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## A Concise Survey on Multicast Routing Protocols for MANETs

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**Abstract**— MANETs are treated to be an important network type in many disaster recovery applications. Nodes in MANETs are often self configuring without centralized infra structure and have limited power. Multicasting is a type of group communication in which group membership management is a crucial task. There are a number of multicast routing protocols which are categorized into two types: tree-based protocols and mesh-based protocols with proactive and reactive routing type. We explore these protocols and coin out the associated advantages and disadvantages. We have also suggested that where to use them in an excellent multicast routing protocols application.

**Keywords**— Mobile Ad Hoc Networks, Multicast Routing Protocols, Tree-Based Protocols, Mesh-Based Protocols

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### I. INTRODUCTION

A mobile ad hoc network (MANET) is a collection of easily deployable autonomous mobile nodes that communicate with each other over wireless links for short period of time. The word ad hoc refers to temporary. Nodes in MANETs will often undergo different topology due to the arbitrary movement of each node. Over the period of time a number of multicast protocols for ad hoc networks have been proposed. On the basis of the routing structure, they can broadly be classified into two main categories tree-based protocols and mesh-based protocols. A single path between any sender-receiver pair is existed in tree-based protocols. They are capable of producing high multicast efficiency. Even though they have high packet delivery ratio tree-based protocols are not fault tolerant against dynamic topology changes and the packet delivery ratio and lacks in reliability Mesh-based protocols are one of the types which provide alternative routes for lasting connectivity to group members. Because of these advantages the low packet delivery ratio problem caused by link failures can be compensated. Mesh-based protocols can yield very high robust to node mobility but cause low multicast efficiency.

In this paper, we have performed contemporary survey of multicast routing protocols for ad hoc networks. The performance comparison study of ad hoc multicast routing protocols is presented in paper [1]. The paper [2] introduces multicast protocols and discusses some ongoing directions whereas paper [3] carries out similar work to ours. In this survey we have compared these works with newly proposed

protocols. we have also narrated their merit and demerit according to context of application.

The rest of this paper is organized as follows. Terminology and background information are explained in section 2. Section 3 and Section 4 describes about tree-based protocols and mesh-based protocols, respectively. Features and Excellency possessed by multicast routing protocol have been dealt in section 5. Section 6 concludes the paper finally

### II. SENDER VS SOURCE INITIATED APPROACH:

Both senders and receivers of the group constitute a multicast group. To establish a connection between sender and receivers, each protocol constructs either a tree or a mesh as the routing structure. Some of nodes act as forwarding nodes in the routing structure, which are not interested in multicasting packets but act as intermediate routers to forward them to exact destination.. Group members forwarding nodes are also called tree or mesh nodes with respect to the routing structure. In the routing structure, a node can be an upstream or a downstream depends on the distance from the root of the tree. If the two nodes belong to the same link, the upstream/ downstream node is also called either the parent or child of the other node.

In a sender-tree based routing protocols sender initially floods a join message to all nodes in the network .Nodes which wants to become one of the participants of the group will reply to the sender via the reverse path. After all reply messages are arrived at the sender, a multicast tree rooted at the sender is formed. This kind of

tree construction is said to be a sender-tree-based one. A multicast group usually has several senders and thus it costs high for each sender to build its own tree. If protocols select a single sender to build a multicast tree that is shared with other senders then this kind of tree construction is called a shared-tree-based one and the selected sender is called the group leader or also called as core node. Once Group leader is selected other senders first transmit data packets to the group leader and the group leader then relays the packets downward the shared tree to all receivers. The kind of initialization of tree construction by one or more senders is called a sender-initiated scheme. The receiver-initiated scheme requires receivers to initiate the tree construction, and it is often used for the shared-tree structure.

Reconfiguration is often required in the routing structure because of node mobility. In a soft state type protocols broken link is identified by periodic flood packets issued by the group leader. New members can also use periodic flood packets to join the group. If a link failure is identified by a node on the link, this kind of protocol is called a hard-state one. Since no periodic flood packets are issued in hard-state protocols in these type new members usually join the group by using expanded ring searches. A group member usually wanted to leave the group sends a departure message to inform its parent. Besides link failures, node mobility may cause partition of the routing structure. Partition must be bound together successfully delivering data packets to all group members.

### III. TREE BASED MULTICAST ROUTING PROTOCOLS

The following section describes about the tree based multicasting protocol with pictorial representation and also advantages and disadvantages are discussed.

#### A. Maodv: Multicast Operation of the Ad-Hoc On-Demand Distance Vector Routing Protocol

MAODV [4] is an example for shared-tree-based protocol that is an extension of AODV [5] to support multicast routing. With the unicast route information of AODV, MAODV constructs the shared tree more efficiently and has low control overhead. In MAODV, the group leader is the first node joining the group and announces its existence by Group Hello message flooding. If any of the nodes within a multicast group has not sent a Hello message, each node

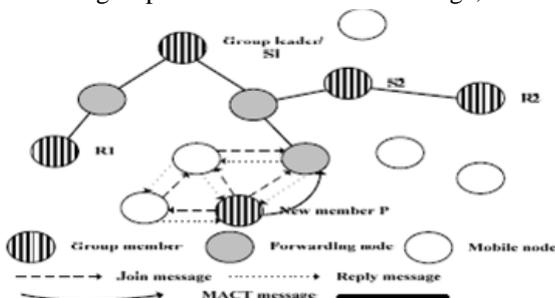


Figure 1. The joining procedure in MAODV

will broadcast a Hello message. The delay of Hello message indicates that the link between a node and its neighbor is broken. Then the node locally floods a join message towards the group leader. Because of node mobility the shared tree may be partitioned hence two or more group leader may co-exist. If that is the case a group member whose group leader has lower IP address than any other group leader will inform its leader to stop the leader role. Then node sends a message to claim the group leader which has highest IP address to be the new group leader of the final merged tree. The figure .1 one shows the working principles of MAODV.

#### B. AMRIS: Ad Hoc Multicast Routing Protocol Utilizing Increasing Id-numbers

AMRIS[5] is an on demand share –tree based protocols in which every nodes is assigned with multicast session –id-number dynamically. The special multicast root tree is called Sid, surrounding node id is increase. These id numerical valu is generated from Sid. By these id number a node can know which neighbors are closer to the Sid and this reduces the cost to repair link failur. The node called Sid floods a new-session message to all its neighbor with help of id-number. Each node receiving the new session message creates its own id=number. A new node wants to join the session sends a join message to one of its potential parent nodes. If the node is parent, it will reply a message otherwise join message is kept forwarded until a tree is found. If the link failur is occurred a node with large id-number takes care of repairing procedure. The figure. 2 depicts work model of AMIRS.

Advantages: The process of assigning a id-number is useful for constructing and maintaing a multicast tree group membership overhead is reduced.

Disadvantages: Due to lack of bandwidth constraints in MANETs, joining and rejoining of anomay consume large time. The usage of periodic beacons consumes

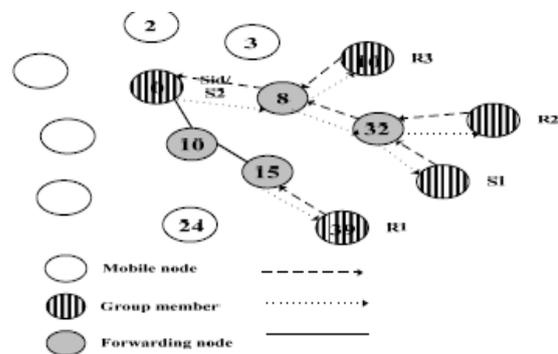


Figure 2. Joining Procedure in AMRIS

bandwidth.

#### C. BEMRP: Bandwidth-Efficient Multicast Routing Protocol

BEMRP[6] is sender tree based protocol which focuses on high multicast efficiency []. It

requires each new members to setup a branch with fewest new forwarding nodes being added to multicast tree. To detect and remove unnecessary forwarding nodes a route optimization technique is introduced. When a new node wants to join the group floods the message into network. The tree node response the joining request through shortest path between the node be joined and the route node. BEMRP uses two link repairing schemes namely local flooding and local re-joining schemes. In local flooding a separate multicast route recover packet is flooded locally. In later method a path is created using local flood using upstream direction. The figure 3 depicts the working methods of BEMRP.

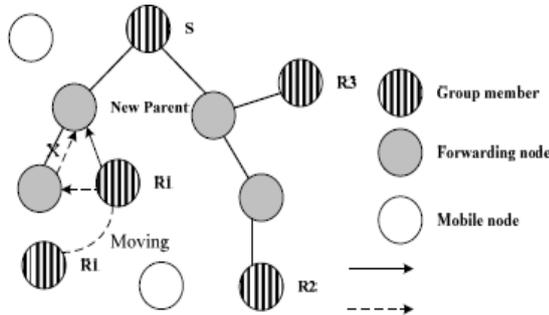


Figure 3. Route Optimization in BEMRP

Advantages: We can obtain higher multicast efficiency and capable of eliminating redundant part that meet to higher efficiency and lower packet transfer delay. It incurs low control over head .

Disadvantages: Joining and rejoining of a node take long time and consume high bandwidth. If a share link is failed receiver are affected.

#### IV. MESH –BASED MULTICAST ROUTING PROTOCOLS:

The following section describes about the Mesh based multicasting protocol with pictorial representation and also advantages and disadvantages are discussed.

##### A. ODMRP: On Demand Multicast Routing Protocol:

We need a protocol that capable enough to provide richer connectivity among group members at high mobility. It can be achieved through mesh based protocols like ODMRP[7]. A forwarding group concept is introduced in it to construct the mesh and mobility prediction scheme to refresh the mesh only at the time of necessity. With help of piggyback method , the first sender floods a join message. To achieve the updated information about the entire network, the join message is periodically flooded and get refreshed. An interested node will respond to join message. Multicast paths constructed by this sender are shared with other sender. The following figure .4 describes principles of ODMRP.

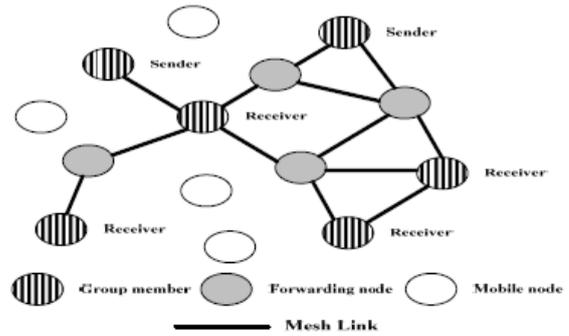


Figure 4. Multicast mesh in ODMRP

Advantages: 1. Most stable path is identified 2. Multicast path are shared.

Disadvantage 1. Control over head is extreme 2. The aid of GPS is necessary.

##### B. DCMP : A dynamic Core Based Multicast Routing Protocols:

We perceived a bit more control over head in ODMRP. With an aim at minimizing the high control over head problem in ODMRP . DCMP [13] is introduced with different category of sender. Each one performs its own specific task in group membership management. They are namely active senders, core sender and passive senders. Active sender propagate join message at regular intervals. Core sender act as one of the active senders for one or more passive senders. A paasive sender takes responsibility to forward its data packet. Active and core senders take responsibility to construct a refresh the mesh. The working principles is displayed in figure .5.

Advantages 1. Minimized control overhead 2. High

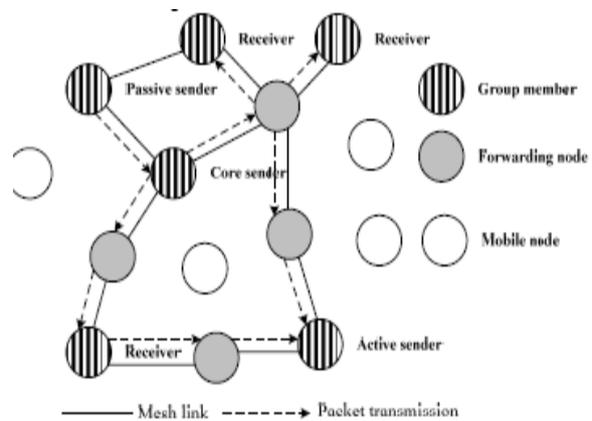


Figure 5. Packet Transmission Path in DCMP

packet delivery ratio.

Disadvantages 1. Path stability is decreased 2. If core node failure, many passive sender suffer.

##### C. ACMRP Adaptive Core Multicast Routing Protocols:

It is well known that mesh type routing protocols provide high packet delivery ratio. ACMRP[9] is as such one, it has a core node to take care of mesh creation and updation. The failures such as link failure, node failure are handled by core nodes, Very first core node initiates group construction process by flooding join messages. Interested nodes will reply JREP messages to core node . sometimes many forwarding nodes takes responsibility to forward JREP messages . Packets are encapsulated in ACMRP. The figure .6 depicts the working principles of ACMRP. Advantages : 1. It incurs low control overhead 2. Over all performance is improved. Disadvantages ; 1. Every node has the ability to encapsulate an decapsulate data packet. 2. Hop count calculation leads to tedious process

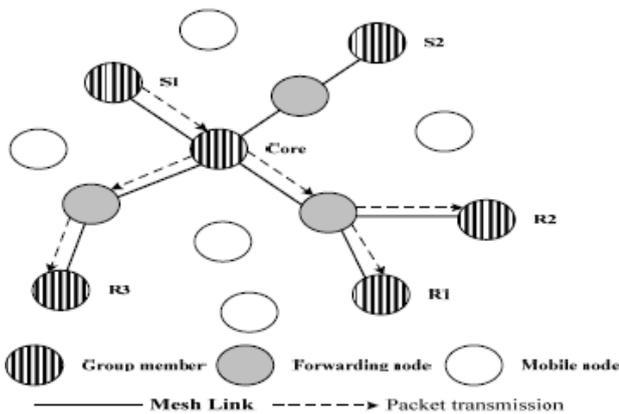


Figure 6. Packet Transmission Path in ACMRP

V. ROBUST AND SCALABLE GEOGRAPHIC MULTICAST PROTOCOL (RSGM).

RSGM[10] protocols uses GPS system to construct several virtual architectures for maintaining state information .This achieves high robust and scalable membership management and packet forwarding in the presence of high network dynamics due to unstable wireless channels and node movements. Specifically, scalable and efficient group membership management is performed through a virtual-zone-based structure, and the location service for group members is integrated with the membership management. Both the control messages and data packets are forwarded along efficient tree-like paths, but there is no need to explicitly create and actively maintain a tree structure.

The stateless virtual-tree-based structures significantly reduce the tree management overhead, support more efficient transmissions, and make the transmissions much more robust to dynamics. Geographic forwarding is used to achieve further scalability and robustness. To avoid periodic flooding of the source information throughout the network, an efficient source tracking mechanism is designed. Furthermore, It handles the empty-zone problem faced by most zone-based routing protocols. We have studied the protocol performance by performing both quantitative analysis and extensive simulations. Our results demonstrate that RSGM can scale to a large

group size and a large network size, and can more efficiently support multiple multicast groups in the network. Compared to existing protocols ODMRP and SPBM, RSGM achieves a significantly higher delivery ratio under all circumstances, with different moving speeds, node densities, group sizes, number of groups, and network sizes. RSGM also has the minimum control overhead and joining delay .The figure 7 explains about RSGM

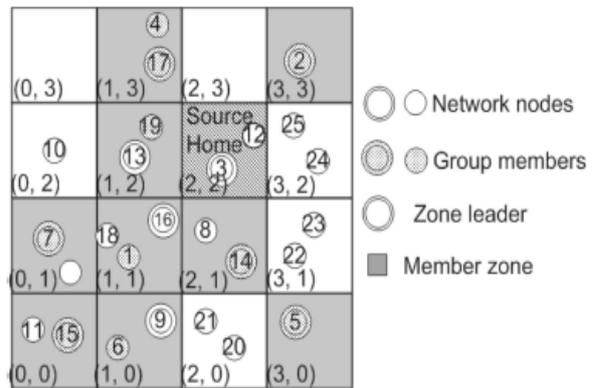


Figure .7 Virtual Architecture used in RSGM

VI. RELIABLE MULTICAST ROUTING PROTOCOLS:

In ad-hoc network environment, every link is wireless and every node is mobile. Those features cause increased loss easily, unreliable as well as multicasting inefficient. It is a major challenge to transmission delays and packet losses due to link changes of a multicast tree at the provision of high delivery ratio for each packet transmission. Reliable multicast routing protocol becomes a very challenging research problem for MANETs. The design of reliable multicast depends on the following three decisions: (1) By whom errors are detected; (2) How error messages are signaled and (3) How missing packets are retransmitted. These protocols have different design principles and operational features in addressing the reliability issue. Other protocols opt for another set of properties while some protocols favor one set of features. The reliable multicast protocols can be classified into the following four types: Sender-initiated, where all receivers send ACKs for each packet that they receive; Receiver-initiated, where the receivers send NACKs on detection of transmission error or packet loss; Ring-based, where receivers are organized in a logical ring and receivers take turns to acknowledge the packets received to ensure reliability; and Tree-based, where receivers are organized into subgroups to relieve the sender by processing all control messages from all receivers. The Reliable Adaptive Multicast Protocol (RAM)[11] and the Reliable On-demand Routing Protocol ROR[12] are examples for reliable multicast

VII. DISCUSSION

In this section we discussed the features that a multicast routing protocol should consider and point out directions for designing the protocol. Basically, the design should take three issues into consideration: robustness, multicast efficiency, and control overhead. If the protocols designed is not able to correct the link failure the problem persists. The mesh structure is very appropriate to be the multicast routing structure. A mesh that is built and maintained by only one core node is robust to low mobility and can avoid duplicate transmissions. Moreover, the number of forwarding nodes in this kind of mesh is limited such that some degree of multicast efficiency is ensured. However, this sort of mesh may not be robust enough to high mobility. An excellent mesh-based protocol should be designed with the connectivity adapted to the degree of mobility.

Since the mesh is constructed and refreshed by one core node, the position of the core node affects the efficiency of the mesh. If the core node is located far away from other group members, multicast efficiency is reduced and longer paths increase the probability of link failures. Therefore, it is important to select a new core located in a better position periodically. How to devise an efficient core migration scheme with low overhead is a crucial issue. The periodic reelection of the core node results in regular flooding of control messages, so the frequency of flooding needs to be further studied.

The soft-state maintenance should be used only for refreshing the mesh; while the hard-state one should be used for repairing broken links. General multicast protocols often provide shortest paths between senders and receivers. Although shortest paths have low data delivery latency and low probabilities of link failures, they reduce multicast efficiency. Hence, the protocol should strike a balance between multicast efficiency and path lengths. At last, a mesh may be partitioned because of node movement. Several protocols merge separated meshes by requiring the core node with highest IP address (or other criteria) to be the new core of the merged mesh. This merging procedure is inefficient and time-consuming. In our opinion, it is better for one of the group members that detect more than one mesh existing to be the new core node. This is because that these members are located in the middle of of these separated meshes.

### VIII. CONCLUSIONS

In this paper, we have reviewed a few very important multicast routing protocols designed for MANETs. We classify all multicast routing protocols into two categories: tree-based protocols and mesh-based protocols. For each protocol, we summarize the properties, describe the operation, and list the strengths and weaknesses. Then, we suggest directions for the design of a novel protocol. We focus only on general multicast routing protocols for ad hoc networks in this paper. There are other multicast routing protocols that aim at providing reliability, QoS guarantees, security, and so on. We plan to investigate these protocols and make our survey more complete in our future work.

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