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Study of Tree-Based Multicast Routing Protocol MAODV and Improvement of Multicast Routing in MANET

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ABSTRACT

A mobile ad hoc network (MANET), it is a self – organizing collection of mobile nodes that form a temporary and dynamic wireless network without a fixed networking infrastructure. Multicast routing protocols play an important role in MANET. Multicast routing protocols in mobile ad-hoc networks (MANETs) are emerging for wireless group communication which includes application which made the analytical design development of the MANETs in a very efficiency manner. Implementing multicast routing protocols to MANETs leads to improve the consumption of bandwidth, improving the efficiency and reducing the cost of communication in the network. In this paper we study the MAODV (Mobile Ad-Hoc on Demand Distance Vector) protocol and the effect of network load on MAODV protocol and an optimized protocol MAODV-BB propose the robustness of the MAODV protocol improved by the combination of advantages of tree structure with the mesh structure. MAODV-BB protocol improves the network performance over conventional MAODV in heavy load ad- hoc networks. It updates shorter tree branches and also builds a multicast tree with backup branches.

Keyword - Multicast routing, tree structure, backup branch, MAODV.

I. INTRODUCTION

A Mobile Ad-hoc-network (MANET) plays an important role in the communication network. A Mobile Ad -hoc Network is a collection of mobile nodes that form a wireless network and communicates to other nodes without the use of any preplanned network. Nodes communication done via multihop wireless links and the nodes move randomly. If two mobile nodes want to communicate with each other, but the nodes are not in direct communication range, then the data packets are forwarded through other nodes. MANETs are useful in many environments and don't need any infrastructure support. Sending multiple copies of packet to different nodes is called multicasting. Multicast is an efficient way to transmit packets from one point to multi points or multi points to multi points, which can reduce the consumptions of network bandwidth and host power by sending the same data to multiple recipients. Multicast routing plays a substantial role in MANET.MANET as shown in Fig.1

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Fig.1 MANET

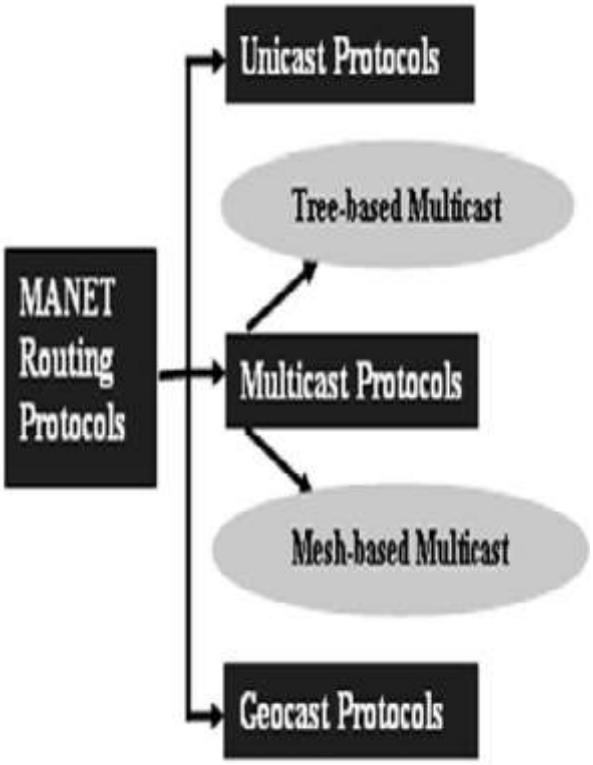

Fig.2 Classification of MANET Routing Protocols

Based on the structure used for data delivery, most of the existing multicast routing protocols can broadly be classified into two categories: tree-based and mesh-based protocols. In tree based multicast routing protocols, only one route exists between a source and a destination and hence these protocols are efficient in terms of the number of link transmissions. In contrast with tree-based protocols, the mesh-based multicast routing protocols multiple route exist between the source node and each of the receivers of the multicast group. Tree -based protocols have the advantage of high multicast efficiency. Mesh-based protocols provide redundant routes for maintaining connectivity to group members. MANET routing protocols as shown in Fig.2.

In this paper, we study a tree-based multicast routing protocol MAODV and propose an optimized protocol MAODV-BB (Backup Branches) to improve the performance of MAODV in heavy load ad hoc networks. MAODV-BB is to make use of GRPH (Group- hello) messages that the group leader broadcast periodically to update shorter tree branches. It also constructs a multicast tree with backup branches. The shorter branches reduce the resource occupied and the existence of backup branches avoids large numbers of tree reconstruction. It also enhances the robustness of the protocol. The improved protocol ensures high packet delivery ratio and low end- to- end delay.

A. Characteristics of MANET

Some main characteristics of MANET are discussed below:

1) *Dynamic Topologies:* Nodes are free to move arbitrarily, thus the network topology may change randomly and rapidly at unpredictable times, and may consist of both bidirectional and unidirectional links.
2) *Infrastructure Less:* MANET is an infrastructure system which has no central server, or specialized hardware and fixed routers.
3) *Multi Hop Routing:* When a node tries to send information to other nodes which is out of its communication range, the packet should be forwarded via one or more intermediate nodes.
4) *Autonomous Terminal:* In MANET, each mobile node is an independent node, which could function as both a host and a router.
5) *Energy- Constrained Operation:* Some or all of the nodes in MANET may relay on batteries or other exhaustible means for their energy. For those nodes, the most important system design criteria for optimization may be energy conservation.
6) *Security Threats:* Mobile wireless network are more prone to physical security threats than fixed cable net.

B. Applications of MANET

MANET is used in following areas:

1) *Military Battlefield:* In the battlefield it is needed by soldiers for relaying information related to situational awareness.
2) *Sensor Networks:* Another application of MANETs is sensor networks. These can be used to detect any number properties of an area. Examples include temperature, pressure, toxins etc.
3) *Disaster Area Network:* Ad hoc can be used in emergency/rescue operations for disaster relief efforts, e.g.in fire, flood, or earthquake.
4) *Personal Area Network:* Personal area networks (PANs) are formed between various mobile devices mainly in an ad- hoc manner, e.g. for creating a home network.

C. Advantages of MANET

The following are the advantages of MANET

1) Less expensive as compared to wired network.
2) They are robust due to decentralize administration.
3) Improved flexibility.
4) These networks can be set up at any place and time.
5) They provide access to information and services regardless of geographic position.
6) Self –configuring network, nodes are also act as a routers.

II. MAODV PROTOCOL

MAODV is the multicast extended routing protocol of AODV.MAODV (Multicast Ad hoc On-demand Distance Vector) is an on-demand routing protocol based on distance vector, which is recommended by IETF MANET.MAODV used for multicast traffic means that it send out multicast data packets. MAODV maintains a shared tree for each multicast group, consisting of only receivers and relays. A multicast group usually has several senders and thus its cost high for each sender to build its own tree. Some protocols select a single sender to build a multicast tree that is shared with other senders. This kind of tree construction is called a shared tree-based one and the selected sender is called group leader. In this section we give a brief description of route mechanism in MAODV and the impact of network load on the MAODV protocol.

A. Route Mechanism

MAODV is a routing protocol designed for ad hoc networks. MAODV has the capability of unicasting and multicasting as well as broadcasting. MAODV protocol can be route information obtained when searching for multicast; it can also increase unicast routing knowledge and vice versa. MAODV protocol constructs a shared delivery tree to support multiple senders and receivers in multicast. The route mechanism in MAODV consists of route establishments and route maintenances.

As a tree- based multicast routing protocol, MAODV discover the routing path and establishes the multicast tree. When a source node wishes to join a multicast group, or it has data to send to the group, it will originate a route request (RREQ) message. Only the members of the multicast group respond to join RREQ. If an intermediate node receives a join RREQ message for a multicast group of which it is not member or it receives a route request it does not have a route to that group. It rebroadcast the RREQ message to its neighbors. After receiving a RREQ message, the member of multicast reply a route reply (RREP) message to setup a forward path. If the source node receives one or more RREP from the target nodes before timeout, it selects one of the routes with the largest sequence number and the smallest hop count. Then it activates the route by unicasting a multicast activation (MACT) message to the next hop and starts to send multicast data packets.

In MAODV, when an on-tree node detects a link broken, it will start the route discovery. First it finds the broken link is upstream or not. If the broken link is upstream, the node will delete the upstream node in its next-hop list, drop multicast data packets which should besent and then send RREQ message with the flag J to reconstruct a new tree branch. Otherwise the node will delete the downstream node in next-hop list and then set purning timer.

B. Impact of Network Load on the MAODV Protocol

The above mechanism of multicast route recovery is effective in light load ad hoc networks. However when the network is highly loaded, large number of packets will be discarded and poor robustness of the tree-based protocols appears.

As shown in fig. 3, to illustrate the impact of network load on MAODV, for send multicast packets we set two source nodes i.e. node s1 and node s2 .These both nodes establish the routes to the multicast tree. When one of multicast group member receives multicast packets, it will broadcast along the tree branches. Due to randomly moving nature of mobile node the structure of multicast tree may be destroyed partly. It needs to take time for repair the link. During this period, multicast data packets arrive in the multicast tree.

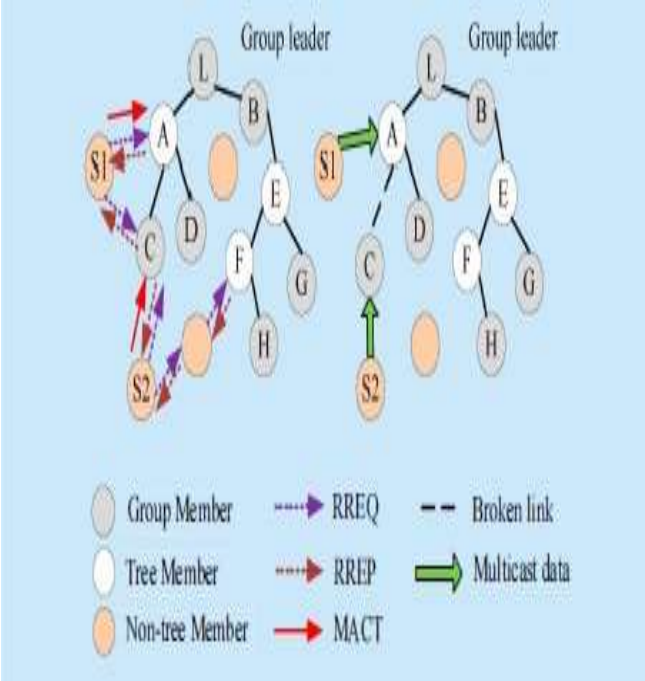

Fig.3 Impact of network load on MAODV

III. IMPROVEMENT OF MULTICAST ROUTING

Improve robustness of the MAODV protocol and to overcome the impact of network load, we extend MAODV protocol to construct a multicast tree with backup branches from two aspects: first one is the backup branches selection and addition and the second one is the mechanism of multicast tree maintenance. In these we also see the GRPH message expansion.

A. GRPH message expansion

In MAODV, the group leader plays a major role and initiates a group hello message (GRPH) throughout the whole network periodically, to specify the existence of that group and its current status. To select and add backup branches correctly, we extend original GRPH (Group- hello) messages with the number of active downstream branches in MAODV-BB (Backup branches).

B. Backup branches selection and addition

In MAODV protocol, when an on-tree node receives a GRPH message with the same multicast group leader address and multicast group address it updates the multicast group information. The GRPH message is identified as the multicast group leader address and multicast address. We add one backup routing table for each on-tree node to save the information of its backup tree branch in MAODV-BB [2]. Backup branches selection and addition is shown in Fig.4.

C. Multicast tree maintenance

In the multicast tree maintenance, when the upstream node detects the link broken, it will delete the downstream node in its next- hop list and set purning timer. When the downstream node finds the broken link, its need to determine whether there is an available backup branch in its backup routing table. If there is backup branch, the downstream node sends a multicast activation (MACT) message with the flag J to enable the backup branch. At the same time, the downstream node needs to send a multicast activation(MACT) message with the flag P to prune the original upstream and deletes the original upstream node in its next-hop list. The existence of backup branches avoids the process of route discovery and ensures multicast data packets to transmit continuously.

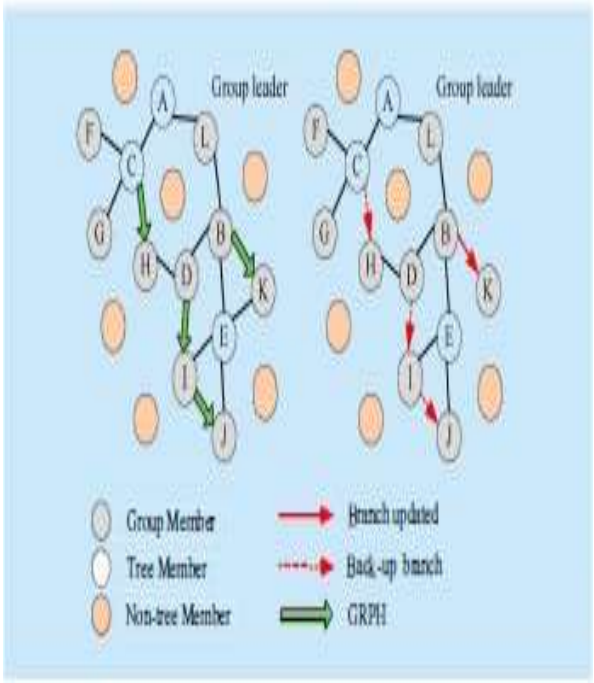

Fig.4 Backup branches selection and addition

CONCLUSION

This paper summarize the tree based multicast routing protocol, MAODV (Multicast ad-hoc on demand distance vector)and an optimized protocol MAODV-BB based on MAODV, which improves robustness of the MAODV protocol by combining advantages of tree structure with the mesh structure. The key idea of MAODV-BB is to make full use of GRPH messages that the group leader broadcasts periodically update shorter tree branches and construct a multicast tree with backup branches. It not only optimizes the tree structure but also reduced the frequency of tree reconstruction.

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