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Application-Independent Based Multicast Routing Protocols in Mobile Ad hoc Network (MANET)

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Abstract
Multicasting is an efficient communication service for supporting multipoint applications. The main goal of most ad hoc multicast protocols is to build and maintain a multicast tree or mesh in the face of a mobile environment, with fast reactions to network changes so that the packet loss is minimized. The topology of a wireless mobile network can be very dynamic, and hence the maintenance of a connected multicast routing tree may cause large overhead. To avoid this, a different approach based on meshes has been proposed. Meshes are more suitable for dynamic environments because they support more connectivity than trees; thus they support multicast trees. In multicast routing protocols many type of risk are involve like rushing, black hole, jellyfish attacks. Many features improve the performance of multicast routing protocol robustness, efficiency, control overhead .in this article mainly focus on application independent based multicast routing protocols, features, and comparison of multicast routing protocols.

Keywords: Ad hoc Network, CAMP, ODMRP, AMRIS, MAODV etc.

1 Introduction

Mobile ad hoc networks (MANETs) [1, 2] have many practical applications, such as emergency and relief operations, military exercises and combat situations, and conference or classroom meetings. Each of these applications can potentially involve different scenarios, with movement pattern, density, and traffic rate dependent on the environment and the nature of the interactions among the participants in a search-and-rescue operation, individuals may fan out to search a wide area, resulting in a fairly regular pattern of movement, low density, and a low traffic rate. In a battlefield scenario, the movements of soldiers may be heavily influenced by the movements of their commander, with higher density and a higher traffic rate. In many other cases, the environment itself may give rise to movement patterns and density such as patrons visiting an exhibit hall and moving among a selected group of displays. In addition, depending upon the communication need, applications can be very demanding, requiring the system to support very high traffic rates. To enable group communication in these scenarios, a number of ad hoc network routing protocols have been proposed. In wireless mobile network can be very dynamic, and hence the Maintenance of a connected multicast routing tree may cause large overhead. To avoid this, a different approach based on meshes has been proposed. Meshes are more suitable for dynamic environments because they support more connectivity than trees; thus they support multicast trees. There are two types of mesh based multicast routing protocols Core-Assisted Mesh Protocol (CAMP) [5, 9] and the On-Demand Multicast Routing Protocol (ODMRP) [3, 8]. These protocols build routing meshes to disseminate multicast packets within groups. The difference is that ODMRP [3, 8] uses flooding to build the mesh, whereas CAMP [5, 9] uses one or more nodes to assist in building the mesh, instead of flooding in independent multicast routing protocols in mobile ad hoc networks.

1.1 Attacks on Multicast Routing Protocols [3, 7]

- **Rushing attack:** which use the duplicate suppression mechanism in their operations, are vulnerable to rushing attacks? When source nodes flood the network with route discovery packets to find routes to the destinations, each intermediate node processes only the first non duplicate packet and discards any duplicate packets that arrive at a later time. Rushing attackers, by skipping some of the routing processes, can quickly forward these packets and be able to gain access to the forwarding group.
- **Black hole attack:** Firstly a black hole attacker needs to invade into the forwarding group by implementing a rushing attack, to route data packets for some destination to itself. Then, instead of doing the forwarding task, the attacker simply drops all of the data packets it receives. It gives very low packet delivery ratio.
- **Neighbor attack:** Upon receiving a packet, an intermediate node records its ID in the packet before forwarding the packet to the next node. However, if an attacker simply forwards the packet without recording

its ID in the packet, it makes two nodes that are not within the communication range of each other believe that they are neighbors one hop away from each other resulting in a disrupted route.

- **Jellyfish attack:** A jellyfish attacker first needs to intrude into the forwarding group and then it delays data packets unnecessarily for some amount of time before forwarding them. Provides significantly high end-to-end delay and delay jitter, and thus degrades the performance of real-time applications.

1.2 Issues in Designing a Multicast Routing Protocol [1, 2, 7]

Many unique characteristics of MANETs have posed new challenges in multicast routing protocol design like dynamic network topology, energy constraints, lack of network scalability and a centralized entity, and the different characteristics between wireless links and wired links such as limited bandwidth and poor security.

- **Robustness**: Because nodes will be moving, link failures are common in MANETs. Data sent by a source may be dropped, which results in a low packet delivery ratio. Hence, a multicast routing protocol should be robust enough to withstand the mobility of nodes and achieve a high packet delivery ratio.
- **Efficiency**: In an ad hoc network environment, where the bandwidth is scarce, the efficiency of the multicast routing protocol is very important. "Multicast efficiency" is defined as the ratio of the total number of data packets received by the receivers to the total number of data and control packets transmitted in the network.
- **Control overhead:** To keep track of the members in a multicast group, the exchange of control packets is required. This consumes a considerable amount of bandwidth. Because bandwidth is limited in ad hoc networks, the design of a multicast protocol should ensure that the total number of control packets transmitted for maintaining the multicast group is kept to a minimum.
- **Quality of service**: dynamic network topology, make it difficult to perform efficient resource utilization or to execute critical real-time applications in such environments. to effectively control the total traffic that can flow into the network. QoS multicast routing is a routing mechanism under which paths for flows are determined according to resource availability in the network as well as the QoS requirement of flows. QoS multicast routing means that it selects routes with sufficient resources for the requested QoS parameters. The goal of QoS multicast routing has two points. The first one is to meet the QoS requirements for each admitted connection, and the second one is to achieve global efficiency in resource utilization. Thus, QoS routing will consider multiple constraints and provide better load balance by allocating traffic on different paths, subject to the QoS requirement of different traffic.
- **Dependency on the unicast routing protocol**: If a multicast routing protocol needs the support of a particular routing protocol, then it is difficult for the multicast protocol to work in heterogeneous networks. Hence, it is Desirable if the multicast routing protocol is independent of any specific unicast routing protocol.
- **Resource management**: Ad hoc networks consist of a group of mobile nodes, with each node having limited battery power and memory. An ad hoc multicast routing protocol should use minimum power by reducing the number of packet transmissions. To reduce memory usage, it should use minimum state information.

2 Architecture of Reference Model Multicast Routing Protocols [1]: reference model architecture of multicast routing protocols can be divided into three layers.

- **Medium access control (MAC) layer [1]**: MAC provides transmission and reception of packets in this reference model architecture of multicast routing protocols. Mac protocols might maintain multicast state information based on the past transmissions observed on the channel with receiver modules scheduling dependent on that state.mac layer handler modules maintains a lists of all neighbor nodes in reference model architectures.

- **Routing layer [1, 2]:** Routing layer responsible for forming and maintaining the unicast session or multicast group. multicast services provides to application layer functions to join/leave a multicast group and to transmit/receive multicast packets and involves many modules for operate in routing layer such as forwarding modules packet should be broadcast or forwarded to a neighbor node, or sent to the application layer, tree/mess construction modules to construct multicast topology to handle the unicast routing information, session maintenances modules to maintenance the multicast And unicast routing tables to perform search for node in order to restore the multcast topology and repair the route when link break by the lower layer, and route cache maintenance module to use when route cache is updated as newer information obtained from the more recent packets heard on the channel. This modules increase efficiency by reducing the control overhead.

- **Application layer [1, 2]**: Application layer utilizes the services of the routing layer to satisfy the multicast requirements of applications. it consists of two modules such as data packet transmit /receive controller and

multicast session initiator /terminator these modules have some actions like joining a group, data packet propagation and route repair modules.

3 Classification of Multicast Routing Protocols

Multicast routing protocols for MANETs can be broadly classified into two types: application-independent and application-dependent multicast protocols. In this article only discuss Application-independent multicast protocols can be classified as follows. Based on multicast topology, ad hoc multicast routing can be classified into two types: tree based [1, 2] and mesh based multicast [1, 2].

3.1 Tree-Based Multicast [1, 2]

Tree-based multicast is generally used in wired and infrastructure mobile networks (i.e., mobile networks with base stations) as well as in MANETs. The tree consists of a root node (r), three intermediate nodes (p, s, and t), seven member nodes of a multicast group, and ten tree links. A multicast packet is delivered from the root node r to seven group members. For node u, for instance, the packet transmission is relayed through two tree links, that is, from r to q and then q to u. This requires two transmissions and two receives. Now consider the last transmission from q to u. Even though all nodes within node q's radio transmission range can receive the multicast packet, only node u will receive the packet because the rest of the nodes are not addressed. To maintain the tree structure even when nodes move, group members periodically send Join Requests to the root node so that the multicast tree can be updated using the path information included in the Join Request messages. Joining a multicast group causes reports join messages to be periodically sent, whereas leaving a multicast group does not lead to any explicit action. The period must be carefully chosen to balance the overhead associated with the tree update and the delay caused by the tree not being updated in a timely fashion when nodes move. Depending on the number of trees per multicast group, a tree-based multicast can be further classified as a per-source tree multicast and shared tree multicast. Although a per source tree multicast is established and maintained for each source node of a multicast group, shared tree multicast utilizes a single shared tree for all multicast source nodes. In the per-source tree multicast, each multicast packet is forwarded along the most efficient path from the source node to each and every multicast group member, but this method incurs a lot of control overhead to maintain many trees. On the other hand, the shared tree multicast has lower control overhead because it maintains only a single tree for a multicast group and thus is more scalable.

3.2 Mesh-Based Multicast [1, 2]

Tree-based protocols, however, may not perform well in the presence of highly mobile nodes because multicast tree structure is fragile and needs to be frequently readjusted as the connectivity changes. A new approach unique to MANETs [1] is the mesh-based multicast. A mesh is different from a tree because each node in a mesh can have multiple parents. Using a single mesh structure spanning all multicast group members, multiple links exist and other links are immediately available when the primary link is broken due to node mobility. This avoids frequent network reconfigurations, which minimizes disruptions to ongoing multicast sessions and reduces the control overhead to reconstruct and maintain the network structure. Figure 3.2 a, b shows an e.g. of a mesh-based multicast. It includes six redundant links in addition to ten tree links. A multicast packet is broadcast within a multicast mesh. Thus, sending a packet from R to U involves three transmissions R, Q, U and fourteen receives 5 neighbors of R, 6 neighbors of Q, and 3 neighbors of U. For e.g. the transmission from node Q is received not only by U but also by neighbor nodes R, S, T, W, and X; the redundant link from Q to W may be Useful when the path from P to W is broken, as shown in Figure.3.2 (b).

3.3 Multicast Routing Protocols:

Multicast routing algorithms for mobile ad hoc networks can be classified into reactive routing and proactive routing in mobile ad hoc network. In source-rooted tree based multicast routing protocols, source nodes are roots of multicast trees and execute algorithm for distribution tree contraction and maintenance. This requires that a source must know the topology information and addresses of all its receivers in the multicast group. Therefore, source rooted tree based multicast routing protocols suffer from control traffic overhead when used for dynamic networks.

The Ad-hoc Multicast Routing (AMRoute) [6]

The Ad-hoc Multicast Routing (AMRoute) [6] is a tree based multicast routing protocol for mobile ad hoc networks to existence of an underlying unicast routing protocol. It has two main phases: mesh creation and tree creation. It is used for networks in which only a set of nodes supports AMRoute routing function, bi-directional unicast tunnels are

continuously created between pairs of group numbers that are close together. When send a packet to a logically adjacent member and physically sent on a unicast tunnel and may pass through many routers. AMRoute created a multicast distribution tree periodically for each multicast group based on the mesh links available. The group members forward and replicate multicast traffic along the branches of the virtual tree. Every receiver and sender of a group must explicitly join a multicast group and every group has at least one logical core that is responsible for member management and tree maintenance. The robustness comes from the virtual mesh links used to establish the multicast tree in AMRout and a core failure does not prevent data flow. It doesn't need to handle node mobility done by the unicast protocol and the non members do not need to support multicast. AMRoute is efficient by constructing a shared tree for each group.

The Ad hoc Multicast routing protocol utilizing Increasing id-numbers (AMRIS) [7]

The AMRIS [7] is a proactive shared tree based multicast routing protocol, which is independent of the underlying unicast routing protocol .The main feature of AMRIS to assinged session member id (msm-id) for each node in the multicast session a session. This msm-id provides a heuristic height and the ranking order of msm-id numbers directs the flow of datagrams in the multicast delivery tree. Each node calculates its msm-id during the initialization phase initiated by a special node called Sid. Generally, Sid is the source node which is used only one source for the session. Otherwise, source node will be minimum msm-id. The sid broadcasts a NEW_SESSION message to its all neighbors. The NEW_SESSION message comprises the Sid's msm-id, the multicast session id, and additionally, all nodes are required to broadcast beacons to its neighbors. A beacon contains the node id, msm-id, membership status, registered parent and child's ids and their msm-ids, and partition id. The tree maintenance procedure operates continuously and locally to ensure a node's connection to the multicast session delivery tree. If a node has not received any beacon message for a predefined interval of time, it is assumed that a link disconnection. In AMRIS, packets losses will when if a link in the tree breaks until the tree is reconfigured.

The On-Demand Multicast Routing Protocol (ODMRP) [3, 8]

The On-Demand Multicast Routing Protocol (ODMRP) [3, 8] is a reactive mesh based multicast routing protocol uses a forwarding group concept for multicast packet transmission; in each multicast group is associated with a forwarding group .The source manages the group membership, establishes and updates the multicast routes on demand or reactive unicast routing protocols have two main phases of ODMRP: the request phase and the reply phase. When a multicast source has a packet to send but it has no routing and group membership information, it floods a Join Request packet to the entire network. Join Request packets are member-advertising packets with piggybacked data payload adapt to node movements by utilizing mobility prediction [8] with the mobility prediction method; the protocol becomes more resilient to topology changes. Mobile nodes forward non-duplicated data packets if they are forwarding nodes. Since all forwarding nodes relay data, redundant paths when they exist are available for data packets delivery when the primary path is disconnected. ODMRP also operates as an efficient unicast routing protocol, and doesn't need support from another underlying unicast routing protocol.

The Core-Assisted Mesh protocol (CAMP) [5, 9]

The Core-Assisted Mesh protocol (CAMP) [5, 9] is a proactive or table driven multicast routing protocol based on shared meshes. The mesh structure provides at least one path from each source to each receiver in the multicast group in mesh. CAMP provides correct distances to all destinations within finite time relies. A Multicast Routing Table (MRT) is based on the Routing Table that contains the set of known groups. Moreover, all member nodes maintain a set of caches that contain previously seen data packet information and unacknowledged membership requests. CAMP can be divided into duplex or simplex members, or non-members nodes in the network. Duplex members, simplex members used respectively are full members of the multicast mesh; create one-way connections between sender only nodes and the rest of the multicast mesh. The core nodes used to limit the control traffic when receivers are joining multicast groups in which all traffic flows through core nodes. The creation and maintenance of meshes are main parts of Core Assisted Mesh Protocols.

The Multicast operation of Ad-hoc On-demand Distance Vector (MAODV) [4]

The Multicast operation of Ad-hoc On-demand Distance Vector (MAODV) is a reactive or on demand tree-based multicast routing protocol with an extension of the unicast routing protocol Ad-hoc On-demand Distance Vector (AODV). Every node maintains three tables, a Routing Table (RT), a Multicast Routing Table (MRT) and a Request Table. RT stores routing information and has the same function as in AODV. All nodes in the network maintain local connectivity by broadcasting "Hello" messages with TTL set to one by using multicast ad hoc on demand distance vector (MAODV) . Multicast Ad hoc on demand distance vector routing protocols provides better performance as compare to the ad hoc on demand distance vector routing protocols in mobile ad hoc networks.

Conclusion: in this paper we discuss the challenges of designing routing protocols in MANETs and main issues features to improve the performance of multicasting routing protocols over several attacks on multicast routing

protocols of mobile ad hoc networks. Routing is an essential component of communication protocols in mobile ad hoc networks to provide better performance over unicast routing protocols. Application independent multicast routing protocol control traffic overhead when used for dynamic networks. In this article mainly focus on Comparison multicast routing protocols for mobile ad hoc network to showing the performance of multicast routing protocols in mobile ad hoc network (MANET).

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Type of node	Active modules
Source/receiver	All modules
Intermediate nodes	All modules of the MAC layer and routing layer
Other nodes	Modules 2,3,8,optionally module 4

Table 1 active Modules in different nodes

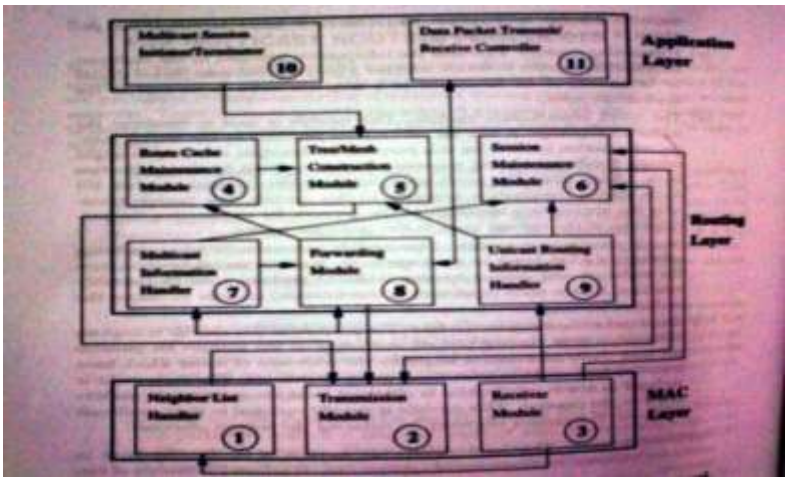

Figure 2.1 Architectural frameworks of ad hoc multicast protocols**.**

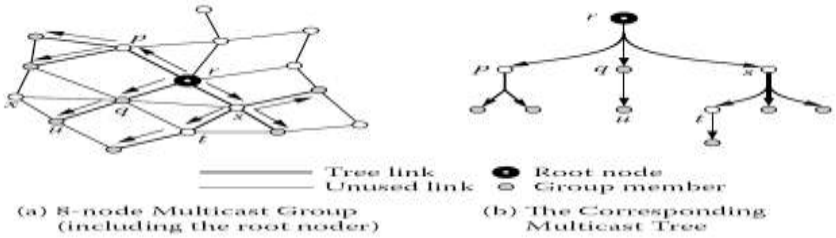

Figure.3.1 (a) and (b) shows multicast tree.

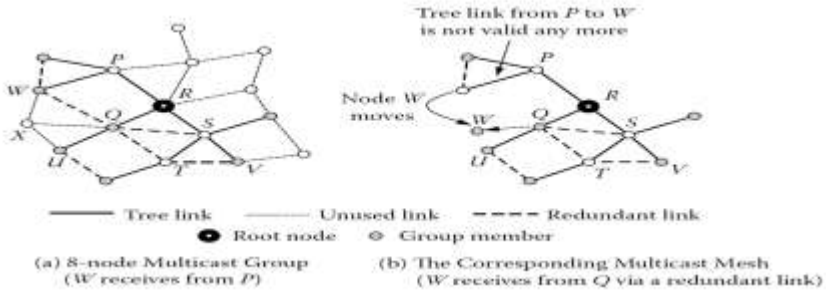

Figure 3.2 (a) and (b) Mesh Based Multicast

IV Comparison of various Applications Independent based Multicast Routing Protocols

Multicast Protocols	Multicast Topology	Initialization	Dependency	Maintenance Approach	Loop Free	Independent of Routing Protocols	Flooding of Control Packets	Group forwarding based	Core based	Periodic Control Messaging
MAODV	Shared tree	Receiver	Yes	No	Hard state	Yes	Yes	No	No	Yes
AMRIS	Shared tree	Source	Yes	No	Hard state	Yes	Yes	No	No	Yes
AMRoute	Shared tree over mesh	Source or receiver	No	No	Hard state	No	Yes	No	Yes	Yes
ODMRP	Mesh	Source	Yes	No	Soft state	Yes	Yes	Yes	No	Yes
CAMP	Mesh	Source	No	No	Hard state	Yes	No	No	Yes	No

Table 2 comparison of independent multicast routing protocols