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# Survey on Efficient Multicast Routing Protocols to achieve Group Communication in MANET

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***Abstract – An Ad Hoc Network is a connection of wireless mobile nodes dynamically forming a temporary network without use of any centralized control or fixed network infrastructure. Flooding and looping are the main problems while transmitting and receiving data in the Mobile Ad Hoc Network. Due to the limited transmission range of wireless networks, multiple network hops may be required for one node to exchange the data with another across the network. In this network, nodes that are close to one another may need to have an exclusive access to a shared resource, which means that only one node can access the resource at the same time. This problem is called mutual exclusion which can be solved by Group Communication. Multicasting is an efficient method for implementing Group Communications. But it is challenging to implement efficient and scalable multicasting in MANET due to the difficulty in Group Membership management over a dynamic topology. This paper examines various Multicast Routing Protocols of Mobile Ad Hoc Network in existence and the current achievements in the research based on a comprehensive study of a tree based and a mess of routing protocols. It has an active significance for MANET to increase its performance in the near future.***

*Keywords-* **Multicasting, Mutual Exclusion, Group Communication.**

## I. INTRODUCTION

A Wireless Ad Hoc Network is a collection of two or more devices equipped with wireless communications and networking capability. Such devices can communicate with another node that is immediately within their radio range or one that is outside their radio range. For the latter scenario, an intermediate node is used to relay or forward the packet from the source toward the destination. A Wireless Ad Hoc Network is self-organizing and adaptive. This means that a formed network can be deformed on-the-fly without the need for any system administration. The term "adhoc" tends to imply "can take different forms" and "can be mobile, standalone, or networked". Adhoc nodes or devices should be able to detect the presence of other such devices and to perform the necessary handshaking to allow communications and the sharing of information and services.

Multicasting [2] is an important communication pattern that involves the transmission of packets to a group of two or more hosts, and thus is intended for group-oriented computing[3][4]. Applications of MANETs include battlefield communications [5], disaster recovery, collaborative and distributed computing, emergency operations, co ordinate task scheduling (such as earth moving or construction, vehicular communication for traffic management, data and information sharing in difficult terrain and extension of the infrastructure based Wireless Networks. The following are the issues in Ad Hoc Wireless Networks.
Medium Access Scheme: The primary responsibility of a medium access control protocol in Ad Hoc Wireless Networks is the distributed arbitration for the shared channel for transmission of packets.

***Routing:*** The responsibilities of a Routing protocol include exchanging the route information; finding a feasible path to a destination based on criteria such as hop length, minimum power required, and lifetime of the wireless link; gathering information the path breaks; mending the broken paths expending minimum processing power and bandwidth; and utilizing minimum bandwidth.

***Multicasting:*** Multicasting plays an important role in the typical applications of Ad Hoc Wireless networks, namely, emergency search-and-rescue operations and military communication. The arbitrary movement of nodes changes the topology dynamically in an unpredictable manner.

***Transport Layer Protocols:*** The main objectives of the transport layer protocols include setting up and maintaining end-to-end connections, reliable end-to-end delivery of data packets, flow control, and congestion control.

***Quality of Service Provisioning*:** Quality of Service is the performance level of services offered by a service provider or a network to the user. It requires negotiation between the host and the network, resource reservation schemes, priority scheduling, and call admission control.

***Self Organization*:** One very important property that an Ad Hoc Wireless Network should exhibit is organizing and maintaining the network by itself. The major activities that an Ad Hoc Wireless Network is required to perform for self-organization are neighbour discovery, topology organization, and topology reorganization.

***Security***: The security of communication in Ad Hoc Wireless Networks is very important, especially in military applications. The lack of any central coordination and shared wireless medium makes them more vulnerable to attacks than wired networks.

***Addressing and Service Discovery***: Addressing and service discovery assume significance in Ad Hoc Wireless Networks due to the absence of any centralized coordinator. Nodes in the network should be able to locate services that other nodes provide.

***Energy Management*:** It is defined as the process of managing the sources and consumers of energy in a node or in the network as a whole for enhancing the lifetime of the network.

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***Scalability:*** Even though the number of nodes in an Ad Hoc Wireless network does not grow in the same magnitude as today's Internet.

## II. RELATED WORK

There are increasing interest and importance in supporting Group Communications over Mobile Ad Hoc Networks. Example applications include the exchange of messages among a group of soldiers in a battlefield, communications among the firemen in a disaster area, and the support of multimedia games and teleconferences with a one-to-many or many-to-many transmission pattern, multicast is an efficient method to realize Group Communications. The conventional multicast protocols [6][7] generally do not have good scalability due to the overhead of route searching, group membership management and tree / mesh structure creation and maintenance over the dynamic topology of MANET. These protocols are usually composed of the following three components that generally cannot scale to large network size:

1) Group Membership management: The management becomes harder for a large group.

2) Creation and maintenance of a tree or mesh-based multicast structure. These will cause significant control overhead over the dynamic topology of MANET.

3) Multicast packet forwarding. The multicast packets are forwarded along the pre-built tree or mesh structure, which is vulnerable to b e broken over the dynamic longer paths [8] [9].

Examples for Tree based protocol are MAODV [10], AMRIS [11], MZRP [12] and Examples for Mesh based protocols are FGMP [13], Core-Assisted Mesh Protocol [14] and ODMRP [15] which are proposed to enhance the robustness with the use of redundant paths between the source and destination pairs. Multicasting in MANETs can be implemented in the network layer, the MAC layer, and/ or the application layer. Accordingly, multicast routing protocols can be classified into three categories: Network (IP) Layer Multicast (IPLM), Application Layer Multicast (ALM), and MAC Layer Multicast (MACLM). IPLM [2] is the most common type of multicasting used in Ad-HOC networks top design efficient and reliable multicast routing protocols. It operates on network (IP) layer that require the cooperation of all nodes in the network, as the intermediate (forwarder) nodes must maintain the multicast state per group. The network layer maintains the best effort uni cast datagram service compared to other types that employ other layers than network layer. Reactive Multicast Routing Protocols: Traditional routing protocols such as On-Demand Multicast Routing Protocol (ODMRP) and Multicast Ad Hoc On-Demand Distance Vector (MAODV) [10] are Reactive multicast routing protocols. Reactive routing that means discovers the route when needed. Reactive routing protocols are well suited for large-scale, narrow-band MANET with moderate or low mobility.

## III. PROTOCOL DESCRIPTION

### *A. Operation of Multicast Routing Protocols*

Multicast Protocols for Ad Hoc Wireless Networks are broadly classified into two types: Source-Initiated Protocols and Receiver-Initiated Protocols.

#### *1) Source-Initiated Protocols*

This section deals with the events as they occur in a source-initiated protocol that uses a soft state approach. In the soft state maintenance approach (Figure-1), the multicast tree or mesh is periodically updated by means of control packets. In such protocols, the source of the multicast group periodically floods a *Join Request (JoinReq)* packet throughout the network. This is propagated by other nodes in the network, and it eventually reaches all the receivers of the group. Figure 1& 2 is shown in Appendix.

A node that wishes to join a group should respond with a Join Reply (JoinRep) packet, which is propagated along the reverse path of that followed by the JoinRep packet .In this protocol communication between the nodes are done by propagation of join request and join reply. This is a two-pass protocol for establishing the tree (or mesh). There is no explicit procedure for route repair. In soft state protocols, the source periodically initiates the above procedure. Hard state is similar to that of a soft state source-initiated protocol, except that there is an explicit route repair procedure that is initiated when a link break is detected.

#### *2) Receiver-Initiated Protocols*

In the receiver-initiated multicasting protocols, the receiver uses flooding to search for paths to the sources of the multicast groups to which it belongs. The soft state variant is illustrated in Figure-2. The tree construction is three phase process. First, the receiver floods a Join Req packet, which is propagated by the other nodes. Usually, the sources of the multicast group and/or nodes which are already part of the multicast tree (or mesh), are allowed to respond to the JoinReq packet with a JoinRep packet, indicating that they would be able to send data packets for that multicast group. The receiver replies with the smallest hop count and sends a Join Acknowledgment (JoinAck) packet along the reverse path.

### *B. An Architecture Reference Model*

In this section, a reference model for understanding the architecture of multicast routing protocols is presented. This helps the reader in understanding the different modules in the implementation of multicast routing protocols for Ad Hoc Wireless Networks. There are mainly three layers in the network protocol stack concerned with multicasting in Ad Hoc Wireless networks. Layering approach provides the flexibility for using Multicast Routing Protocols.

#### 1) Medium Access Control(MAC) Layer

The important services provided by this layer to the ones above are transmission and reception of packets. This MAC layer consists of three principal modules. Transmission modules: This module also includes the arbitration mode which schedules transmission on the channel.

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**Receiver Module:** This module receives the information from higher layers.

**Neighbour list handler:** It informs the higher layers whether a particular node is a neighbour node or not. It also maintains a list of all the neighbour nodes. Figure-3 represents an Architecture Reference Model.

**2) Routing Layer**

This layer is responsible for forming and maintaining the unicast session/ multicast group. For this purpose, it uses a set of tables, timers, and route caches. The important multicast services it provides to the application layer are the functions to join/leave a multicast group and to transmit / receive multicast packets. Most of the multicast routing protocols operate in the routing layer. It uses the following components / modules:

**Unicast routing information handler:** It is used to discover unicast routes.

**Multicast information handler:** It includes a list of its downstream nodes, the address of its upstream nodes, sequence number information, etc related to multicasting.

**Forwarding module:** It is used to decide whether a received multicast packet should be forwarded to a neighbour node, or be sent to the application layer.

**Tree / Mesh construction module:** This module is used to construct the multicast topology. It might initiate flooding to join a group by the application layer.

**Session maintenance module:** It uses information from the multicast and unicast routing table to perform a search for the node in order to restore the multicast topology. Route cache maintenance module: This module is used to collect information from routing packets overheard on the channel.

2) **Application Layer**

This layer utilizes the services of the routing layer to satisfy the multicast requirements of applications. It consists of two modules. Data packet transmits / receives controller and Multicast session initiator / terminator. Joining a group: Module 10, which exists in the application layer, makes a request to join a group to module 5 present in the routing layer, which can use cached information form module 4 and the unicast route information from module 9. It then initiates flooding of JoinReq packets by using module 2 of the MAC layer. These JoinReq packets are passed by module 3 of other nodes to their forwarding module, which updates the multicast table and propagates this message. During the reply phase, the forwarding states in the multicast tables of intermediate nodes are established. Figure 3 is shown in Appendix.

***Data Packet Propagation***: Data packets are handled by module 11 in the application layer, which passes them on to module 8 (forwarding module), which makes the decision on whether to broadcast the packets after consulting module 7. The above figure represents how various modules are integrated. A similar process occurs in all nodes belonging to the multicast topology until eventually the data packets are sent by the forwarding module of the receivers to the application layer.

***Route Repair***: Route repair is handled by module 6 on being informed by module 1 of link breaks. It uses the unicast and multicast routing tables to graft the node back into the multicast topology.

## IV. CLASSIFICATION OF MULTICAST ROUTING PROTOCOLS

Multicast routing protocols for Ad Hoc Wireless Networks can be broadly classified into two types: Application-independent / generic multicast protocols and Application dependent multicast protocols. While Application-independent multicast protocols are used for conventional multicasting, Application-dependent multicast protocols are meant only for specific applications for which they are designed.

**1. Based on Topology:** In this section, based on topology Multicast Routing Protocols are broadly classified into two types. Tree based [10][11][12] and Mesh based [13][14][15]. In tree-based multicast routing protocols, there exists only a single path between a source-receiver pair, whereas in mesh-based multicast routing protocols, there may be more than one path between a source-receiver pair. Tree based multicast protocols are more efficient compared to mesh-based protocols, but mesh-based multicast protocols are robust due to the availability of multiple paths between the source and receiver. Tree-based multicast protocols can be further divided into two types source-tree-based and shared-tree-based. In source-tree-based multicast protocols, the tree is rooted at the source, whereas in shared-tree-based multicast protocols, a single tree is shared by all the sources within the multicast group and is rooted at a node referred to as the core node. The source-tree-based multicast protocols perform better than the shared-tree-based protocols at heavy loads because of efficient traffic distribution. But the latter type of protocols is more scalable. The main problem in a shared-tree-based multicast protocol is that it heavily depends on the core node, and hence, a single point of failure at the core node affects the performance of the multicast protocol.

**2. Based on initialization of the Multicast session:** The multicast group formation can be initiated by the source as well as by the receivers. In a multicast protocol, if the group formation is initiated only by the source node, then it is called a source-initiated multicast routing protocol, and it is initiated by the receivers of the multicast group, then it is called a receiver-initiated multicast routing protocol. Some multicast protocols do not distinguish between source and receiver for initialization of the multicast group.

**3. Based on the topology maintenance mechanism**: Maintenance of the multicast topology can be done either by the soft state approach or by the hard state approach. In the soft state approach, control packets are flooded periodically to refresh the route, which leads to a high packet delivery ratio at the cost of more control overhead, whereas in the hard state approach, the control packets are transmitted (to maintain the routes) only when a link breaks, resulting in lower control overhead, but at the cost of a low packet delivery ratio.

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## V. TREE-BASED MULTICAST PROTOCOLS

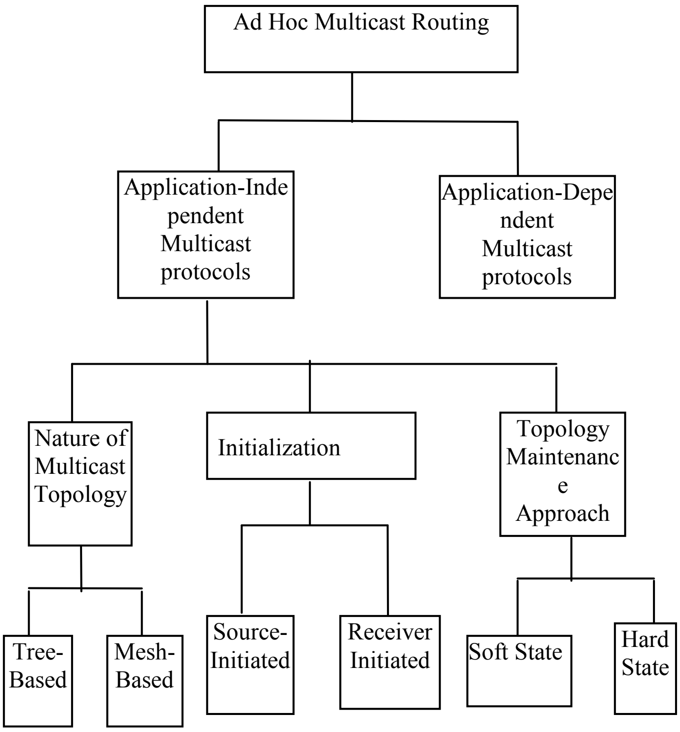


**Fig.4. Classification Ad Hoc Multicast Routing Protocols**

Tree-based multicasting is a well-established concept used in several wired multi9cast protocols to achieve high multicast efficiency. In tree-based multicast protocols, there is only one path between a source-receiver pair. There are two types of Tree-based multicast protocols: source-tree based multicast routing protocols and shared-tree-based multicast routing protocols. In a source-tree-based protocol, a single multicast tree is maintained per source, whereas in a shared-tree-based protocol, a single tree is shared by all the sources in the multicast group. Shared-tree-based multicast protocols are more scalable compared to source-tree-based multicast protocols. By scalability, it is meant the ability of the protocol to work well without any degradation in performance when the number of sources in a multicast session or the number of multicast sessions is increased. In source-tree-based multicast routing protocols, an increase in the number of sources gives rise to a proportional increases in the number of source-trees. Another factor that affects the scalability of source-tree-based protocols is the memory requirement. When the multicast group size is large with a large number of multicast sources, in a source-tree-based multicast protocol, the state information that is maintained per source per group consumes a large amount of memory at the nodes. But in a shared-tree-based multicast protocol, since the state information is maintained per group, the additional memory required when the number of sources increases is not very high.

### *A. Bandwidth-Efficient Multicast Routing Protocol(BEMRP)*

Ad Hoc Networks operate in a highly bandwidth-scarce environment, and hence bandwidth efficiency is one of the key design criteria for multicast protocols. Bandwidth efficient multicast routing protocol (BEMRP) [17] tries to find the nearest forwarding node, rather than the shortest path between source and receiver. Hence, it reduces the number of data packet transmissions. To maintain the multicast tree, it uses the hard state approach, that is, to rejoin the multicast group, a node transmits the required control packets only after the link breaks. The main advantage of this multicast protocol is that it saves bandwidth due to the reduction in the number of data packet transmissions and the hard state approach being adopted for tree maintenance. The main disadvantage of this protocol is, since the protocol uses the hard state approach for route repair, a considerable amount of time is spent by the node in reconnecting to the multicast session, which adds to the delay in packet delivery.

### *B. Multicast Routing Protocol Based on Zone Routing(MZRP)*

In Multicast Zone Routing Protocol (MZRP) [12], the flooding of control packets by each node which searches for members of the multicast group is controlled by using the zone routing mechanism. In zone routing, each node is associated with a routing zone. For routing, a pro-active approach is used inside the zone (the node maintains the topology inside the zone, using a table-driven routing protocol), whereas a reactive approach is used across zones. This protocol combines the best of both on-demand and table-driven routing approaches. MZRP [12] has reduced control overhead as it runs over ZRP. The fact here is unicast and multicast routing protocols can exchange information with each other. MZRP is important as it shows the efficiency of the zone-based approach to multicast routing. The size of the zone is very important in MZRP. The size should be neither too large nor too small. The main disadvantage of this protocol is that a rece3iver node which is located far off from the source needs to wait for a long time before it can join the multicast session.

### *C. Multicast Core-Extraction Distributed Ad Hoc Routing (MCEDAR)*

To increase the robustness while maintaining the efficiency, a different approach is used in multicast core-extraction distributed ad hoc routing (MCEDAR). A source-tree over an underlying mesh infrastructure called m graph is used for forwarding data packets. In this architecture, a minimum dominating set (MDS), which consists of certain nodes (called core nodes) in the network, is formed using a core computation algorithm. After joining the MDS, each core node issues a piggy-backed broadcast through its beacon packet to inform its presence up to the next three hops. This multicast routing protocol is robust, and using source-tree over mesh for forwarding the data packets makes it as efficient as other tree-based multicast routing protocols. Depending on the robustness factor parameter, the dominator node of a receiver has multiple paths to the multicast session. So even if the current path breaks, the dominator node always has an alternate path to the multicast session. The main disadvantage of this protocol is that is more complex compared to other multicast routing protocols.

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*D.Associatively-Based Ad Hoc Multicast Routing (ABAM)*

Associatively-based ad hoc multicast routing (ABAM) [18] is an on-demand source-tree-based multicast protocol in which a path (form source to receiver) is constructed based on link stability rather than hop distance. Hence, this multicast protocol is adaptive to the network mobility. In ABAM [18], the path between a source and receiver is more stable compared to other multicast protocols, and hence it achieves a higher packet delivery ratio. Also, the control overhead is less due to a fewer number of link failures. But increased hop distance between the source-receiver pair makes the protocol less efficient. When there are a lot of receivers belonging to the same multicast session close by, it results in congestion of the most stable path, which in turn may result in increased delay and reduction in the packet delivery ratio.

*E. Differential Destination Multicast Routing Protocol(DDM)*

DDM [20] is a stateless multicast routing protocol that avoids maintaining multicast states in the nodes. It is particularly applicable where the group size is small. It uses a soft state mode to maintain the tree. Since DDM does not maintain the multicast state, it uses minimum memory resources. Due to the centralized admission control policy, security is assured. Any shift in the location of a receiver results in the automatic rerouting of packets to its new location. But the main drawback is that it is not scalable when the multicast group size increases. DDM [20] involves periodic control packet transmissions from the receiver nodes to the source node. Bandwidth consumption is high in this protocol.

*F. Weight-Based Multicast Protocol(WBM)*

The weight-based multicast (WBM) [22] protocol uses the concept of weight when deciding upon the entry point. In the multicast tree, before joining a multicast group, a node takes into consideration not only the number of newly added forwarding nodes (here, forwarding nodes refers to the nodes which are currently not part of the multicast tree, but which need to be added to the tree in order to connect the new multicast receiver to the multicast session), but also the distance between the source node and itself in the multicast tree. The weight concept provides flexibility for a receiver to join either the nearest node in the multicast tree or the node nearest or the multicast source.

The decision taken by newly joining nodes on the entry point to join the tree, which balances the number of additional nodes to be added to the existing multicast tree and the hop distance to the source node, results in high efficiency of the protocol. The prediction-based preventive route repair mechanism avoids path breaks and as such, packet loss is less and packet delivery is high. The disadvantage of this scheme is that the localized prediction scheme may not work consistently well under all network conditions. There is always a finite probability that the prediction might be inaccurate, resulting in unnecessary handoffs.

*G.Preferred Link-Based Multicast Protocol(PLBM)*

This protocol uses a preferred link approach for forwarding Join Query packets. PLBM [21] is an extension of the PLBR protocol. The main concepts involved in PLBM are the selection of a set of links to neighbour nodes, called preferred links, and the use of only those links for forwarding of Join Query packets. The PLBM [21] protocol makes use of two-hop local topology information for efficient multicast routing. PLBM provides better flexibility and adaptability through the preferred link concept. The criterion for selecting the referred list need not be restricted to the neighbour degree alone; any other node or link characteristic can be used for computing the preferred links. One of the shortcomings of PLBM is the usage of periodic beacons. Transmission of periodic beacons by each and every node in the network incurs significant control overhead in the already bandwidth-constrained ad hoc wireless networks.

*H. Multicast Ad Hoc On-Demand Distance Vector Routing Protocol(MAODV)*

Multicast ad hoc on-demand distance vector (MAODV) [10] routing protocol, is an extension of the AODV protocol. MAODV adds multicast capability to the AODV protocol; multicast, unicast, and broadcast features have been streamlined into MAODV. MAODV used sequence numbers to ensure that the most recent route to the multicast group is used. One of the advantages of MAODV [10]is the integration of unicast and multicast into a unified framework. Thus, information gleaned during unicast route discovery can be used in the multicast route discovery and vice versa. This sharing of information helps in reducing the control overhead, which is one of the aims of an ad hoc multicast protocol. The protocol is also free from lops. The disadvantage stems from its tree-based multicast topology; poor packet delivery under mobility, congestion along links in the tree, etc.

*I. Ad Hoc Multicast Routing Protocol Utilizing Increasing ID-Numbers(AMRIS)*

Ad hoc multicast routing protocol utilizing increasing id-numbers (AMRIS) [11] is a source-initiated multicast routing protocol in which a shared-tree is constructed to support multiple sources and receivers. The main idea in his protocol is that each tree node has a session specific multicast session member identifier (MSM-ID) which indicates its logical height in the shared tree. The purpose of MSM-ID is to avoid any loop formation and repair the broken links locally. Since AMRIS uses MSM-ID, it avoids lop formations, and link breaks are repaired locally. Hence, the control overhead is less. Another advantage of AMRIS is its simplicity as compared to other multicast protocols. The main disadvantages of this protocol are the wastage of bandwidth due to usage of beacons and the loss of many data packets due to collisions with beacons.

*J. Ad Hoc Multicast Routing Protocol (AMRoute)*

A different approach is used in ad hoc multicast routing protocol (AMRoute) [19] in order to enhance the robustness of the tree-based approach. This multicast protocol emphasizes robustness even with high mobility by creating a multicast tree over the underlying mesh. It assumes the existence of an underlying unicast routing protocol in the network dynamics. It has two main phases: mesh creation and virtual user-multicast tree creation phase. The logical core node initiates mesh creation and tree creation. AMRoute [19] protocol is robust due to its tree structure over an underlying mesh. But it is less efficient due to lop formations in the multicast tree. Also, under mobility conditions the hop count of the unicast tunnels increases, thereby decreasing the throughput. Similar to other shared-tree-based protocols, AMRoute also has the risk of single point of failure of the core node. Failure of the core node caused loss of packets and increases the delay, as considerable time is wasted before one of the existing nodes is made as the core node. When the size of the network is large and the node mobility is high, the core nodes keep changing frequently.

## VI. MESH-BASED MULTICAST ROUTING PROTOCOLS

In Ad Hoc Wireless Networks, wireless links break due to the mobility of the nodes. In the case of multicast routing protocols, the path between a source and receiver, which consists of multiple wireless hops, suffers very much due to link breaks. Multicast routing protocols which provide multiple paths between a source-receiver pair are classified as mesh-based multicast routing protocols. The presence of multiple paths adds to the robustness of the mesh-based protocols at the cost of multicast efficiency. In this section, some of the existing mesh-based protocols are described in detail. The following are some of the mesh-based multicast routing protocols.

### *A. On-Demand Multicast Routing Protocol(ODMRP)*

In the on-demand multicast routing protocol (ODMRP) [15], a mesh is formed by a set of nodes called forwarding nodes which are responsible for forwarding data packets between a source-receiver pair. These forwarding nodes maintain the *message-cache* which is used to detect duplicate data packets and duplicate JoinReq control packets .Since ODMRP uses the soft state approach for maintain g the mesh, it exhibits robustness. But this robustness is at the expense of high control overhead. Another disadvantage is that the same data packet (from source to receiver) propagates through more than one path to a destination node, resulting in an increased number of data packet transmissions, thereby reducing the multicast efficiency.

### *B. Dynamic Core-Based Multicast Routing Protocol(DCMP)*

The dynamic core-based multicast routing protocol (DCMP) [23] attempts to improve the efficiency of the ODMRP multicast protocol by reducing control overhead and providing better packet delivery ratio. Mesh-based protocols, such as ODMRP, suffer from the disadvantages:

1. ***Excessive data forwarding*:** Too many nodes become forwarding nodes, resulting in an excessive number of retransmissions of data packets. In ODMRP, all nodes on the shortest path between each source and each receiver become forwarding nodes, resulting in too many forwarding nodes.
2. ***High control overhead*:** In ODMRP, each source periodically floods its JoinReq packets and the mesh is reconstructed periodically. This leads to a heavy control overhead.

The primary advantage of DCMP [23] is its scalability due to decreased control overhead and its superior packet delivery ratio. The performance improvement of DCMP over ODMRP increases with the number of sources in the multicast group (though they start performing on par beyond a certain number of sources, when almost all nodes are part of the mesh). One of the drawbacks of DCMP is that the parameters associated with it, *MaxPassSize* and *MaxHop*, are likely to depend on the network load conditions, group size, and number of sources, and optimal values of these parameters may even vary from one node to another.

### *C. Forwarding Group Multicast Protocol(FGMP)*

Another mesh-based multicast routing protocol [13], which is also based on the forwarding group concept, is forwarding group multicast protocol (FGMP-RA [receiver advertising]). The major difference between ODMRP and FGMP-RA lies in who initiates the multicast group formation. ODMRP is a source-initiated multicast routing protocol, whereas FGMP (FGMP-RA) is a receiver-initiated multicast routing protocol. Due to its mesh topology and soft state maintenance scheme, it is more robust as compared to the tree-based multicast routing protocols.

### *D. Neighbor Supporting Ad Hoc Multicast Routing Protocol (NSMP)*

Neighbor supporting ad hoc multicast routing protocol (NSMP) [24] is a mesh-based multicast protocol which doe3s selective and localized forwarding of control packets. Like in ODMRP and FGMP, to initialize the mesh, the source floods the control message throughout the network. But for maintenance of the mesh, local route discovery is used, that is, only mesh nodes and multicast neighbor nodes forward the control message to refresh the routes. Multicast neighbour nodes are those nodes which are directly connected to at least one mesh node. Due to localized route discovery and maintenance, NSMP reduces control overhead while maintaining a high packet delivery ratio. It's joining policy, which is based on a weight parameter, makes it more efficient compared to the previous schemes. The value for the relative weight parameter may not be globally constant. It is likely to vary with different network load conditions.

### *E. Core-Assisted Mesh Protocol(CAMP)*

It is known that mesh-based multicast protocols deliver more data packets compared to tree-based multicast protocols, due to the existence of multiple paths between the source and receiver. But some of the existing mesh-based multicast protocols such as ODMRP and FGMP use the flooding approach to create and maintain the mesh topology, which results in reduced efficiency in bandwidth utilization. To eliminate flooding of control packets, core-assisted mesh

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protocol (CAMP) [14] uses core nodes in the mesh. The main improvement in CAMP is that it exhibits a high packet delivery ratio while keeping its total control overhead less, compared to other multicast routing protocols, by avoiding the flooding of control packets. Another drawback of CAMP is that it needs the support of a routing protocol that can work correctly in the presence of router failures and network partitions. As such, not all routing protocols are compatible with CAMP. Table 1 is shown in Appendix.

## VII. SUMMARY OF MULTICAST ROUTING PROTOCOLS

Table 1 summarizes the characteristics of the various multicast routing protocols for Ad Hoc Wireless Networks described so for. It helps in characterizing and identifying the qualitative behavior of multicasting protocols. However, a quantitative comparison study in terms of their performance under a wide range of parameters such as connectivity and size of the network, mobility of nodes, number of multicast sources, and multicast group size requires extensive analytical and / or simulation studies. The following table summarizes the Multicast topology, Initialization and different Maintenance approach.

## VIII. CONCLUSION

There is an increasing demand and a big challenge to design more scalable and reliable multicast protocol over a dynamic Ad Hoc Network (MANET). This paper presents a comprehensive survey on Efficient Multicast routing protocols namely BEMRP, MZRP, MCEDAR, ABAM, DDM, WBM, PLBM, MAODV, AMRIS, AMRoute, ODMRP, DCMP, FGMP, NSMP and CAMP which are used to achieve Group Communication. Working nature of various Multicast Routing Protocols with its relative merits and de-merits have been analyzed for improving the performance and to achieve Group Communication in an efficient manner. Substantial research efforts over the last decade have been focused on developing and implementing routing protocols and security techniques that better suited the nature of MANETs.

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## APPENDIX

**Fig. 1 Source-Initiated, Soft state Multicast Protocol**

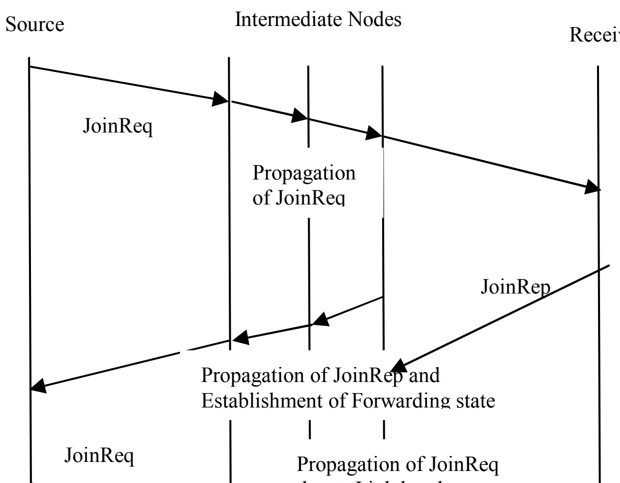

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**Fig.2.**

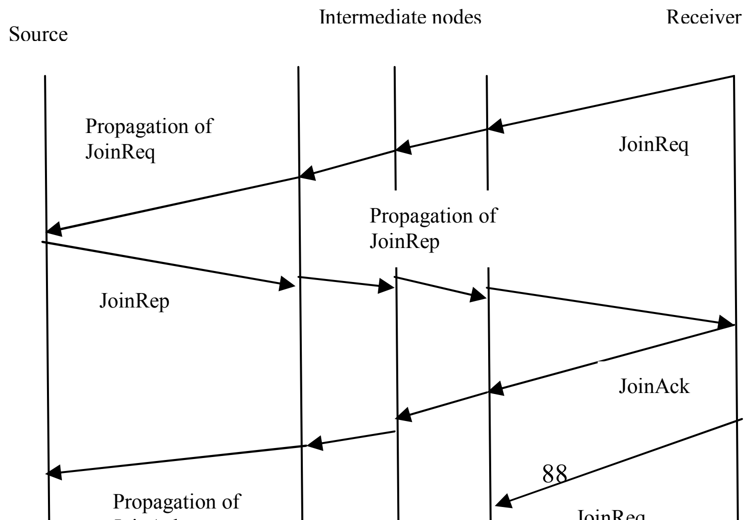

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**Fig.3. Architectural Framework of an Ad Hoc Multicast Protocol**

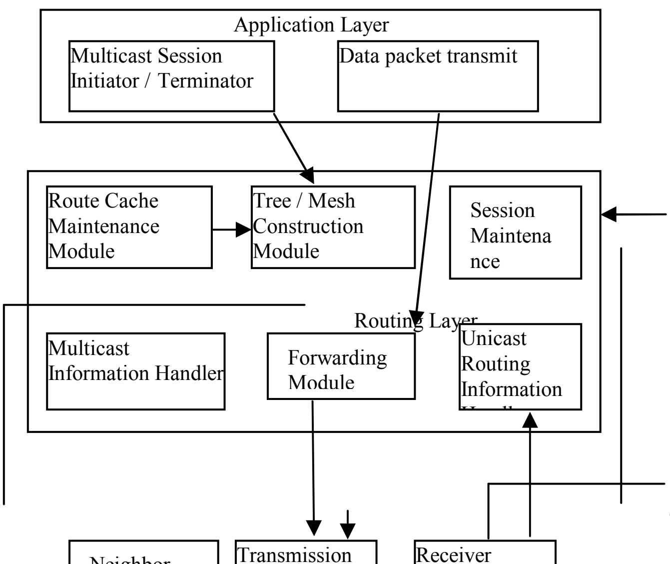

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**Table 1 .Summary of characteristics of the various multicast routing protocols**

| Multicast Protocols | Multicast Topology | Initialization | Maintenance Approach |
|---|---|---|---|
| ABAM | Source-tree | Source | Hard state |
| BEMRP | Source-tree | Receiver | Hard state |
| DDM | Source-tree | Receiver | Soft state |
| MCEDAR | Source-tree over Mesh | Source or Receiver | Hard state |
| MZRP | Source-tree | Source | Hard state |
| WBM | Source-tree | Receiver | Hard state |
| PLBM | Source-tree | Receiver | Hard state |
| MAODV | Source-tree | Receiver | Hard state |
| AMRIS | Shared-tree | Source | Hard state |
| AMRoute | Shared-tree over Mesh | Source or Receiver | Hard state |
| ODMRP | Mesh | Source | Soft state |
| DCMP | Mesh | Source | Soft state |
| FGMP | Mesh | Receiver | Soft state |
| CAMP | Mesh | Source or Receiver | Hard state |
| NSMP | Mesh | Source | Soft state |