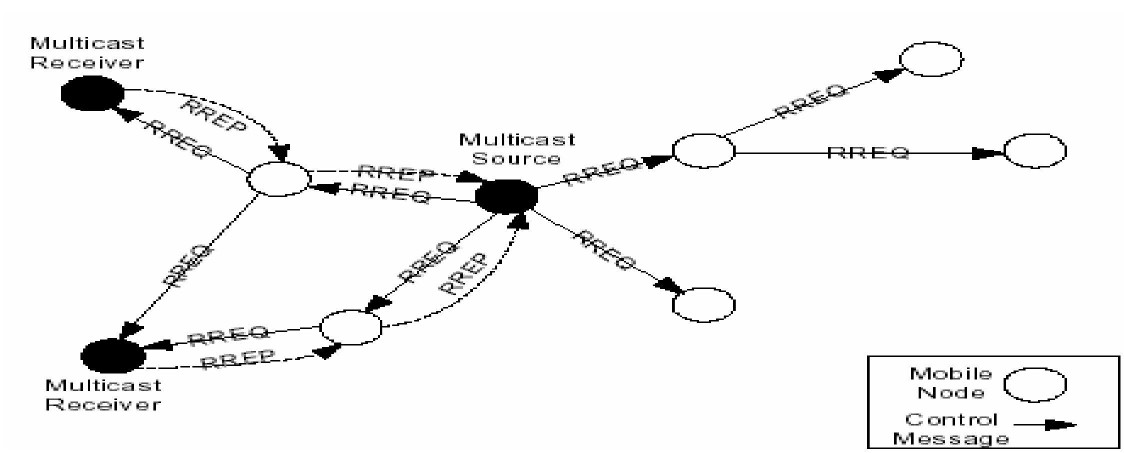


Fig 1 MAODV Path Discovery

2.2 On Demand Multicast Routing Protocol (ODMRP)

ODMRP [2] is a mesh based rather than a conventional tree based scheme and uses a forwarding group concept (only a subset of nodes forwards the multicast packets via scoped flooding). By maintaining a mesh instead of a tree, the drawbacks of multicast trees in ad hoc networks like frequent tree reconfiguration and non-shortest path in a shared tree are avoided. In ODMRP, group membership and multicast routes are established by the source on demand when a multicast source has packets to send, but no route to the multicast group, it broadcasts a Join-Query control packets to the entire network. This control packet is periodically broadcast to refresh the membership information and updates routes as shown in the fig 2.When the Join-Query packet reaches a multicast receiver, it creates and broadcasts Join-Reply to its neighbours.when it has been received by the node, it checks if the next hop node id of one of the entries in Join_Reply table matches its own id. If it is does, the node realizes that it is on the path to the source and becomes the part of the forwarding group by setting the FG_FLAG (Forwarding Group flag). When receiving a multicast data packet, a node forwards it only when it is not a duplicate, hence minimizing traffic overhead. Because the nodes maintain soft state, finding the optimal flooding interval is critical to ODMRP performance. ODMRP uses location and movement information to predict the duration of time that routes will remain valid. With the predicted time of route disconnection, a "join data" packet is flooded when route breaks of ongoing data sessions are imminent. It reveals that ODMRP is better suited for ad hoc networks in terms of bandwidth utilization.

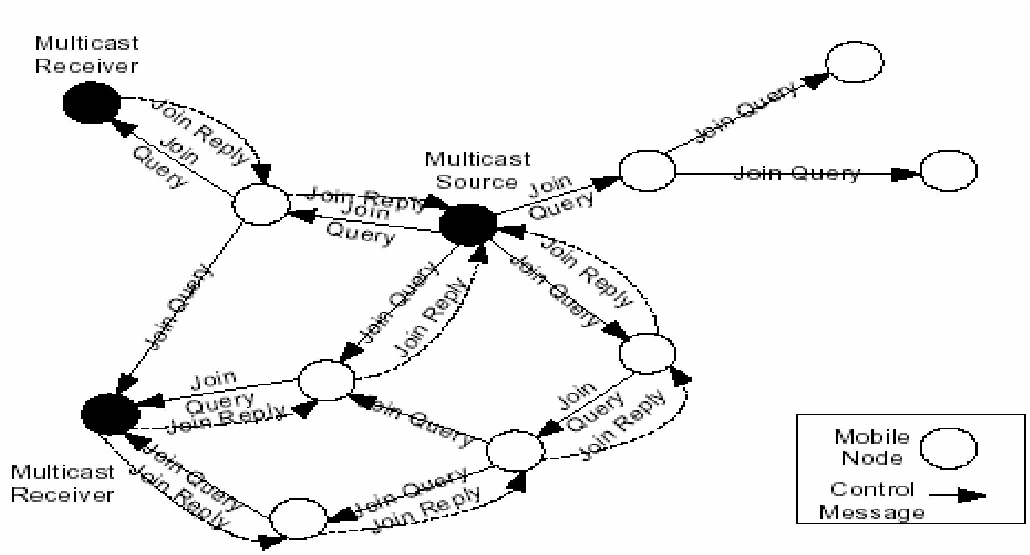


Fig 2 ODMRP Mesh Creation

3. Qualitative comparative study of MAODV and ODMRP

The table depicted below has given the side by side comparison of the two protocols [7].

Characteristics	**MAODV**	**ODMRP**
Unicast supportability	Yes. Uses AODV unicast table	No
Multicast support required on each node	Yes all nodes need to participate	Yes all nodes needs to participate
Distributed operations	Yes	yes
Proactive operations	No	no
Loop free	Yes	Yes
Periodic messaging	Yes. Group leader sends periodic hello Message	Yes. Source node sends periodic group join query message
Routing mechanisms	Tree based routing	Mesh based routing

Table-1 Qualitative features of MAODV and ODMRP

4. SIMULATION ENVIRONMENT

The simulation environment used is based on GLOMOSIM, a network simulator that provides support for simulating multi-hop wireless networks complete with physical and IEEE 802.11 MAC layer models

4.1 Experimental Setup

Parameter	**Value**	**Description**
Number-of-nodes	50	Network nodes
Terrain range	(1000, 1000)	(x,y) dimension of motion in m.
Power-range	225 m	Node's power range
Bandwidth	2 Mbps	Node's bandwidth
Simulation time	500S	Simulation duration
Node-placement	Random	node placement policy
Mobility	Random waypoint model	Changes direction randomly
Mobility	0-20m/s	Mobility of the nodes
Traffic type	CBR	Constant bit rate protocol
Pause time	0	Non-mobility time at the terrain boundary

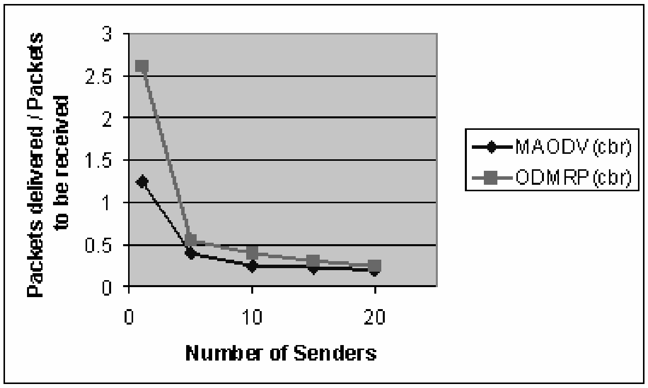
Table -2 General experimental setup parameters

4.2 PROTOCOL PERFORMANCE METRICS:

The following metrics were given by the IETF MANET working group for routing/multicast protocol evaluation [5]:

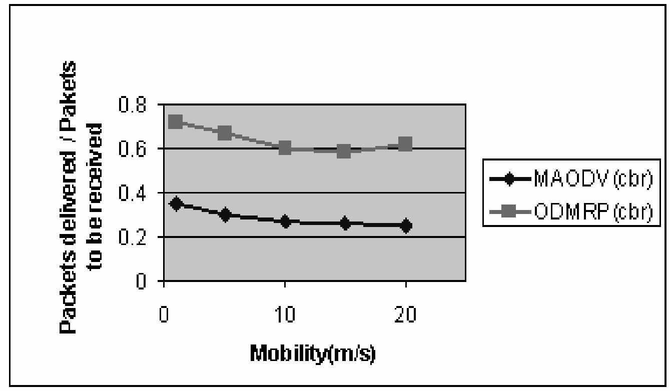
(a). Packet Delivery Ratio.
(b). Number of data packets transmitted per data packet delivered.
(c). Number of control packets transmitted per data packet delivered.
(d). Number of control packets and data packets transmitted per data packet delivered.

We have performed a number of experiments to explore the performance nature of MAODV and ODMRP with respect to a number of parameters such as number of senders, node mobility, and multicast group size.



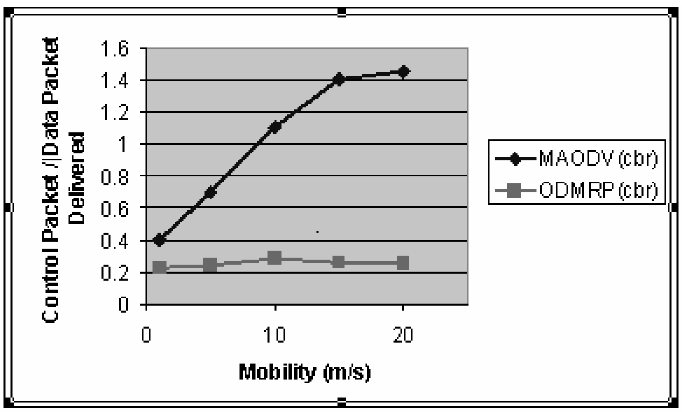
Data delivery ratio as a function of number of senders

FIG-3



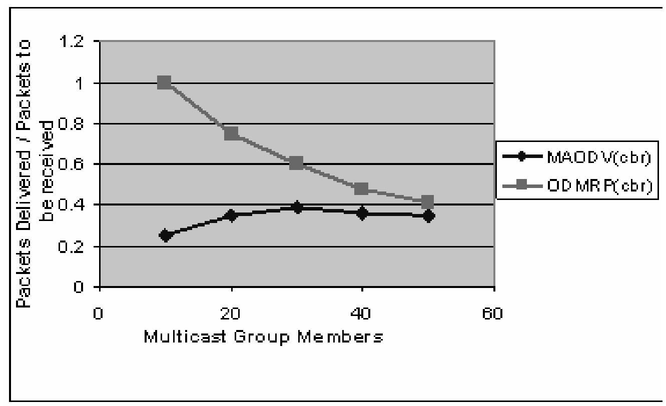
Data delivery ratio as a function of mobility

FIG-4



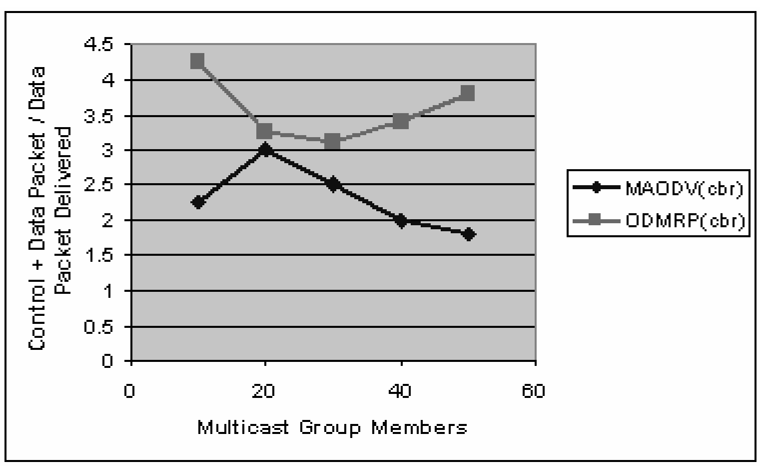
Control overhead as a function of mobility

FIG-5



Data delivery ratio as a function of group size

FIG-6



Control and data packets as a function of group size

FIG-7

4.2.1 SENDERS

As a starting set of simulations we have varied the number of senders to evaluate the protocol scalability based on the number of multicast source nodes and the traffic load. We inferred from the fig-3 that ODMRP is over 33% more effective than MAODV in data delivery ratio as the number of senders incremented from 0-20.we have also observed that both protocols has not performed well if the number of senders increased above 20.

4.2.2 MOBILITY

Follows the second set of simulations we evaluate the ability of protocols to deal with the route change by varying the mobility. From fig-4 it has been inferred that ODMRP is 104% more effective than MAODV in packet delivery ratio as the mobility increases from 0-20m/s. From fig-5 it has been observed that the control overhead of ODMRP decreases by 74% than MAODV as the mobility reaches 20m/s. Generally it has been notified that ODMRP is unaffected by mobility because of its mesh based topology than to the MAODV because of its tree based approach.

4.2.3 MULTICAST GROUP

Follows the third set of simulation, we have tested the scalability of the protocol with respect to the group size by varying the number of members in the group. From fig-6 it has been inferred that for control and data packet transmission MAODV decreases by up to 46% than MAODV for each data packet delivered. We also inferred that packet delivery ratio also decreases as the group size increases in ODMRP. With respect to the increase in the group member size MAODV is doing well than ODMRP, which can be attributed because of the collision that occur due to the frequent broadcast through the network.

CONCLUSION:

The performance of two prominent on demand multicast protocol MAODV and ODMRP have been for adhoc networks. Both the protocols uses on-demand route discovery but with different routing mechanisms.in general ODMRP outperforms in packet delivery ratio than the MAODV. But ODMRP hasn't have good scalability as the number of senders or the group size increases.The self-pruning of the ODMRP and MAODV decreases the control overhead in the network future direction for improving the ODMRP performance can be done by improving the dominant pruning approach for flooding of packets.The rudimentary area for improving the MAODV is the fragileness of the bi-directional shared tree which causing the poor delivery ratio.Much room still exists to improve protocol performance (as measured by the packet delivery ratio) while reducing the associated overhead.

REFERENCE:

[1]. Elizabeth M. Royer, Charles E. Perkins. “Multicast Operation of the Ad-hoc On-demand Distance Vector Routing Protocol”.

[2]. Sung-Ju Lee, William Su, Mario Gerla. “On-Demand Multicast Routing Protocol (ODMRP) for Ad Hoc Networks”. INTERNET-DRAFT- <draft-ietf-manet-odmrp-02.txt>

[3].S.Deering, C Patridge, and D.Waitzman,”Distance Vector Multicast routing Protocol”,RFC-1075,Nov. 1988.

[4]. C.C Chiang ,M.Gerla, and L.Zhang ,”Forwarding Group Multicast Protocol(FGMP) for Multihop, Mobile Wireless Networks,” Baltzer Cluster computing ,Vol.1 no.2, 1998,pp.187-196.

[5]. Elizabeth M. Royer, Charles E. Perkins. “Multicast Operation of the Ad-hoc On-demand Distance Vector Routing Protocol”.

[6]. J. Schiller. “Mobile Communications” Addison-Wesley, 2000.

[7]. R. Bagrodia, M. Gerla, J. Hsu, W. Su, and S.-J. Lee. “A performance comparison study of ad hocwireless multicast protocols”, Proc. of the 19th Annual Joint Conf. of the IEEE Computer and Communications Societies, March 2000, pages 565 –574.