An Efficient Routing Protocol for MANET

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Abstract: Mobile Ad-hoc networks are widely research area where mobile nodes can roam freely and set up communication each other without any central Co-ordinator. MANETs has no fixed topology due random movement of nodes. Therefore many routing protocols have been constructed to maintain efficiency and reliability in the network. An improved Ad-hoc On-demand Distance Vector routing protocol (I-AODV) has been proposed to provide less routing overhead and improving delay. MAODV is an extended version of AODV, used for multicast load. These two protocols have been examined with respect to some performance metrics like Packet Delivery ratio (PDR), End to End Delay (E-to-E Delay) and Routing Overhead using NS-2.35.

Keywords: AODV, I-AODV, MAODV, Routing Protocol, MANET

I. INTRODUCTION

In the wireless and mobile communication, the cellular system have reached high access rate, enabling worldwide mobile connectivity. Recently, wireless LAN access in home for sharing the data has been very much increasing day by day. However all these networks are wireless network with a fixed infrastructure network and consuming a lot of time and set up and maintenance cost. Such this network one another alternative network is developing for mobile communication application which is self organizing, self creating wireless network, called a Mobile adhoc Network. A MOBILE ad hoc networks (MANETs) can be defined as a set of mobile nodes which communicate using the wireless system via access point i.e. centralized supporting structure. So it can easily perform multihop datagram forwarding over wireless links in presence of a limited fixed supporting coordinate but do not require any pre-determined infrastructure network and does not need to depend on any fixed telecommunications network infrastructure. Each and every node can send or receiving the data packet. So any node act as router and this node can do all the router function through sending route request and route reply message with a route discovery and route maintenance procedure. MANET has no fixed base station. So the mobile nodes dynamically exchange the data packet to all other node through selecting appropriate router. Multicasting process has more advantageous as compared to unicasting data delivering process. When same data packet sent from one end to another end then there some characteristics like cost bandwidth delivery ratio need to observe. We use the multicast extension version of the Adhoc On-Demand Distance Vector Routing Protocol and tree based multicast routing protocol Multicasting Adhoc routing Protocol (MAODV) and another enhanced version of AODV [4] and hybrid protocol used in this paper. It is an I-AODV.it has two feature i.e. Multipath and path accumulation.

II. MULTICAST ADHOC ON DEMAND DISTANCE VECTOR ROUTING PROTOCOL

MAODV is the multicast extended routing protocol of AODV. AODV, MAODV [5], [6] and IAOVD are On-Demand routing protocols for ad-hoc networks. AODV used for unicast traffic, means that it send data packet unicastly and MAODV used for multicast traffic, where each node sends out the multicast data packet broadcast from source to destination. It creates the tree structure.
where includes the entire node as a group members and several routers. The tree members consist of all the group member nodes and the routers which belong to the group tree. In every multicast tree, first it creates a group leader in between all group member nodes for that tree and sending Group-Hello (GRPH) messages to all group member nodes in the whole network. The group leader also maintains the group sequence number which is propagated the GRPH messages in the network. Each node maintains three tables. Firstly, Unicast route table which record the next hop for routes to other destinations for unicast traffic. Secondly, Multicast route table which records the all information of the next hop of each multicast group. Every node are associated with other neighbor node, it can be either downstream or upstream. Now, if the next neighbor node is one-hop closer to the group leader node, the direction is upstream; otherwise, the direction is downstream. In the tree the group leader node has no upstream nodes, while other nodes have one and only one upstream. The third one is the Group leader table which records the currently-known multicast group address, group leader address and the next hop address towards the group leader after receiving a periodic GRPH message.

1.1. Route Discovery and Maintenance
In MAODV, every node sends out multicast traffic. In the route discovery[3] process multicast data packet choose the two steps for including data source node which are not in tree member. In the first step, data source node creates a route up to the tree member node then tree member receives multicast data packet and propagates it to the entire tree and every group member node and maintenance for sending a specific node address in AODV to complete the first step. The data source node initiates the RREQ packet and sends to the multicast address and choose a route to reach the group leader node if it has the group leader table. All node information is stored in the group leader table and RREQ packet can be sent unicastly towards the group leader. When RREQ is sending to the nodes then the reverse route RREP packet is generated towards the source node. When the RREP packet is sent back to the source node, every intermediate node and the source node automatically updates with the destination address set to the multicast group address, so route has been creates in their Unicast route tables. So the first step is complete with entire path. In the multicast tree construction second step is accomplished.

![Figure 1. Initial RREQ Message](image)

1.2. Multicast Tree Construction:
In MAODV used tree construction method to initiates a RREQ with a join flag (RREQ-J) when it is not a tree member and wants to join in the multicast group. At first the node creates an entry in its Multicast route Table then sends out RREQ-J, and identifies itself as a group member with an unknown group leader address. Usually, RREQ-J is broadcast in the network, but RREQ-J can be sent unicastly towards the group leader node to join in the tree member. Multicast Route Activation
(MACT) message is send to the tree member node for joined in a branch of the tree. For joining the upstream node sends out a MACT with a join flag (MACT-J) and adds the new next hop in its Multicast route table. Every node that receives MACT-J for adding a new next hop indicating the downstream from where it receives the MACT-J in its Multicast route table.

1.3. Multicast Tree Maintenance:
Multicast tree maintenance consists of Periodic Group-Hello Propagation, Neighbor Connectivity Maintenance, Group Leader Selection and Tree Merge.

1.3.1. Periodic Group-Hello Propagation
The group leader node broadcast a Group-Hello message (GRPH) to the entire network and tree member nodes receive this packet and update their current the group sequence number from its own upstream node and send the GRPH to be propagated from upstream to downstream step by step in its own tree structure. If the group leader information recorded in its Multicast Route Table is same as GRPH packet then it can easily transmitted otherwise it check the existing tree structure and then propagate the message and follow the previous process.

1.3.2. Neighbor Connectivity Maintenance
If link is broken from downstream node to upper node, broadcast message is not transmitted or receiving to neighbor node in a specific time then tree neighbor connectivity is maintained. After detecting a link breakage, at first the downstream node obsolete that next hop (its only upstream) in its Multicast route table, send the RREQ-J to discover a new branch. This new RREQ-J and existing tree member node RREQ-J is different and new request packet wants to join in the multicast group. Then downstream node avoids the old branch and receives a RREQ-J with extension, checking the hop count to the group leader and respond with a RREP-J. The source node tries to repair that branch, but after that has not received any RREP-J, tree partition happened due to network partition and new group leader must be selected for this partitioned tree.

1.3.3. Group Leader Selection
A new group leader must be chosen for the partitioned tree. After tree partitioning if the current node is a group member, it will become the new group leader. Otherwise, it will select one of its tree neighbors to be the leader. If the current node only has one downstream node, it remove the path from the multicast route table and sends out a MACT with a prune flag (MACT-P) to this downstream node and indicate to leave from the tree and sends a MACT message with a group-leader flag(MACT-GL) towards that node. The downstream node receiving MACT-GL from upstream, the node changes the upstream direction into downstream.

![Figure 2. Group Leader in Multicast tree](image-url)
1.3.4. Tree Merge
When a tree member with a smaller group leader address receives a GRPH packet from another
group leader then tree merge can be detected. To initiate the process the tree member sending RREQ
with a repair flag (RREQ-R) to the group leader for requesting to rebuild the tree and it can send
back a RREP with a repair flag (RREP-R) to that request node. If the group leader having the larger
addresses then the RREQ-R and RREP-R cycle is omitted and it is realized by the existing leader.
Tree-rebuilding starts when the request node unicastly sends a RREQ with a join-and-repair flag
(RREQ-JR) to the group leader with larger address.

II. IMPROVED AD HOC ON DEMAND DISTANCE VECTOR ROUTING (I-AODV)
Improved Ad hoc On Demand Distance Vector Routing (I-AODV) protocol is a hybrid routing
protocol which integrates the two features: multiple path between a source and a destination and
accumulation of routing information. It is equipped with source routing characteristics, namely the
path accumulation technique, which permits nodes listening to routing messages to acquire
knowledge about routes to other nodes without initiating route request discovery themselves. This
method increases the routing packet size, but decreases the required transmission. Path accumulation
feature enables us to add all discovered paths between source and destination nodes [1]. Hence, at
any intermediate node the route request (RREQ) packet contains a list of all nodes traversed. Route
discovery establishes a route connecting a pair of nodes when required by the upper layer, and route
maintenance repairs the route in case of link.

![Figure 3. Accumulation of Routing Path](image)

Just like AODV, I-AODV consists of two operations: route discovery and route maintenance. Routes
are discovered when a source node wants to send a packet to a destination node and it does not have
a route to that node in its routing table. A RREQ message is broadcasted in the network and when
RREQ message reaches to the destination, a RREP message is sent back containing the accumulated
routing path of the network. In I-AODV, each route table entry, RREQ and RREP packet records the
two hops information in the path. The improved AODV reset the shortest routing path during moving
nodes [2].

The Route Discovery process of I-AODV depicted in fig.2: Suppose Node 2 wants to communicate
with Node 10. Each neighbouring node sending the RREQ creates a reverse route to 2 used when
sending RREP. When sending back the RREP, nodes on the reverse route create routes to node 10.

![Figure 4. Route Discovery of I-AODV](image)
Route maintenance is the process of movement in topology that occurs after a route has been created. Each node in the network continuously check the active links and update the Valid Timeout field of entries in its routing table when receiving and sending data packets. If a node wants to send a packet for a destination and it does not have a valid route, it must respond with a Route Error (RERR) message. The process is depicted in fig.3. The link between nodes 6 and 9 breaks, and node 6 generates an RERR message. Only nodes having a route table entry for node 9 propagate the RERR message further.

![Network Diagram](image)

**Figure 5. Route Maintenance of I-AODV**

I-AODV has another important feature multiple routes between a source and a destination. In I-AODV, when all the path fail or expire it creates a new route discovery process unlike AODV. So, alternative path are used when primary path fails. In order to keep primary path alive, the extension of the time period may be considered and unnecessary invalid path can be avoided from the routing table. The advantage of I-AODV is that it reduces the packet overhead and end to end delay and enhances throughput of the network.

### III. PERFORMANCE EVALUATION

#### 3.1. Simulation

The simulations are performed using Network Simulator 2 (NS-2) [8], i.e. we used NS-2.35 in the wireless networking scenario. The performance of MAODV is evaluated by comparing it with I-AODV protocol in same condition. In our simulation, MAC protocol is the IEEE standard 802.11 Distributed Coordination Function (DCF) [7].The traffic sources are constant bit rate (CBR). For mobile nodes, velocities ranged between 0 m/s and 25 m/s, while the pause time was set to 25 seconds. The data packet size is 512 bytes. We conducted two sets of scenarios. First, with the number of CBR flows as 20 constantly, the nodes in the network increase from 20 to 50 gradually. The size and the area are selected. So the nodes density is approximately constant. Second, we studied the performance of the protocols when the CBR flows from 20 to 40 in networks with 50 nodes. Each simulation was run for duration of 800 seconds. Every sample data we use is an average of 5 simulations. We evaluated three performance metrics:

1. **Packet delivery ratio:** It is ratio of number of successfully received data packets to the number of sent data packets.

2. **Average control overhead:** It is the sum of all the control packets i.e. route discovery, route maintain, cluster maintain sent by all the sensor nodes to sink node in the network.
4.1.3. **End-to-end delay:** The Average Delay is depends on sending and receiving packet and connecting pair in the network.

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\text{Delay} = \frac{\text{Received packets} - \text{sending packets}}{\text{Total number of connected pairs}}
\]

3.2. **Simulation Result:**

![Fig 6(a). Routing Overhead](image)

![Fig 6(b). End to End Delay](image)

Figure 4(a) shows that the M-AODV has higher routing overhead than I-AODV. I-AODV reduces routing overhead by using source routing technique in route request & route reply and use less no. of control packets in route discovery and maintenance process.

Figure 4(b) shows comparison of I-AODV and M-AODV with respect to End to End Delay. As no. of nodes less, the gap between two protocols decreases. As soon as no. of nodes becomes increases I-AODV takes less delay than M-AODV. In I-AODV, when primary path breaks alternate paths are ready to use, so route discovery process takes no amount of time to start.

![Fig 6(c). Packet Delivery Ratio](image)

Figure 4(c) shows the Packet delivery ratio between the two protocols. M-AODV gives good performance at lower no. of nodes since it uses multicast technique. I-AODV gives better performance at higher no. of nodes since source node has the enough information about the entire route to destination; they can easily send the packets through route cached in their routing table.
IV. CONCLUSION
The performance of a hybrid routing protocol namely I-AODV and a reactive routing protocol namely M-AODV have been evaluated and compared the X-graph between these two protocols with some metric like end to end delay, Overhead and Packet delivery ratio using Ns-2.35 simulator and simulation has been carried out with identical topologies. The improved AODV reduces delay and also give better result in case of routing overhead. It also improves the packet delivery ratio by using multipath technique. To study the performance of I-AODV in different pause time, different CBR and in wireless network are the main focus in future days.

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