A Comprehensive Study of Existing Mesh-based Multicast Routing Protocols Used In Mobile Ad Hoc Networks

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ABSTRACT
Mobile Ad-hoc Networks are collection of mobile hosts correlated wirelessly with no fixed communications or central supervision. The mobile hosts are self-organized and can be deployed everywhere and at any time. One of the major applications of MANETs is military and disaster recovery. These applications demand for proper communication and coordination among the mobile host. This is achieved with the help of multicasting. Multicasting plays a vital role in mobile ad hoc networks. Multicasting is more beneficial than multiple unicast in a bandwidth-constrained ad hoc networks. In this paper we made a comprehensive study on existing mesh-based multicast routing protocols based on their initialization approaches.

General Terms
Multicast Routing

Keywords
MANET, Multicast Routing Protocols.

1. INTRODUCTION
MANETs is one type of wireless networks offers a wide range of application deployment. The nodes in a mobile ad hoc network are mobile hosts. The MANETs is characterized by mobility, error-prone shared broadcast radio channel, limited security, hidden and exposed terminal problems, and bandwidth and power constraint network. The applications range from resident application to domestic applications. Most of these applications demand for multicasting. Multicasting is one type of broadcast saves bandwidth when compared to a multiple unicast packet [19] [20]. Also it involves in less host and router processing. MANETs is deploying at minimal cost when compared to the other types of network. This provides on the wing information to its users.

1.1 Transmission Modes
Unicast: It is one type of transmission in which information is sent from only one sender to only one receiver.

All LAN's Ex: Ethernets and IP networks support unicast.

Application: HTTP, SMTP, FTP, and TELNET.

Advantages: Saves power, increased reliability.

Disadvantages: Only one user can access.

Broadcast: Broadcast is a type of transmission in which information is sent from one sender to all the recipients connected to the network.

It is supported on LAN's Ex: Ethernet and may be used to send the same message to all computers on the LAN.

Application: T.V., Video Broadcast.

Advantages: Usage of bandwidth reduces packet loss.

Disadvantages: More delay, overhead.

Multicast: Multicast is a type of transmission in which more than one sender sent information meant to set of receivers. Multicast saves bandwidth compared to broadcast.

Application: Bulk Data transfer, Streaming continuous media, Shared data applications, Data feeds, Web cache updating and Interactive gaming.

Advantages: Limited bandwidth used, delay can be reduced.

Disadvantages: Loss of connectivity, overhead

2. CLASSIFICATION OF MESH-BASED MULTICAST ROUTING PROTOCOLS
In general the multicast routing protocols used in mobile ad hoc networks are broadly classified into two broad categories based on the topology[1][3][6]. Tree based multicast routing protocols and mesh-based multicast routing protocols. The following section briefly describes about the mesh-based multicast routing protocols with respect to initialization approaches.

2.1 Source-Initiated Mesh Based Multicast Routing Protocols

2.1.1 On Demand Multicast Routing Protocol (ODMRP):
ODMRP [1][4] is source initiated mesh based soft state multicast routing protocol. A source sends a JOIN DATA [13] packet for constructing path to send the data along the route. When a forward node along the path receives this packet it stores its sender node as upstream node and rebroadcast the packet. When the packet reaches to the desired receiver it will create JOINTABLE and multicast to its neighbors. The neighbor nodes will check next node ID if it matches then it is a node that is along path of forwarding and finally these nodes become forwarding group. These packets will be broadcasted

until nodes find the shortest path to the source. This process is used to build forwarding group and routes between sources to receivers. If a node wants to leave, no need of any leave message. Patch ODMRP [11][14] is used to save control overhead derived by ODMRP by using local route maintenance (3-hop). However Pool ODMRP [7][15][16] is introduced to reduce control overhead in local route maintenance from 3 hops to 1 hop. Advantage is less control overhead and is used to find efficient routes. Disadvantage is this protocol is not suited for more mobility environment and more nodes, as delay will be increased in transmitting.

2.1.2 Dynamic Core Based Multicast Routing Protocol (DCMP):

DCMP [2] is source initiated mesh based soft state multicast routing protocol. DCMP selects only limited senders to be as cores. This protocol forms mesh by having three sources for broadcasting JREQ packet: active, passive and core active [14]. Active and core active sources flood the JREQ packets and passive sources transmit these packets to the core active nodes, and moreover these packets broadcast through the mesh. Distance between passive and core active node should be less for higher delivery ratio of data. Here there are parameters such as: MaxHop and MaxPassSize. MaxHop represents no of links between passive and active core node. MaxPassSize represents the number of passive sources that are present. Advantage is it is more scalable, high packet delivery ratio. Disadvantage is if core active source fails then multicast operation will fail.

2.1.3 Neighbour Supporting Multicast Protocol (NSMP):

NSMP [3] is source initiated mesh based soft state multicast routing protocol. In this, source will broadcast request to all the nodes. Forwarding nodes will stores upstream node status and forward the packet to the other nodes. When a receiver receives the packet, it will reply to the upstream node and nodes will store node status in the routing table for the reverse path. The receiver will select route request packet by considering the weight factor which is based on forwarding and not forwarding nodes along the path Source will locally broadcasts route discovery packets to update the routes and mesh. Any node want to join, node has to wait for this local route discovery process and has to join. Any links that have to be repaired is transmitted to the source. Here the condition is the only distance with 3 or 2 hops has to join. Otherwise, it has to broadcast the request. Advantage is it reduces control overhead by performing only local route discovery and high packet delivery ratio. Disadvantage is weight metric is fixed it will have a problem when there is high network variations.

2.1.4 Enhanced-On Demand Multicast Routing Protocol (E-ODMRP):

E-ODMRP [4] is source initiated mesh based hard state multicast routing protocol. It is same as ODMRP [18] but it uses dynamic broadcasting to reduce the control overhead in ODMRP. This protocol also performs local route discovery by using ERS [17]. ERS requires more processing. It's not suitable for low end mobile devices. Packet delivery will be same as in ODMRP. Advantage is it reduces control overhead. Disadvantage is it suffers from scalability and nodes will perform ERS that leads to malicious activities. It requires more processing overhead.

2.1.5 Optimized Polymorphic Hybrid Multicast Routing Protocol (OPHMR):

OPHMR [5] is source initiated mesh based hard state multicast routing protocol. This protocol uses proactive routing within the zone and reactive between zones or groups. Mobile nodes contain two modes: proactive and reactive modes. If a node wants to join groups of multicast nodes, node will perform broadcasting JREQ [12] messages in reactive mode. If the node is in proactive mode it will check its routing table that whether there is a route to join to multicast group, then it will unicast the packet, else broadcast JREQ packet. Nodes will record the route status while JREQ message is passing along the route. Advantage is packet delivery will be increased and delay will be decreased. Disadvantage is delivery ratio decreases when mobile node increases.

2.1.6 Mesh Based Multicast Routing Protocol with Consolidated Query Packets (CQMP):

CQMP [6] is a source initiated mesh based hard state multicast routing protocol. It uses a consolidated query packet mechanism. A source will multicasts query packet. It contains (sender ID and sequence number) name of sources, query sequence number, last hop ID, multicast group ID, current seq, next seq and hop count. The receiver receives many query packets from different sources. Each source will be represented as a, first field will be next seq of source. To consolidate query packet, it first compares the senderID and sequence number with the cache that is present. If it matches, it is treated as duplicate and discards packet. Otherwise it is processed, for each source query that contains sourceID and current seq will be checked with the cache and saves its id, nextseq and INT values in its routing table (RT). The Numsources field will be incremented every time. The receiver will forwards reply packet after checking everything, and if node detects, that it is the next node, and then it will change path status to source node which is forwarding group. When a packet reaches along source path, a source for the receiver route is formed. Nodes will be formed as forwarding the packets to that group. Advantage is, it does not include any additional transmissions as it contain *query already transmitted* field. It becomes more effective, even there are more sources. And less control overhead is achieved by consolidating the query packets. Disadvantage is the data delivery ratio will be reduced in high mobility conditions.

2.1.7 Bandwidth Optimized and Delay Sensitive (BODS):

BODS [7] is source initiated mesh based hard state multicast routing protocol. It is suitable for both bandwidth and delay sensitive applications ex: multimedia applications. The source node will broadcast query packet that contains nearest participant and distance to nearest participant. Receiver will check the nearest participant field by using priority i.e. highest and lowest. When the MREQ packet reaches by the path contain nodes that are members of a group, then it has higher priority. Otherwise it has lower priority. It will be known by the field nearest participant which contains any value. The highest priority will reduce the delay. Timer will be used in a packet that is transmitted. It will expire after some time. If there is more than one path, then it will set to the non empty nearest distance field. BODS is an algorithm that is used by any protocol. In this algorithm, nearest participant and the distance will be added to the header of the join query packet and a delay timer set. When it expires, it will rebroadcast the packet. Advantage is it has more effective bandwidth, control overhead will be very less and packet delivery ratio will be more. Disadvantage is it will be suited for low mobility situations.

2.2 Receiver-Initiated Mesh Based Multicast Routing Protocols

2.2.1 Forward Group Management Protocol (FGMP)
FGMP [8] is a receiver or sender initiated shared tree based soft state protocol. It is completely based on a group of nodes that has to be forwarded. Each node maintains a group of nodes that forwards the packets. If the receiver or sender wants to join there are two methods: FGMP-RA receiver advertising and FGMP-SA sender advertising. In FGMP-RA, the receiver will advertise its presence by JREQ packets and sender that receives the packet, will update its table with group of receivers. In FGMP-SA, the sender will advertise its presence and receiver will update its table with a group of senders and broadcasts this joining table to form forwarding group. The forwarding table consists of receiver Ids and joining table consists of sender Ids. Advantage is it will flood its packets to forwarding group only, as it reduces control overhead and storage overhead. Disadvantage, it does not work for high mobile environments. It works better for, when the number of receivers is more than senders.

2.2.1 Multicast Core Extraction Distributed Ad hoc Routing (MCEDAR):
MCEDAR [9] is source tree based hybrid routing protocol. In this protocol, mesh is created by using CEDAR [10]. CEDAR will creates set that contains minimum number dominating core nodes by using core computation algorithm. Dominating core nodes are core node of senders or receivers or core node which is near to the requesting node. When a node wants to join the group the core node of that group will broadcast JoinReq (MA, JoinID). MA is the address of the group that wants to join and JoinID is the current id of the group. When a node that does not belongs to desired group receives the packet, it will broadcast to the nearby core nodes. Otherwise node will send JACK to the id that is smaller than id that is present in JoinREQ packet or it will send JACK to the node that has larger id as a replying node. mgraph contains two tables they are parent and child. Parent contains all upstream nodes and child set contains downstream nodes. Advantage is it is robust when the receiver has links to the source. Disadvantage is it doesn't work well for small groups. More control overhead will be obtained due to change of cores in a mobile environment.

Table 1: Comparison of Multicast routing protocols based on different characteristics

Protocols	Source-Initiated	Receiver-Initiated	Soft state	Hard state	Control overhead	QOS Support
ODMRP [1]	Yes	No	No	Yes	Less	No
DCMP [2]	Yes	No	Yes	No	Less	Yes
NSMP [3]	Yes	No	Yes	No	Less	Yes
E-ODMRP [4]	Yes	No	No	Yes	Less	No
OPHMR [5]	Yes	No	No	Yes	Less	No
CQMP [6]	Yes	No	No	Yes	Less	Yes
BODS [7]	Yes	No	No	Yes	Less	Yes
FGMP [8]	No	Yes	Yes	No	Less	Yes
MCEDAR [9]	No	Yes	No	Yes	More	No

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4. CONCLUSION
Multicasting can efficiently support a wide variety of applications that are characterized by a close degree of collaboration, typical for many MANETs. Design of the multicast routing protocols are obtained by specific goals and requirements based on respective assumptions about the network properties or application areas. This paper presented a survey of existing mesh based multicast routing protocols designed for MANETs. We presented classification of mesh based multicast routing protocols based on different characteristics, namely, multicast topology, initialization of multicast connectivity, routing information update mechanism, control overhead and QOS support. These issues should be considered in the design of an efficient multicast routing protocol in MANETs. A multicast protocol can hardly satisfy all previous requirements. Many protocols don't satisfy all requirements, but rather each protocol is designed to provide the maximum possible requirements according to certain required scenarios. Even if a multicast protocol meeting all the requirements is designed, it will be very complicated and need a tremendous amount of routing information to be maintained.

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