ISSN: 2278 – 1323
International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
Volume 2, Issue 3, March 2013

PERFORMANCE ANALYSIS OF MULTICAST ROUTING PROTOCOLS IMAODV, MAODV, ODMRP AND ADMR FOR MANET

J.Gold Beulah Patturose, P.Immanuel Vinoth

***Abstract*--A Mobile Adhoc Network(MANET) is a collection of wireless mobile terminals that are able to dynamically form a temporary network without any aid from fixed infrastructure or centralized administration. Many application such as video conferencing, video-on-demand services, and distributed database applications require multicast communication. Reliable multicast is one of the basic requirements in a MANET for which better routing protocols have to to be developed for disaster management, emergency relief, and mobile conferencing and many other applications. As mobile terminals change its position too frequently, hence, multicast routes have to be updated frequently. This poses several challenges to provide an efficient multicast routing. In this paper, we have reviewed an Improved Multicast Ad hoc On Demand Distance Vector (IMAODV) protocol , Multicast Ad hoc On Demand Distance Vector (MAODV) protocol, On-demand Multicast Routing Protocol(ODMRP),Adaptive Demand-Driven Multicast Routing(ADMR).Paper reveals that IMAODV performs better in terms of Packet Delivery Ratio (PDR), and End-to-End delay MAODV,ODMRP and ADMR.**

***IndexTerm*s--ADMR,IMAODV,MAODV, ODMRP**

I.INTRODUCTION

A mobile ad hoc network (MANET) is a collection of autonomous mobile nodes that communicate with each other over wireless links. The topology of an ad hoc network is highly dynamic due to the arbitrary movement of each node[1].

In recent years, a number of multicast protocols for ad hoc networks have been proposed. Based on the routing structure, they can broadly be classified into two categories: tree-based protocols and mesh-based protocols. In tree-based protocols, there exists a single path between any sender-receiver pair. Tree-based protocols have the advantage of high multicast efficiency (which is defined as the ratio of the total number of data packets received by all receivers to the total number of data packets transmitted or retransmitted by senders or intermediate nodes). However, tree-based protocols are not robust against frequent topology changes and the packet delivery ratio (which is defined as the ratio of the number of data packets delivered to all receivers to the number of data packets supposed to be received by all receivers) drops at high mobility. Mesh-based protocols provide redundant routes for maintaining connectivity to group members. The low packet delivery ratio problem caused by link failures is alleviated due to redundant routes. Mesh-based protocols are robust to node mobility. However, redundant routes cause low multicast efficiency.

A multicast group is composed of senders and receivers. For connecting senders and receivers, each protocol constructs either a tree or a mesh as the routing structure. There are some nodes called forwarding nodes in the routing structure that are not interested in multicast packets but act as routers to forward them to receivers[7].

Group members (senders and receivers) and forwarding nodes are also called tree or mesh nodes depending on the routing structure. In the routing structure, a node is an upstream (downstream) node of another node if it is closer to (farther away) the root of the tree. If the two nodes belong to the same link, the upstream (downstream) node is also called the parent (child) of the other node. Generally, a sender initially floods a join message to all nodes in the network. Interested nodes reply to the sender via the reverse path. After all reply messages arrive at the sender, a multicast tree rooted at the sender is formed. This kind of tree construction is called 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. 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 the group leader (or core node). 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[4].

Due to node mobility, the routing structure requires reconfiguration. If a broken link is repaired by periodic flood packets issued by a sender (or the group

***J.Gold Beulah Patturose** ,Department of Computer science and Engineering, Anna University, Tuticorin, India,91-9626512661*

***P.Immanuel Vinoth**, Department of Electronic and Communication Engineering, Anna University, Tuticorin,India,91-9629238999*

leader), this kind of protocol is called a soft-state one. Periodic flood packets also help new members join the group. If a link failure is repaired 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, new members usually join the group by using expanded ring searches (i.e., iteratively expand the flood range). A group member usually leaves the group by sending a message to inform its parent of its departure. In addition to link failures, node mobility may cause partition of the routing structure. Partition must be merged for successfully delivering data packets to all group members.

Sender-tree-based protocols incur higher control overhead than shared-tree-based ones because each sender builds its own tree. Shared-tree-based protocols have two main drawbacks: single point of failure of the group leader and sub-optimal multicast paths. Moreover, the group leader may locate in a bad position which further decreases multicast efficiency and increases packet latency. The mesh structure is robust against topology changes, but multicast efficiency is reduced. In soft-state protocols, a new member cannot join a group as soon as it wishes and hence it may miss interested packets for a while.

II. REACTIVE MULTICAST ROUTING PROTOCOLS

Traditional routing protocols such as On-Demand Multicast Routing Protocol (ODMRP) , Multicast Ad hoc On-demand Distance Vector *(*MAODV) and Improved Multicast Ad hoc On Demand Distance Vector (IMAODV) protocol are Reactive multicast routing protocols. Reactive routing that means discovers the route when needed. Reactive routing protocols are well suited for a large-scale, narrow-band MANET with moderate or low mobility. Below is a brief description of the protocols[8].

A.On-Demand Multicast Routing Protocol(ODMRP)

ODMRP[2] provides richer connectivity among group members and builds a mesh for providing a high data delivery ratio even at high mobility. It introduces a “forwarding group” concept to construct the mesh and a mobility prediction scheme to refresh the mesh only necessarily. The first sender floods a join message with data payload piggybacked. The join message is periodically flooded to the entire network to refresh the membership information and update the multicast paths. An interested node will respond to the join message. Note that the multicast paths built by this sender are shared with other senders. In other words, the forwarding node will forward the multicast packets from not only this sender but other senders in the same group.

Due to the high overhead incurred by flooding of join messages, a mobility prediction scheme is proposed to find the most stable path between a sender-receiver pair. The purpose is to flood join messages only when the paths indeed have to be refreshed. A formula based on the information provided by GPS (Global Positioning System) is used to predict the link expiration time between two connected nodes. A receiver sends the reply message back to the sender via the path having the maximum link expiration time.

Advantages: 1. It proposes an effective “forwarding group” concept. 2. The offering of shortest paths reduces data delivery latency. 3. The mobility prediction scheme lowers control overhead
at mobility.

Disadvantages: 1. It suffers from excessive flooding when there is a large number of senders. 2 The duplicate transmissions waste bandwidth at low mobility.

B. Adaptive Demand-Driven Multicast Routing(ADMR)

ADMR is an on-demand sender-tree-based protocol which adapts its behavior based on the application data sending pattern. It does not require periodic floods of control packets, periodic neighbor sensing, or periodic routing table exchanges. The application layer behavior allows efficient detection of link breaks and expiration of routing state. ADMR temporarily switches to the flooding of each data packet if high mobility is detected. A multicast tree is created when a group sender originates a multicast packet for the first time. Interested nodes reply to the sender’s packet to join the group. Each multicast packet includes the inter-packet time which is the average packet arrival time from the sender’s application layer. The inter-packet time lets tree nodes predict when the next multicast packet will arrive and hence no periodic control messages are required for tree maintenance. If the application layer does not originate new packets as expected, the routing layer of the sender will issue special keep-alive packets to maintain the multicast tree. The sender occasionally uses network floods of data packets for finding new members. A new member P globally floods a solicitation message to join a group[7].

Upon a receipt of this message, a tree node unicasts the message toward the sender. The sender either chooses to advance the time for the network flood or unicast a packet to P as a reply. Each tree node maintains a disconnection timer which is based on the inter-packet time value contained in the last received packet, plus a time proportional to the node’s hop count to the sender. If the timer expires, a node Q floods a hop-limited reconnect message and transmits a repair one to prevent its downstream nodes from executing their own repair procedures . Upstream nodes of Q will unicast the message toward the sender when receiving the reconnect message. The sender responds a message to help Q reconnect to the tree.

Advantages: 1. It utilizes the application data sending pattern to avoid periodic control messages. 2. It can adapt to the change of mobility.

Disadvantages: 1. The joining and rejoining processes waste bandwidth and take time. 2. The occasional flooding of multicast packets is an overhead.

C.Multicast Ad-hoc On-demand Distance Vector(MAODV)

MAODV is a shared-tree based protocol that is an extension of AODV 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. An interested node P sends a join message toward the group leader. Any tree node of the group sends a reply message back to P. P only answers an MACT message to the reply message with minimum hop count to the originator.

Each node will broadcast a Hello message to its neighbors if it does not send any packet within a period of time. The lack of a 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. Only those tree nodes which are closer to the group leader and have fresher paths to the group leader respond to this join message.

The shared tree may be partitioned due to node mobility and hence two or more group leaders may co-exist. When this happens, a group member Q whose group leader has a lower IP address than any other group leader will inform its group leader to stop the leader's role. Q then sends a message to ask the group leader with the highest IP address to be the new group leader of the final merged tree.

Advantage: With the unicast route information, the multicast tree can be constructed more quickly and efficiently.

Disadvantages: The group leader continues flooding Group Hello messages even if no sender for the group exists.

III. IMAODV

MAODV[1] has multicasting capability where as IMAODV (Improved Multicast Ad-hoc On Demand Distance Vector) has multicasting and higher reliability in the applications where high mobility rate and large network area are constraints. It is a shared tree based protocol. It builds multicast trees on demand to connect group members from various networks. As nodes join the group, a multicast tree composed of group members is created. Multicast group membership is dynamic, group members have the choice to in and out of the group and group members are routers in the multicast tree. In the case of link breakage, downstream node broadcasts a route request message for repairing the broken link. It responds quickly to link breaks in multicast trees by repairing in time. IMAODV offers some specific features as quick adaptation to dynamic link conditions, has low processing and memory overhead, and low network utilization. These features can result in the form of application in an area where topology of the network changes too frequently, high mobility. IMAODV creates bi-directional shared multicast trees and these trees are maintained as long as group members exist within the connected portion of the network. Each multicast group has a group leader that maintains the group sequence number, which is used to ensure freshness of routing information. The sequence numbers are used to prevent loop in the network. IMAODV enables mobile nodes to establish a tree connecting multicast group members. Multicast trees are established independently in each partition, and trees for the same multicast group are quickly connected if required. However, IMAODV has many features as AODV[3] and MAODV . Every multicast group in IMAODV is identified by its own unique address and group sequence number . If node is not a tree member, it will check its Unicast Route Table to find the next hop for the multicast address. If it has the information, the data packets are forwarded towards the next hop; otherwise, it will send an unsolicited Route Reply (RREP) back to the source node . This make the source node to know about destination is not reachable. If the node itself is a tree member, it will follow its Multicast Route Table to forward the packets. An important feature in IMAODV is Group-Hello Message (GRPH). These messages are broadcasted throughout the whole network, to indicate the existence of group. When a non-member node receives GRPH first time, it tries to join the group. In the event, where a tree is partitioned or a group leader revokes its group membership, a new group leader is selected, in the process, each node must update its Group Leader Table to indicate newly elected/ selected group leader.

In IMAODV the multicast data transfer occurs in two different scenarios, first is that when a node wants to send multicast data packets to its multicast group and this node is close to the existing shared-tree root node, it delivers its data packets along the original shared-tree and the second one occurs when a node wants to send multicast data packets to its multicast group and this node is far away from the existing shared-tree root node , it initiates a new route discovery. If there exist some potential communication links between any pair of existing nodes which are on the existing tree, and these potential communication links can be used to deliver data from the new source node, they are called forwarding path with respect to the new source node. When a source node that is far away from the group leader, it initiates the new forwarding route discovery; forwarding table will be set up for the nodes that are involved in new route discovery and forwarding path establishment . This new forwarding table contains Source Node IP Address; Next Hops; Group Leader IP Address; Hop Count to Source Node. In the defined forwarding table, source node is the node that initiates a new send and next hops are a list of both the upstream and downstream link nodes. Each next hop contains two fields: next hop IP address and link direction. Link direction is determined upon whether a Forwarding Query Message is received from a requesting node. UPSTREAM indicates receiving and DOWNSTREAM indicates forwarding. Hop Count to Source Node is the number of hops away from source node. If a node is involved in forwarding new data, this forwarding table will be maintained as long as the sending session of the source node continues. After the source node completes its own sending, the forwarding table will be invalidated[5].

The Query Message consist of destination address, hop count, hop count difference, broadcast identifier, multicast group leader address and the Forwarding Reply Message that contains information like destination address, last hop address, source address, and multicast group leader address. Where destination address is the IP address of multicast group and the hop count is the number of hops that current node is away from the source node. Hop count difference is the distance of the responding node from the last node on the shared multicast tree. Broadcast identifier is used to identify the RREQ each time it is generated by a source node. The source address is the address of the initiating source node. To establish new forwarding path within the near area of the existing shared tree to reduce the average end-to-end delay and therefore, the new route discovery will be exploited when a node that is far away from the group leader wants to send data.

In IMAODV, the existing shared tree established by the group leader is maintained for use such as grafting a new branch, pruning an existing branch, forwarding data packets that originated from the group leader or nodes close to group leader, and repairing a broken link . When a link along the forwarding path breaks, the node downstream of the break is responsible for repairing the link which is very much similar to MAODV. The downstream node initiates the repair by broadcasting a RREQ with source address set to the new source node. When a node on the new forwarding tree receives the RREQ, it can reply to the RREQ by unicasting a RREP back to the initiating node. RREP forwarding and subsequent route activation with the MACT message are handled similarly as in MAODV. It will test for reliability of packet delivery.

IV. SIMULATION RESULT

For simulation proposed approach, the OPNET simulator (Optimum Network) has been used. OPNET is general purpose network simulator that operates as discrete event, and it uses C++ codes for simulating. Main purpose of OPNET is optimizing costs, performance and accessibility. It uses a hierarchical model to define each aspect of the system. The top level consists of the network model, where topology is designed. The next level is the node level, where data flow models are defined. A third level is the process editor, which handles control flow models. Finally, a parameter editor is included to support the three higher levels.

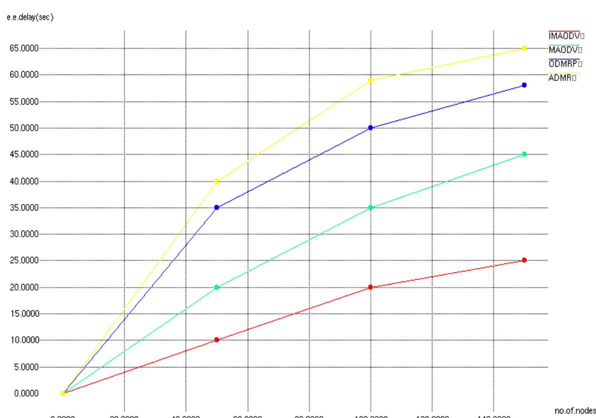

Fig 4.1 End to End delay vs No. of nodes

In Fig 4.1 we used the four protocols, the graph is plotted between the end to end delay vs number of nodes if the node value increases the end to end delay decreases using the routing protocols IMAODV. We used the 150 nodes and the packet size is 4KB to find the packet delivery ratio and End to End delay. End to end delay is measured as the time elapsed when a multicast packet is sent from a node and is successfully received by all the multicast group members. It includes all possible delays, as delay for route discovery, interface queuing transmission delays, and propagation and transfer times of data packets.

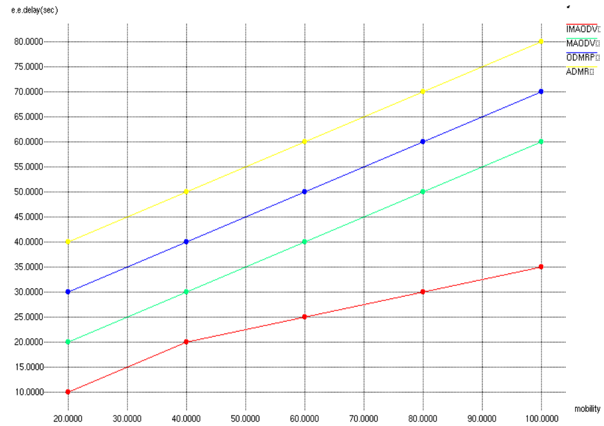

Fig 4.2 End to End delay vs Mobility

In Fig 4.2,4.3,4.4 are plotted between the end to end delay vs mobility,communication range and packet size.The communication range is 3m .Comparing all routing protocols the end to end delay decreases using the protocol IMAODV. The ADMR routing protocol the end to end delay highly increases to increase the mobility ,communication range and packet size. In ODMRP slightly better compared to ADMR.But IMAODV routing rotocol is better compared to above three routing protocol.

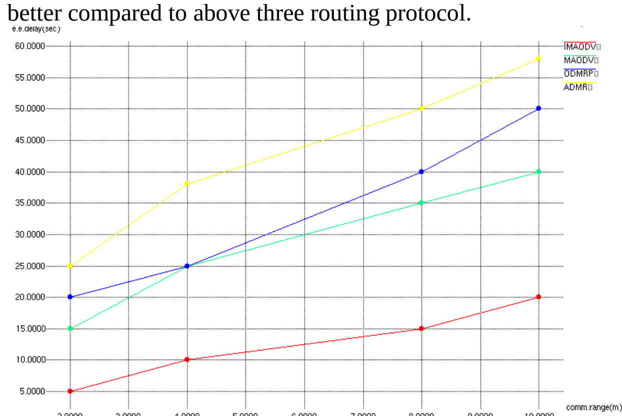

Fig 4.3End to End delay vs Commun. Range

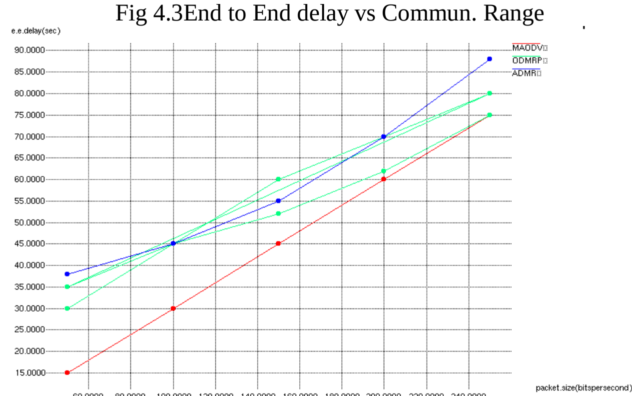

Fig 4.4 End to End delay vs Packet Size

In IMAODV the end to end delay will be decreases compared to the above routing protocols .In Fig 4.5 ,4.6,4.7 and 4.8 the graph is plotted between the packet delivery ratio vs number of nodes, mobility, communication range and packet size. Packet delivery ratio is defined as the ratio of number of data packets forwarded from a particular node to the number of data packets converging to that node. It is a measure of reliability. If PDR is more, network and data transfer is more reliable. The MAODV,ODMRP and ADMR the packet delivery ratio decreases to increases the number of no nodes .But in the IMAODV routing protocols the packet delivery ratio increases.

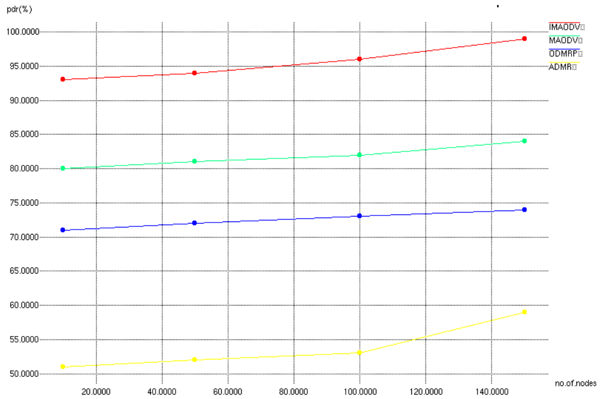

Fig 4.5 PDR vs No. of Nodes

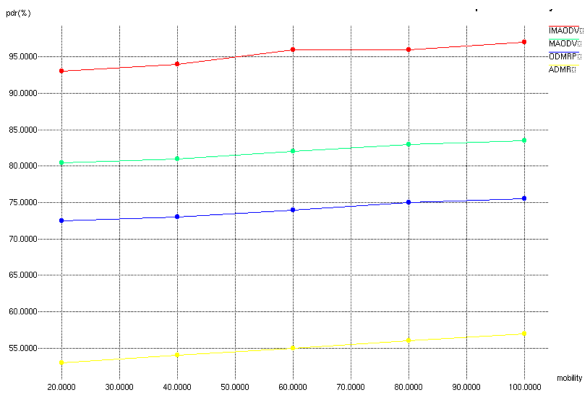

Fig 4.6 PDR vs Mobility

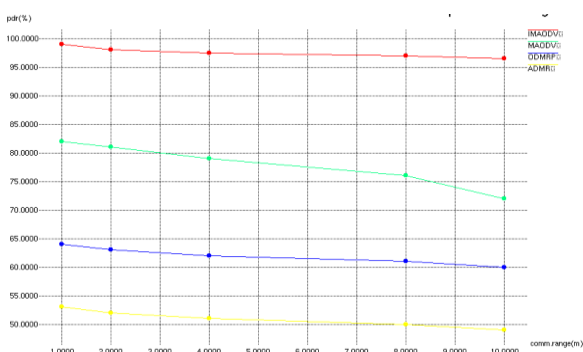

Fig 4.7PDR vs Comm.Range

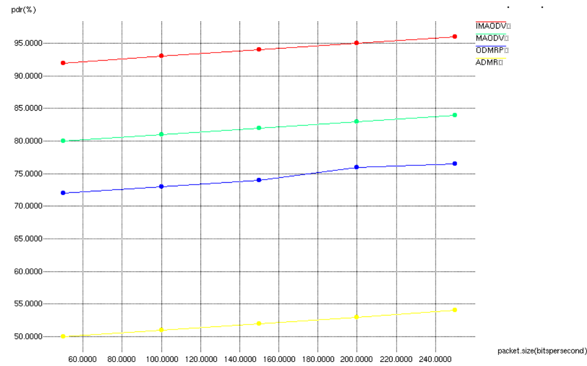

Fig 4.8 PDR vs Packet Size

V CONCLUSION

Reliability is an important aspect for data transfer in MANET and the condition become much important in multicasting. IMAODV provides the better PDR and end to end delay as compared to MAODV,ODMRP and ADMR, thus it is more reliable and can be used for applications such as broadcasting and multicasting. However, it can be concluded that IMAODV protocol is suitable for reliable and time sensitive multicasting in MANET environment. From the observations, we enlighten that IMAODV ensures better reliability by providing more PDR for broadcasting and multicasting purposes. However, for the applications such as audio or video conferencing, the throughput is too low. So we plan to modify the IMAODV such that it can be compatible to MAODV in terms of throughput, to support the services, where throughput cannot be tolerated.

ACKNOWLEDGEMENT

The author are indebted to Prof.R.Jesuraj for providing the source code of their routing protocol algorithm used the simulation valid of IMAODV.In addition,the author would like to thank Prof.M.Karthik Marimuthu for providing a tool that generate strongly connected random network topologies for the NS2 experiments

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J.Gold Beulah Patturose received the B.E. degree in Electronic and Communication Engineering from the Anna University, Tamilnadu, India, in 2010, and is currently pursuing the M.E. degree in computer science and Engineering at Anna University, Tamilnadu.

Her current research focuses on network coding and optimization in wireless networks.

P.Immanuel Vinoth received the B.E degree in Electronic and Communication Engineering from the Anna University, Tamilnadu,India in 2009 and also received the M.E degree in Communication system from the Anna university,Tamilnadu in 2011.Now he is working Assitant professor at St.Mother Theresa Engineering. College, Tuticorin

His research interests include cross-layer designs and resource allocation for wireless networks.