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A Survey of Multicast Routing Protocols

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Abstract: A mobile ad hoc network (MANET) is a self-configuring infrastructure less network of mobile devices connected by wireless.A protocol manages group membership and controls the path that multicast data takes over the network. Examples of multicast routing protocols include Protocol Independent Multicast (PIM). There are lots of multicast routing protocols, some works with wired networks while the others with wireless networks, some protocols deals with both wired and wireless networks. But applying this concept in Mobile Ad Hoc networks (Manets) is a big challenge. The main aim of this paper is to explore the performance characteristics of multicast protocols.

Keywords: MANET, Tree-Based, Mesh-Based, Zone-Based, Hybrid-Based Multicast Routing Protocols

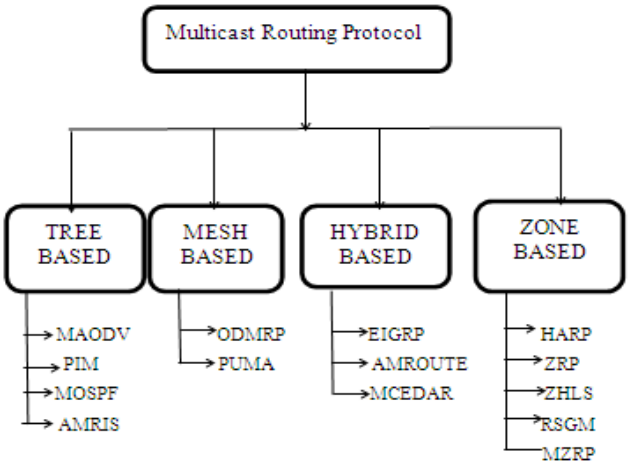
I . Introduction

A Mobile Adhoc Network (MANET) is a collection of autonomous mobile nodes that communicate with each other over wireless networks.Characteristics. The nodes of a mobile ad hoc network do not have a centralized mechanism, each node act as both host and router. That is it is autonomous in behavior. The nodes can join or leave the network at any time, making the network topology dynamic in nature. Mobile nodes are characterized with identical light weight features with similar responsibilities and capabilities and hence form a complete symmetric environment. Multicast is the delivery of a message or information to a group of destination computers simultaneously in a single transmission from the source. Characteristics-More efficient, reliable.

II. Classification of Multicast Routing Protocols

Based on the routing structure, the multicast routing protocols are classified into four types[4] as shown in the following figure.

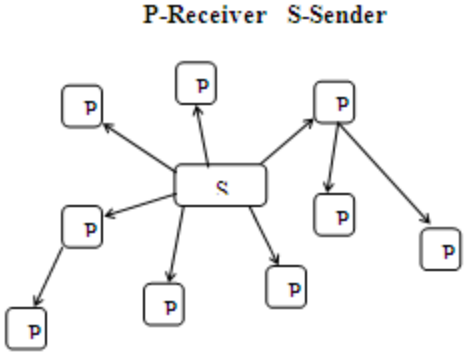
Fig 1: Classification of Multicast Routing Protocols



III. Tree Based Multicast Routing Protocols

A tree based multicast routing protocol establishes and maintains a shared routing tree to deliver data from a source to destination[1].

Fig 2: Tree Based Topology



a) MAODV

Multicast Ad-hoc On-Demand Distance Vector (MAODV) [5] is a multicastExtension of (Ad-hoc On-Demand Distance vector) AODV protocol. MAODV has the capability of unicasting and multicasting as well as broadcasting MAODV protocol can route information obtained when searching for multicast. When a node wishes to join a multicast group or it has data to send to the group but does not has a route to that group , it originates a route request (RREQ) message. Only the members of the multicast group respond to join RREQ. If an intermediate node receives a join RREQ for a multicast group of which it is not member or it receives a route RREQ and it does not have a route to that group. It rebroadcast the RREQ to its neighbours. But if the RREQ is not a join request any node of the multicast group may respond.

b) PIM

PIM is a multicast routing protocol that uses an existing unicast infrastructure. PIM refers to Protocol Independent because it uses routing information provided by other routing protocols such as the Border Gateway Protocol (BGP), Routing Information Protocol (RIP), Open Shortest Path First (OSPF) and Multicast Source Discovery protocol. PIM consists of a group of multicast routing protocols each of which is dedicated for a different environment. They include PIM Sparse Mode (PIM-SM) ,PIM Dense Mode (PIM-DM) ,PIM Source Specific Multicast (PIM-SSM) and Bidirectional PIM.In sparse mode few receiver at most of the location. State information is refreshed at the routers by periodic control messages.

c) MOSPF

Multicast Open Shortest Path First [3] is a multicast extension on OSPF (Open Shortest Path) protocol to provide efficient multicasting with in a network. IGMP (Internet Group Management Protocol) is used in MOSPF routers to examine membership in multicast group by broadcasting IGMP host

membership queries and receiving IGMP host membership reports. The group information is transmitted in the network by flooding of OSPF Link State Advertisement (LSA). This information is used by the routers to build the shortest path tree where source is the root and multicast receivers are leaf nodes. A separate shortest path is created for each source destination group pair. Compare to Distance Vector Multicast Routing Protocol (DVMRP), faster network convergence is provided by MOSPF.

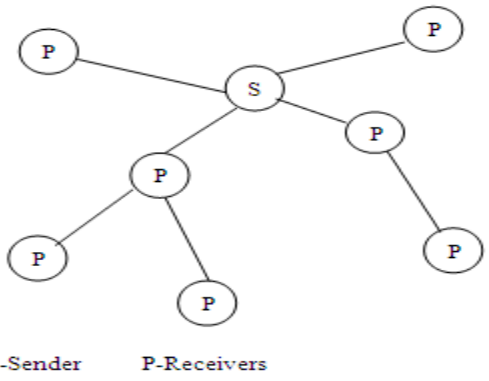
d) AMRIS

MAODV does not exhibit the limitations of AMRIS(Ad hoc Multicast Routing protocol)utilizing Increasing idnumber ,which rely on underlying unicast protocol.AMRIS is an on-demand protocol that constructs a sharedmulticast delivery tree to support multiple senders and receivers in a multicast session and shared tree formulticast data forwarding. Each node in the network is assigned amulticast session ID number. The ranking order of ID numbers isused to direct the flow of multicast data.

IV. MESH BASED MULTICAST ROUTING PROTOCOLS

Mesh based protocols provide multiple paths between sender and receivers[1]. The following figure shows the mesh based topology.

Fig 3: Mesh Based Topology



a) ODMRP

The On-Demand Multicast Routing Protocol (ODMRP) is an on-demand mesh based protocol where a mesh is formed by a group of nodes known as forwarding nodes. These nodes forward the data packets between the source and destinations and keep a message cache which helps in the detection of duplicate data and control packets. To maintain multicast group numbers a soft-state approach is used. Explicit control message are not required to leave the group. This protocol is more attractive in mobile wireless networks due to reduction of channel/storage overhead and the richer connectivity. This protocol establishes multicast routes and group membership which are added to source on-demand. Forwarding group is set of nodes which are in charge of forwarding multicast packets and also it supports shortest paths between any membered pairs. Altogether it seems best when compared to tree based protocols such as MAODV, PIM and MOSPF.

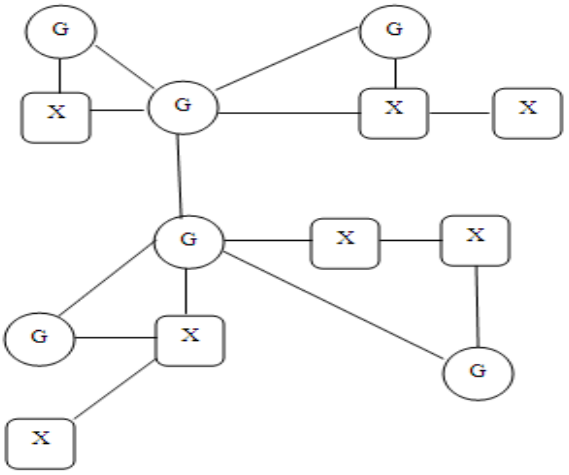
b) PUMA

Puma can act both as multicast protocol. It supports any of the source to send multicast packets addressed to a given multicast group. The election algorithm used here is similar to the spanning tree algorithm. It implements the distributed algorithm to elect one of the receivers as a coordinator of the group. The sender sends a packet along any of the shortest paths between the sender and coordinator of the group. When the data packet reaches a mesh member, it is flooded with in mesh and nodes maintain a packet ID cache to drop duplicate packets PUMA uses MAP (Multicast Announcement Packet) a single control message for all its functions.

V. HYBRID BASED MULTICAST ROUTING PROTOCOLS

The hybrid based multicast routing protocols inherits the properties of both tree and mesh based. The following figure shows the topology for hybrid based multicast routing protocols.

Fig 4: Hybrid Based Topology



Where, G=group member router, X=nonmember

a) EIGRP

An evolved version of IGRP addresses the demands of large-scale internetworks and the changes in network technology that have been developed since the implementation of IGRP. The QoS-supported IPTV channel state is defined by two types of video quality: high definition (HD) and standard definition (SD).

The IPTV QoS channel state can be represented by multicast tree symbol with QoSlevel .The is the multicast group joining to the specified source for watching channel no and is the shared multicast group joining to the common source with RP router for aggregated surfing channels. In other words, the watching channel set is delivered by source tree for HD quality stream. The surfing channel is delivered by RP shared tree for SD quality stream.

b) AMRoute

The ad hoc multicast routing protocol (AMRoute) presents a novel approach for robust IP multicast in mobile ad hoc networks by exploiting user-multicast trees and dynamic logical cores. It creates a bidirectional shared tree for data distribution using only group senders and receivers as tree nodes. Unicast tunnels are used as tree links to connect neighbors on the user-multicast treeThus AMRouter does not need to track network dynamics; AMRouter does not require a specific unicast routing protocol. AMRoute protocol enables the use of IP Multicast in MANETs. It emphasizes robustness

even with rapidly changing membership or highly dynamic networks; It does not attempt to provide the absolute minimum bandwidth or latency guarantees in a given topology.

Two key features of AMRoute protocol that make it robust and efficient in MANETs are:

i). User-multicast trees, where replication and forwarding is only performed by group members over unicast tunnels.

ii). Dynamic migration core node according to group membership and network connectivity

c) MCEDAR

MCEDAR is an extension to CEDAR architecture and provides the robustness of mesh based routing protocols and approximates the efficiency of tree based forwarding protocols. It decouples the control infrastructure from the actual data forwarding infrastructure. The decoupling allows for a very minimalistic and low overhead control infrastructure while still enabling very efficient data forwarding.

MCEDAR multicast routing protocol address both the issues of robustness and efficiency in one framework. It has following key design goals:

- To support the robustness of a mesh based routing protocol
- To provide the efficiency of a tree based forwarding protocol
- To decouple the control and data forwarding infrastructures
- To support mechanisms for efficient joins, leaves and pruning

Essentially, MCEDAR uses two of CEDAR components, namely Core and the core broadcast. The infrastructure for a multicast group resides entirely within the core and the core broadcast mechanism is used to perform data forwarding on the infrastructure.

VI. ZONE BASED ROUTING PROTOCOLS

a) ZONE ROUTING PROTOCOL (ZRP)

It's a hybrid routing protocol in wireless network. It's both reactive and proactive routing protocols. Protocol is designed to speed up delivery and reduce process by selecting the efficient type protocol throughout the network. If a packet destination is same as the origin zone, the proactive protocol in routing table is used to deliver packets. If route extends outside the origin a reactive protocol checks the successive zone inside that zone. These reduce the processing overhead for those routes. Once the zone is conformed that it is used to deliver the packets through route listing table. Packets delivered to nodes outside the sending zone avoid the overhead of checking routing tables in reactive protocol to check the destination node.ZRP reduces the control overhead for longer routes necessary for using proactive routing protocols throughout the entire route.

b) ZONE BASED HIERARCHICAL LINK STATE ROUTING PROTOCOL (ZHLS)

Zone-based Hierarchical Link State routing is a hybrid routing protocol. In ZHLS, mobile nodes are assumed to know their physical locations with assistance from a locating system like GPS. The network is divided into non-overlapping zones based on geographical information. ZHLS uses a hierarchical addressing scheme that contains zone ID and node ID A two-level network topology structure is defined in ZHLS, the node level topology and the zone level topology. Respectively, there are two kinds of link state updates, the node level LSP (Link State Packet) and the zone level LSP. A node level LSP contains the node IDs of its neighbours in the same zone and the zone IDs of all other zones.

A node broadcast its node level LSP to all other nodes in the same zone. Therefore, through periodic node level LSP exchanges, all nodes in a zone keep identical node level link state information. In ZHLS, gateway nodes broadcast the zone LSP throughout the network whenever a virtual link is broken or created. Every node knows the current zone level topology of the network. Before sending packets, a source firstly checks its intra zone routing table. If the destination is in the same zone as the source, the routing information is already there

c) DENSE MULTICAST ZONE ROUTING PROTOCOL (DMZ)

It based on adaptive mesh structures. It uses dense zone approach. A high concentration of multicast members in the specific place in the network, each dense zone has a connection to the multicast group. There are special nodes in the multicast group placed on the upper level named leader's node. This approach provides more robustness and scalability for multicast data transmission in ad-hoc networks.

d) ROBUST AND SCALABLE GEOGRAPHIC MULTICAST PROTOCOL (RSGM)

It is based a two-tier membership management and forwarding structure. At the lower tier, a zone structure is built based on position information and a leader is elected on demand when zone group members are present. A leader manages the group membership and collects the positions of the member nodes in its zone. At the upper tier, the leaders of the member zones report the zone membership to the sources directly along a virtual reverse-tree-based structure. If a leader is unaware of the position or addresses of the source, it could obtain the information from the Source Home. With the knowledge of the member zones, a source forwards data packets to the zones that have group members along the virtual tree rooted at the source. After the packets arrive at a member zone, the leader of the zone will further forward the packets to the local members in the zone along the virtual tree rooted at the leader. It is assumed that every node is aware of its own position. The forwarding of data packets and most control messages is based on a geographical unicast routing protocol. A zone ID will help the node to locate a zone. Zone leaders are elected to avoid unnecessary management overhead. When a member moves in to a new zone, if the leader is unknown it floods query messages to its neighbour nodes in the zone. In case two leaders exist in a zone, e.g., due to the slight time difference of leader queries and announcements, the one with the larger ID will win and be selected as the leader.

e) MULTICAST ZONE ROUTING PROTOCOL (MZRP)

It is a source-initiated multicast protocol that combines reactive and proactive routing approaches. Every node has a routing zone. A proactive approach is used inside this zone and a reactive approach is used across zones. First, a source node constructs a multicast tree inside its routing zone, and then it tries to extend the tree outside the zone (the entire network). A node (which is already a multicast forwarding node for that group), wishing to join a multicast group, changes its status from multicast forwarding node to multicast group member. Any other node sends a multicast route request (MRREQ) message. There are two kinds of MRREQ, unicast or broadcast based on the information in the source node. If the source node has a valid route to any node on the tree and it

wants to join that group, it sends a unicast MRREQ along the route to the multicast tree and waits for a multicast route reply, MRREP.

When the bordercast MRREQ reaches the peripheral nodes, they will check whether or not they have a valid route to that multicast group or group leader. If so, they will send unicast MRREQs instead of bordercast MRREQs and wait for the MRREPs. Otherwise, bordercast MRREQs will be sent via the bordercast tree of the peripheral nodes, and so forth. Reverse paths will be established among the intermediate nodes. When a destination node receives an MRREQ for a multicast group, and if it is a multicast tree member of that multicast group, it will send an MRREP to the source and wait for the multicast route activation MRACT message from the source node to activate the new branch of the multicast tree. The MRREP is sent to the source along the reverse path.

VII. CONCLUSION

MANET has many classifications depends on various criteria.Multicast protocols are more efficient and the communication is reliable when compared to multicast protocols. The research in routing protocols is very important with many parameters like Power control, Routing, Qos and Security and the other parameters are throughput,packet delivery ratio and end to end delay.

These multicast protocols are distinct based routing protocols including tree,mesh,zone and hybrid.Each includes its own scalable performance difference in routing. So this study gives base for research on multicast routing sprotocols.

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