Volume-4, Issue-8, August-2015 • ISSN No 2277 - 8160

Research Paper | Engineering

A Comparative analysis on Multicast routing protocols in Mobile Ad-hoc networks: MAODV, ODMRP, PUMA & AM Route

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ABSTRACT

MANET is a collection of various autonomous mobile users with variable network topologies. Among several multicast protocols in MANET more prominent protocols are Multicast Ad-hoc On Demand Distance Vector (MAODV), On-Demand Multicast Routing Protocol (ODMRP), Protocol for Unified Multicasting through Announcement (PUMA) and Ad-hoc Multicast Routing Protocol(AM Route). In this paper, the comparative analysis based on routing mechanisms, characteristics of the protocols have been analyzed and tabulated theoretically.

KEYWORDS : MANET, Multicast Routing, MAODV, ODMRP, PUMA & AM Route.

I.INTRODUCTION

Mobile Ad-Hoc Network (MANET) is a combination of mobile nodes that are self-organizing and cooperative to ensure efficient and accurate packet routing between nodes. MANETs are infrastructure less wireless communication networks. MANETs are mainly evolved to tackle the situations like tsunami, earth quakes , terrorist activities, battle fields etc Because of limited battery capacity, high mobility of nodes, less stability and power variations ,un reliability in MANETs may increase. QoS is one of the significant components to evaluate MANET performance .Reliability of MANETs increases by improving QoS parameters such as Packet delivery ratio, Throughput, Delay, Bandwidth etc . [8]

Multicasting means sending message to many no of receivers. There are many benefits of multicasting in MANET's. Some of them are: (i) Delivery to destinations simultaneously, (ii) Deliver the messages over each link of the network only once and (iii) Only create copies when the links to the destination split etc. Among the various multicast routing protocols available ,in this paper comparison of multicasting protocols MAODV,ODMRP, AMROUTE and PUMA is discussed based on routing mechanisms and their applications .Based on topology, routing mechanisms, maintenance approach , initialization etc. the classification of the multicast routing protocols is as shown in Fig1.

The rest of the paper is organized as follows: Section II, describes the challenges of multicast routing protocols, Section III, describes briefly about the protocols mentioned, Section IV describes comparisons among the routing protocols and in Section V gives the conclusion of the paper .

II. CHALLENGES OF MULTICAST ROUTING PROTOCOLS

Limited bandwidth availability, mobility of nodes with limited energy resources and limited security make design of multicast protocols for ad hoc networks a challenging one. Based on this there are several issues presented below:

(i) Minimize the network load (avoid loops and avoid traffic concentration on a link or a sub-network).
(ii) Provide basic support for reliable transmission, that is, make sure that route changes have no side effects on the way data is delivered to group members that remain in the group.
(iii) Consider different cost parameters when optimally designing the multicast routes (the cost parameters can be the availability of the resources, bandwidth, number of traversed links, node connectivity, charged price, end to- end delay). This is also closely related with maintenance of the optimality of a certain route, when changes occur either in the group or in the network. Thus, a good compromise should be achieved between the optimality of the route and the group dynamics.
(iv) Minimize the state stored in the routers, otherwise delivery to a large number of groups is not realistic.
(v) Minimize computer processing at the network nodes.

III. MULTICAST ROUTING PROTOCOLS

A. Multicast Ad hoc On Demand Distance Vector Routing Protocol(MAODV):

MAODV [5] is multicast extension of unicast protocol ad hoc on-demand distance vector (AODV) routing (ref-my paper). MAODV uses shared tree concept for every multicast group, which consists only of destinations and forwarding nodes. It originates a RREQ packet and unicasts the packet if it has the address of the group leader. Only the group leader or a member of the desired multi- cast group with a sequence number larger than that in the RREQ packet, can respond to a JOIN RREQ packet. When the group leader or a member of the desired multicast group receives multiple RREQ packets, it selects the one with the highest sequence number and the lowest hop count, and unicasts a RREP packet to the requesting node. The RREP packet contains the distance of the replying node from the group leader and the current sequence number of the multicast group. When the destination node receives more than one RREP packet, it selects the most recent one and the shortest path from all the RREP packets. Then, it sends a multicast activation message (MACT) to its next hop to enable that route. If a non-leaf node wishes to leave a multicast group, it sends a multicast activation message to their next hop with its prune flag set and prunes itself; otherwise, it cannot leave and it must remain on the tree. MAODV employs an expanding ring search (ERS) to maintain the multicast tree. When a broken link is detected between two nodes, the downstream node is responsible for initiating the repair link.

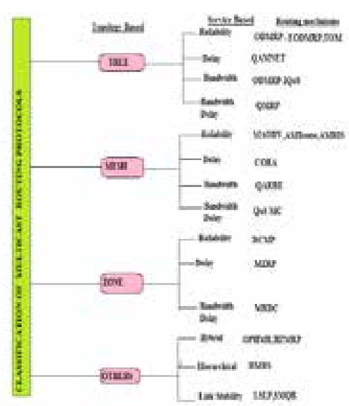

Fig1.Classification of multicast routing protocols

The drawbacks of MAODV are as follows. Long delays and high overheads associated with fixing broken links in conditions of high mobility and traffic load. Also, it has a low packet delivery ratio in scenarios with high mobility, large numbers of members, or a high traffic load. Because of its dependence on AODV, MAODV is not flexible. Finally, it suffers from a single point of failure, which is the multicast group leader.

B. On Demand Multicasting Routing Protocol (ODMRP):

ODMRP [6] is one of the reliable mesh based multicast routing mechanism over which many enhancements are done. In ODMRP, group membership and multicast routes are established and updated on-demand by the source. It comprises of request and reply phase similar to on-demand unicast routing mechanisms. Whenever a multicast group member desires to send packets to other members, the request phase begins. In the request phase, the source broadcasts a packet called JOIN REQUEST periodically to the entire network that acts as member advertising packet. The periodic transmission of JOIN REQUEST refreshes the membership information and updates the route in the following steps: (1) when a node receives a non-duplicate JOIN REQUEST, it stores the upstream node ID (i.e., backward learning) and rebroadcasts the packet; (2) when the JOIN REQUEST packet reaches a multicast destination, the destination creates or updates the source entry in its member table; (3) while valid entries exist in the member table, JOIN TABLES are broadcasted periodically to the neighbors; and (4) when a node receives the JOIN TABLE packet, it checks if the next node ID of one of the entries matches its own ID. If it matches, the node realizes that it is on the path to the source and thus becomes a part of the forwarding group. Later, the node sets a flag known as the forwarding group flag and broadcasts its own JOIN TABLE which is built upon matched entries. The JOIN TABLE is thus propagated by each forwarding group member until it reaches the multicast source via shortest path. This process constructs (or updates) the routes from source to destinations and builds a mesh of nodes called as forwarding group. The nodes in forwarding group are responsible to forward multicast packets to all the group members. The nodes involved in all the forwarding groups of a network are fully connected which forms a mesh structure. Forwarding group nodes support shortest paths between any member pairs. Note that a multicast destination node can also be a forwarding group node if it is on the path between a multicast source and another destination. This type of mesh structure enables richer connectivity among multicast members. Flooding redundancy among forwarding group members helps to overcome node failures and mobility. Data packets are transmitted through forwarding group members if the packet is not a duplicate and the node is alive. Periodic control packets are sent so as to update mesh routes. Essential database maintained at each node in ODMRP are member table, routing table, forwarding group table and message cache. It uses soft state approach for joining/leaving of member nodes and all existing nodes update their database to keep recent routing information. Being robust in handling link and node failures, ODMRP has high packet delivery ratio and low control overheads. Another advantage is its ability to function as both unicast and multicast.

The limitations of ODMRP are as follows: (1) child node disconnection in case of parent node failure; (2) periodic refreshing of the routes to maintain connectivity during node mobility; (3) overhead of maintaining redundant mesh routes; (4) exponential growth in number of control packets with increase in number of nodes due to its broadcasting nature; and (5) reduced scalability. There are several proposals to improve the routing performance over ODMRP by overcoming its limitations.

C. Ad Hoc Multicasting Routing Protocol (AMRoute):

AMRoute [7] creates a multicast shared-tree over mesh with bidirectional shared multicast tree using unicast tunnels to provide connections between multicast group members. Each group has at least one logical core that is responsible for group members and tree maintenance. Initially, each group member declares itself as a core for its own group of size one. Each core periodically floods Join Requests (JREQs) to discover other disjoint mesh segments for the group. Any member, either core or non-core in the mesh segment, can respond to the JREQ message to avoid adding many links to a core. According to the core resolution algorithm, among all cores, one of them will be the logical core. After the mesh has been created, the logical core periodically transmits TREECREATE control packets to mesh neighbors in order to build a multicast shared tree. When a member node receives a non-duplicate TREECREATE from one of its mesh links, it forwards the packet to all other mesh links. If a duplicate TREECREATE packet is received, a TREECREATE-NAK is sent back along with the incoming link. The node receiving a TREECREATE-NAK (TREECREATE-negative acknowledgement) marks the link as a mesh link instead of a tree link. The nodes wishing to leave the group send the JNAK (Join-Negative Acknowledgement) message to the neighbors and do not forward any data packets for the group.

AMRoute creates an efficient and robust shared tree for each group. It helps to keep the multicast delivery tree unchanged with changes of network topology as long as paths between tree members and core nodes exist via mesh links. When the mobility is present, AMRoute suffers from loop formation, creates non- optimal trees, and requires higher overhead to assign a new core. Also, AMRoute suffers from a single point of failure of the core node.

D. Protocol for Unified Multicasting through Announcement (PUMA):

PUMA [13] is used in ad hoc network. It does not require any pre-assigned core and unicast routing protocol for its operation. Very simple multicast announcement signaling is used here for the creation and maintenance of the multicast routing structure. It uses a receiver initiated approach, in which the receiver elects a core to serve as the point of contact between the group and non-members of the group. The multicast receivers connect the core through the shortest path between the core and the individual receiver.

The nodes on the shortest paths between any receiver and the core collectively form the mesh structure. Multicast announcement is a single control message used in PUMA for all its functions. This control message gives the details about sequence number, group ID, core ID, distance to the core and parent details. Parent indicates the preferred neighbor to reach the core. The core of the group transmits these multicast announcements every three seconds periodically. Whenever there is a change in the user member status, during that time also a new multicast announcement was generated. If a receiver wants to join a multicast group, then it verifies first whether it has received a multicast announcement for that group or not. If the multicast announcement is already received then the core specified in that announcement is taken as its core. If the announcement is not received then it considers itself as a core for the group and starts to send a new announcement to its neighbor. If several receivers try to join the group at a time, than the receiver with highest ID was elected as the core for that group.

In PUMA, the multicast packets move hop by hop, until they reach the mesh members. A node forwards a multicast packet it receives from the neighbors if it is the parent for that neighbor's node. Once the data packets reach the mesh, they are flooded within the mesh. Packet ID cache is used to detect and discard the duplicate packets.

IV.COMPARISIONS OF ROUTING PROTOCOLS

Table 1: Routing mechanisms and performance metrics of MAODV, ODMRP, PUMA & AM Route

Protocol	parameters						
	Route discovery	Routing mechanism	Routing efficiency	Reliability	Control overhead	Scalability	QoS
MAODV	Source initiated	Reactive	H	H	M	L	L
ODMRP	Source initiated	Reactive	H	M	M	H	L
AM Route	Hybrid	Proactive	H	H	H	L	L
PUMA	Receiver initiated	Reactive	H	H	L	H	H

Note: H-High, L-Low, M-Medium

The features of routing protocols are compared as well as routing mechanisms have been discussed in terms of robustness ,scalability, reliability, Qos , applications and advantages &disadvantages in given in table1 &table2.

TABLE 2 :FEATURES OF PROTOCOLS MAODV, ODMRP, PUMA & AM ROUTE

Protocol	Parameters			
	Operation	**Advantage**	**Disadvantage**	**Applications**
MAODV	Shared tree is created for every multicast group. RREQ, RREP and sequence numbers are used.	Minimal space complexity and maximal band width utilization.	Poor packet delivery under mobility.	Group communication, video conference.
ODMRP	Forwarding group formed with control packets.	Very robust to route failures, less overhead.	Needs periodic refresh, less scalable, more overhead with the increase in no of nodes.	Video conferencing and defense services.
AM Route	Creates multicast tree using unicast tunnels.	Multicast tree unchanged with changes of network topology, more robust	Loop formations when mobility is high.	In interactive applications that require low response time.
PUMA	It does not require any pre assigned core and unicast routing protocol. Receiver elects a core to serve as point of contact between the group and non members of the group	Robustness is high, more efficient channel access.	Interference is produced if more than one group is formed and if they have some common area.	Used in high mobility and high traffic conditions. More suitable for video streaming applications

V.CONCLUSION

In this paper theoretical comparision of multicast routing protocols MAODV, ODMRP,AMRoute and PUMA is done based on features and routing mechanisms etc. Among all the protocols discussed it is to be noted that PUMA protocol is more robust under high mobility conditions. It is also producing high routing efficiency, scalability, reliability and QoS compared with others.

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