PERFORMANCE EVALUATION ON EXTENDED ROUTING PROTOCOL OF AODV IN MANET

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ABSTRACT

A Mobile Ad-hoc Network is a collection of mobile nodes that form a wireless network and the mobile nodes dynamically communicate to other nodes without the use of any preplanned infrastructure. Each node can acts as a router and forwards data packets to every other nodes in the network. Topology of the network changes very frequently due to mobility of the nodes. AODV(Ad-hoc on demand distance vector routing protocol) has been extensively used protocol in MANET. But AODV and other on demand routing protocol use single route reply. An extension version of AODV called RAODV (Reverse AODV) [11] tries multiple route replies and enhances the network performances like packet delivery ratio. Another extended version of AODV namely MAODV allows each node in the network to send out multicast data packets rather than sending unicast traffic. An evaluation of these two protocols has been carried out by using NS-2.34.The comparisons of these protocols has been studied using some performance metrics like end to end delay, overhead by varying number of nodes which has not been done.

KEYWORDS

Manet, Raodv, Maodv, Routing Protocol, MACT massage, GRPH massage

1. INTRODUCTION

Mobile ad hoc network (MANET) plays an important role in the communication networks now-a-days and for coming advancement. The important role is the fact that as the distances among the nodes in an ad hoc network become very less, the network easily access information from space that provides capacity per Joule of energy. Recent research advances in low power, low cost and low rate wireless communications endure a promising future for the deployment of sensor networks to support a broad range of applications like health monitoring, habitat monitoring, target tracking and disaster management [1, 2, 3].

Mobile ad hoc networks consist of nodes that can communicate through the use of wireless links and do not form any static topologies. The fundamental features of these networks is that it does not possess any infrastructure and dedicated nodes which are present in the fixed kind of networks and provide network connectivity operations. For maintaining connectivity in a mobile ad hoc network all mobile nodes in the network go through routing operation of network traffic.

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The communication among the nodes cannot be imposed by a centralized administration system. Thus, for such self-deployed a protocol of physical or network layer must be come in the frame that enforce connectivity requirements in order to guarantee the unstoppable operation of the higher layer protocols.

Mobile ad hoc networks (MANET) composed of set of mobile nodes which communicate with each other wirelessly and do not need any preinfrastructure. The mobile ad-hoc network topology changes very frequently since the nodes are capable to move and we need to cope with problems raised through this type of networks. If the source and destination nodes are not within the transmission range of each other, then intermediate nodes would be served as intermediate routers for the communication between the two nodes. Moreover, if the communication between mobile nodes does not occur mutually, it can use other neighboring nodes to achieve communication and communicates through frequently changing network [4, 5].

The main contribution of this paper is that we have made a substantial effort to study the performance of two AODV family of routing protocols, namely MAODV, and RAODV for a Mobile Ad-Hoc network environment. Since the computation time between two receiving signals is less for an MANET, these two protocols find undisrupted links and feasible routes from performance parameters without considering the fluctuation in signal strengths and network topologies of mobile ad hoc networks. Firstly, we take a widely used protocol namely Ad-hoc On-Demand Distance Vector Routing Protocol (AODV) that uses a source on-demand route establishment process, then represent an extended version of this algorithm namely Reverse AODV (RAODV). Route stability parameters have been used for selecting stable routes in the network [6]. The remaining part of the paper describes about another extended version of AODV called Multicast AODV (MAODV).In the next section, these two protocols have been compared with some deterministic metrics and finally we concluded our paper.

2. REVERSE ADHOC ON-DEMAND DISTANCE VECTOR ROUTING PROTOCOL

It is the extended reverse version of AODV. In AODV and other on-demand routing protocol, source node initiates route discovery process [8] by broadcasting route request packet to its neighbor to find a route to the destination. Each intermediate node acknowledges the RREQ by sending a Route Reply (RREP) packet to the source node or rebroadcasts the RREQ to its neighbors after incrementing the broadcast id. One of the disadvantages of AODV is that it is based on single route reply along the first reverse path to establish routing path. Random change of topology in the network leads that the route reply could not reach to the source node. Loss of RREP leads to the source node to reinitiates route discovery process which degrades the routing performances. In R-AODV, loss of RREP messages considered. This protocol discovers routes or paths when source node needs a new route by using a reverse route discovery procedure. The source node and destination node plays basically same role during route discovery process from the point of sending control messages. So, when the destination node receives route request (RREQ) packet, it broadcasts reverse request (R-RREQ) packet to find out the source node. When source node gets an R-RREQ message it starts data transmission.

The source node initiates route discovery procedure by broadcasting RREQ to its neighbor. Whenever the source node issues aRREQ, the broadcast ID is incremented by one. The source node broadcasts the RREQ to all other nodes in the network. When a RREQ received by an intermediate node, it starts checking that already it has that RREQ with the same source address. The node cashes broadcast id and source address and drops redundant RREQ messages. The RREQ packet contains the following fields:

Type	Reserved	Hop Count
Broadcast ID		
Destination IP address		
Destination Sequence number		
Source IP address		
Source Sequence number		
Request Time		

Table:1Packet Format of RREQ

When the destination node receives first route request message, it generates reverse request (R-RREQ) message and broadcasts it to neighbor nodes in the network. The R-RREQ packet contains the following fields:

Type	Reserved	Hop Count
Broadcast ID		
Destination IP address		
Destination Sequence number		
Source IP address		
Reply Time		

Table: 2 Packet Format of R-RREQ

When intermediate node receives R-RREQ messages, it goes check for redundancy. If it already had that the same message, then it drops the message, otherwise send it to the next neighboring nodes. When the first reverse request message reaches to the source node, it starts transmission of packet in the network and other R-RREQs that arrived to the source node slowly will reserve for future use.

3. MULTICAST ADHOC ON-DEMAND DISTANCE VECTOR ROUTING PROTOCOL

MAODV is the multicast extended routing protocol of AODV. Both AODV and MAODV are on-demand routing protocols for ad-hoc networks. AODV used for unicast traffic and MAODV[7][9] for multicast traffic means that it send out multicast data packets and it goes through the multicast group tree and composed of the group members and several routers, which are not member of the group member. So all the group member nodes and the routers are all tree members and belong to the group tree. In every multicast tree, the group member that first builds the tree is the group leader for that tree, responsible for maintaining the group tree broadcasting Group-Hello (GRPH) messages periodically in the whole network. Every node has three tables in the network. Firstly, there is a table called Unicast route table which record the next hop for routes to other destinations for unicast traffic. Secondly, another table where every hop record the next hops for the tree structure of each multicast group and known is multicast route table. Each node and its next neighbour node is connected with each other either downstream or upstream depends on position. Now, If the next neighbour node is one-way nearer to the group leader node, the direction is upstream; otherwise, the direction is downstream. In the group leader nodes there have no upstream nodes, while other nodes in the tree should have one and only one upstream. The third table is the Group leader table. It stores the currently-known multicast group address and its group leader address and the next hop when a node receives a periodic GRPH message towards that group leader.

3.1. Route Discovery and Maintenance

In MAODV, in the network each node tries to send out multicast traffic, if the data source node is not includes a tree member, then how the packet arrive to the multicast group member. In this case, there we can incorporate two step. In first step, one route is to be established from that data source node to a tree member; after that the tree member receives the multicast data packets, and then it propagates the data through the whole tree, reaching every group member. This mechanism used for route discovery and maintenance for sending a specific node address in AODV to accomplish the first step. If the source node discovers a RREQ for MAODV which are the same as the RREQ used in AODV, broadcasted in the network. The source node knows a route to reach the group leader if it has the group leader table. In the Group leader table all information are stored, by using this RREQ packet can be sent unicastly towards the group leader if this is the first time the node sends RREQ. When RREQ goes through the network, the reverse route towards the source node to next hop is constructed. If any node has fresh enough route to that multicast address, or any tree member with identified group leader can respond to this RREQ with a RREP. Through the reverse route when the RREP is sent back to the source node, every intermediate node and the source node automatically updates the route to that tree member with the destination address set to the multicast group address, thus the forwarding route is established in their Unicast route tables. For this first step, the end node is a tree member. In the multicast tree construction second step is accomplished.

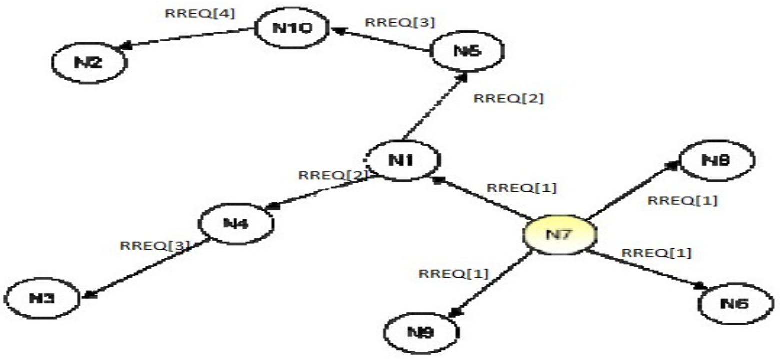

Figure 3: Initial RREQs

3.2. Multicast Tree Construction

The control packets i.e. RREQ and RREP used in MAODV for tree construction which are borrowed from AODV. When any node is not a tree member then it initiates a RREQ with a join flag (RREQ-J) and creates multicast route table then it wants to join that multicast group. After that it identifies itself as a group member, but with an unknown group leader address. Generally, in the network RREQ-J is flooded and a node in the multicast group can get information how to reach data to the group leader address through checking its own Group Leader Table, and for the first time that it sends out RREQ-J and it can be sent directly towards the group leader.

3.3. Multicast Tree Maintenance

Multicast tree maintenance procedure consist of Periodic Group-Hello Propagation, Neighbour Connectivity Maintenance, Group Leader Selection and Tree Marge.

3.3.1. Periodic Group-Hello Propagation

In this case, group leader plays the 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. So the tree member node receives GRPH from its own upstream can use the GRPH to update their current group sequence number, current group leader and the current distance from the group leader. It requires the GRPH messages to be propagated to its own tree structure from upstream to downstream gradually. Now, a GRPH message is received by a tree member then it first checks its group leader information stored in its Multicast Route Table. This GRPH is to be discarded if it is the same group leader address is specified, and the node waits for next GRPH from its own upstream. If its Multicast Route Table record the group leader information there exists another tree with the same multicast group address and these two trees can be connected.

3.3.2 Neighbour Connectivity Maintenance

The neighbour connectivity is organised by repairing the downstream node of a link in the tree realizes that the link is broken. Then it is not receiving any broadcast messages from that neighbour in a specific time. Then, the downstream node deleting next hop becomes the request source node sending out RREQ-J to determine a new limb. RREQ-J wants to join the multicast group, in that this RREQ-J must be broadcast and attached with an extension including other information about the node hop count to the group leader, When a RREQ-J with Extension received by a tree member, it must check its own hop count to the group leader, it avoid the old branch and its own downstream nodes responding to the RREQ-J. Tree partition will be happened; when the request source node tries several times (RREQ_RETRIES) to repair that branch, but has not received any RREP-J then network partition should be created. So, for this partitioned tree a fresh group leader is selected.

3.3.3 Group Leader Selection

In the partitioned tree, a new group leader must be selected or if the group leader revokes its group membership. Then the current node is a group member, it will become the new group leader after partitioned the tree. Otherwise, it will force one of its tree neighbours to be the leader. If there is any downstream node, it removes the entry for that group in its Multicast route table, specifying it is not the member to the tree anymore, and broadcast a multicast activation (MACT) message to this downstream node, indicating that it has no existence in that tree and for maintaining the all nodes the tree needs a leader. If more than one downstream node are there, then the recent node selects one downstream, become upstream link and broadcasts a a group-leader flag(MACT-GL) towards that node, indicating that it has other address in the tree then creates a new group leader node. The node changes the upstream direction into downstream after receiving MACT-GL from upstream. Otherwise, it continues the above procedure till a group member is reached and becomes the new group leader.

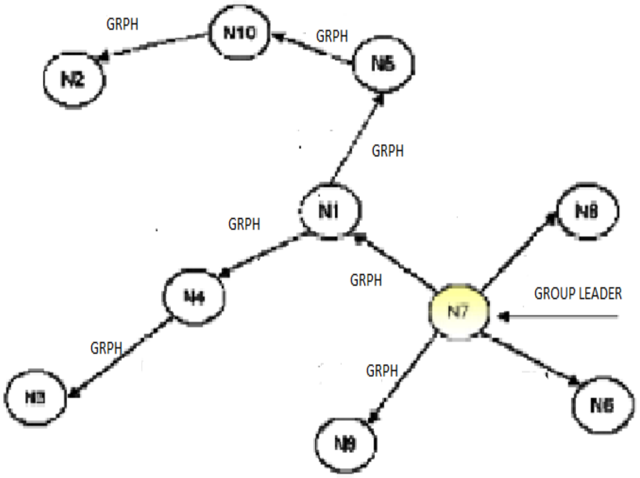

Figure 4: Group Leader in Multicast Tree

3.3.4 Tree Merge

If the member of the tree has a smaller group leader address that receives group hello packets (GRPH) generated by another group leader with a larger address for the same group then tree merge can be detected. After confirming for the leader's permission for reconstruct the tree, the tree member initiates the merge by unicastly sending a RREQ with a repair flag (RREQ-R) to the group leader. Until the leader is reached from downstream to upstream the RREQ-R propagates continuously. If the other nodes do not have the permission to reconstruct the tree, it can acknowledge a RREP with a repair flag (RREP-R) to that request node. The RREP-R follows this reverse route to the request node when receiving RREQ-R, the reverse route to the request node is formed. If there is another tree for that group with a group leader having a larger address then, the RREQ-R and RREP-R cycle is omitted and the leader has not allowed any other tree member to recreate the tree.

4. PERFORMANCE EVALUATION

4.1. SIMULATION

The simulations are performed using Network Simulator 2 (NS-2), particularly popular in the wireless networking community. The performance of RAODV is evaluated by comparing it with MAODV protocol in same condition. In our simulation, MAC protocol is the IEEE standard 802.11 Distributed Coordination Function (DCF) [10].The traffic sources are constant bit rate (CBR). Half of nodes are static, half of nodes move with a random mobility model. For mobile nodes, velocities ranged between 0 m/s and 20 m/s, while the pause time was set to 30 seconds. The data packet size is 512 bytes.

In the scenarios, the no of nodes in the network increase from 20 to 100 gradually. The size and the area are selected .So that the nodes density is approximately constant, which would properly reflect the scalability of routing protocols. Each simulation was run for duration of 900 seconds. In graph we use is an average of 5 simulations sample data. We evaluated three performance metrics:

4.1.1. Packet delivery ratio:

The ratio of the data packets delivered to the destinations to those generated by the sources.

$$\frac{\sum Numberof\,ReceivedDataPackets}{\sum NumberofSentDataPackets}$$

4.1.2. Average control overhead:

The control packet overhead that for route discovery, clusters maintain and route repair etc.

4.1.3. End-to-end delay:

The average delay includes all possible delays caused by route discovery, propagation, and transfer times etc.

$$\frac{\sum \left(Time_{packetarrive\,@\,dest} - Time_{packetsent\,@\,source}\right)}{TotalNumberofConnectionPairs}$$

4.1.4. Throughput :

The amount of packet successfully delivered to all the nodes in the network. It is generally expressed in bits per second (bps) or kilobits per second (kbps).

4.2. RESULT AND ANALYSIS:

In the scenario, we studied the scalability of the protocols. For our simulation we have assumed that the sensor network is static, where all the sensor nodes have the same radio range and also energy is uniformly distributed among all the sensor nodes. Simulations are carried out in a non-beacon mode and all the devices have the capabilities of a coordinator.

The results are shown in Fig.3. As shown in Fig. 3(a), both RAODV and MAODV show high packet delivery ratio even for networks with 100 nodes. But RAODV consistently delivers about 1-2 percent more data packets than MAODV. Due to multipath in MAODV [12] there can be many stale routes which may contribute to less packet delivery and increase of routing overhead in the network. Thus, an active route in RAODV usually lasts longer and more data packets can be delivered.

Fig. 3(b) shows the route overhead of the comparing route protocols. When nodes are above 40 then overhead of MAODV is increasing slowly with RAODV, when the nodes are more than 60, the overhead of MAODV increase rapidly. In MAODV uses the multicast routing traffic so it allows the packets to move in many paths. RAODV on the other hand uses reverse path technique to find the paths which naturally increases the number of control packets needed to keep track of the increasing number of paths. Here for our simulation since we have assumed that the nodes are static, link failures is very rare and hence computing for link failures will lead to additional overhead in MAODV, The low control overhead is critical for RAODV. RAODV has light overhead.

In fig. 3(c) RAODV has less network delay when compared with MAODV. If the control packet or overhead is to be more then successful packet will delivered less for that reason delay also be more and converge at a point as the packets are varied indicating that the network gets saturated.

Here in MAODV the duplicate copies are not discarded immediately. This leads to more end to end delay in the network for MAODV. So the interval time between sending by the source node and receiving by the destination node, which includes the processing time and queuing time increases.

In fig. 3(d) shows the throughput of comparing route protocols. RAODV has better outcomes than MAODV. It is mainly depends on the lower delay and better successful packet delivered in the network because when the route will be lost then MAODV uses multicast routing traffic but RAODV sends packet consistently due to fast route recovery process than MAODV.

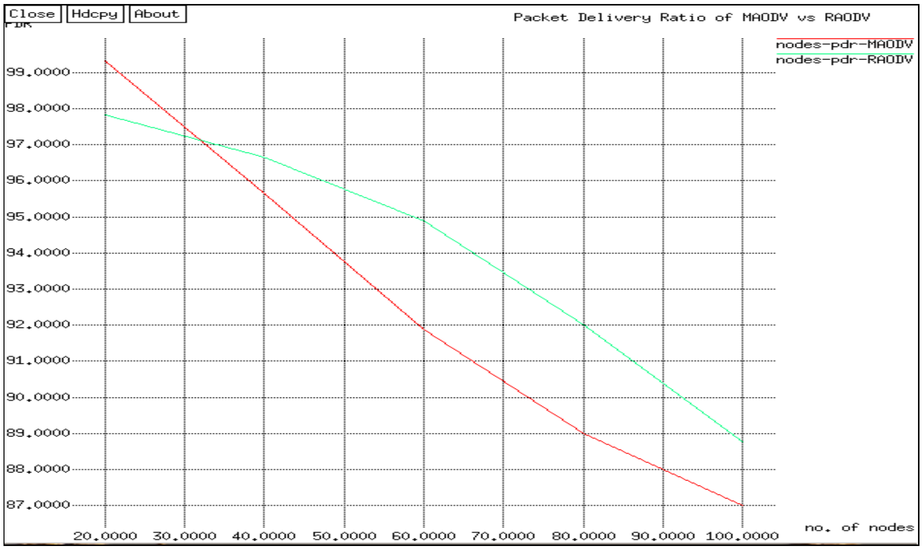

Fig: 3(a) Packet Delivery Ratio

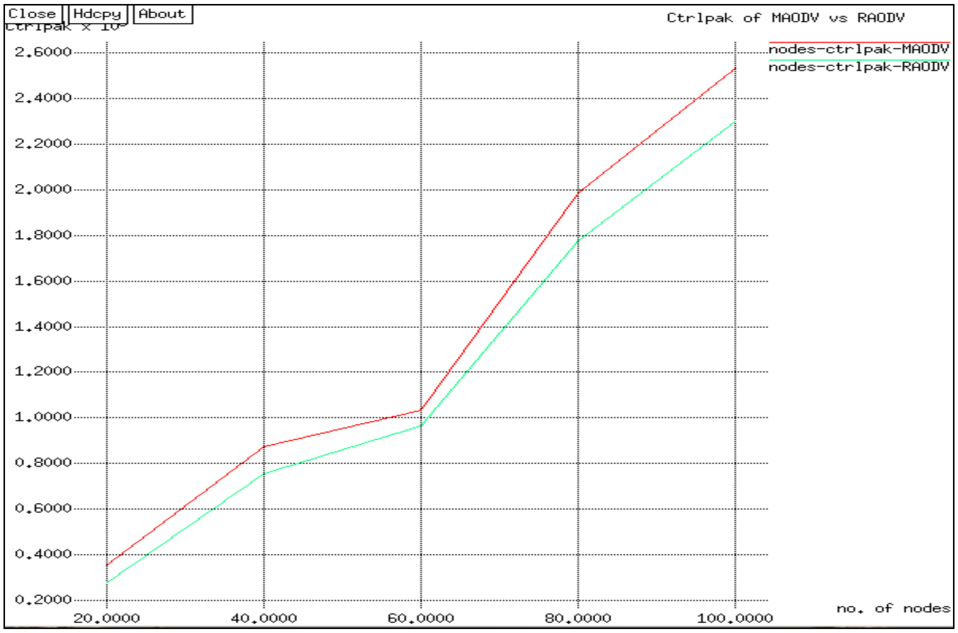

Fig: 3(b) Average Control Packet

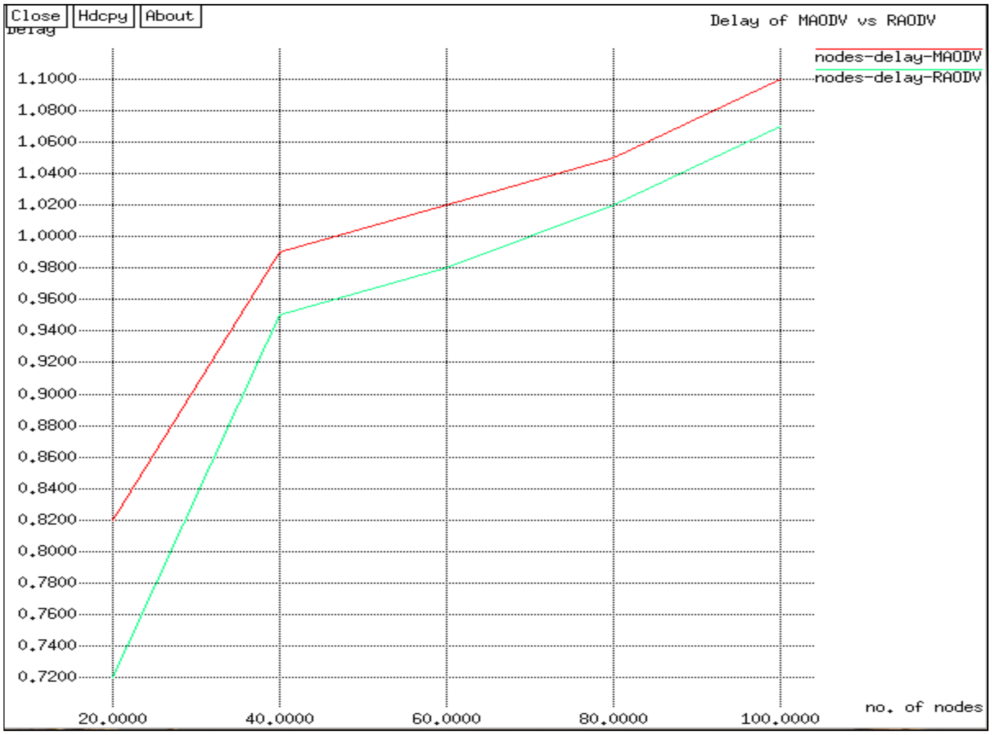

Fig: 3(c) End to End Delay

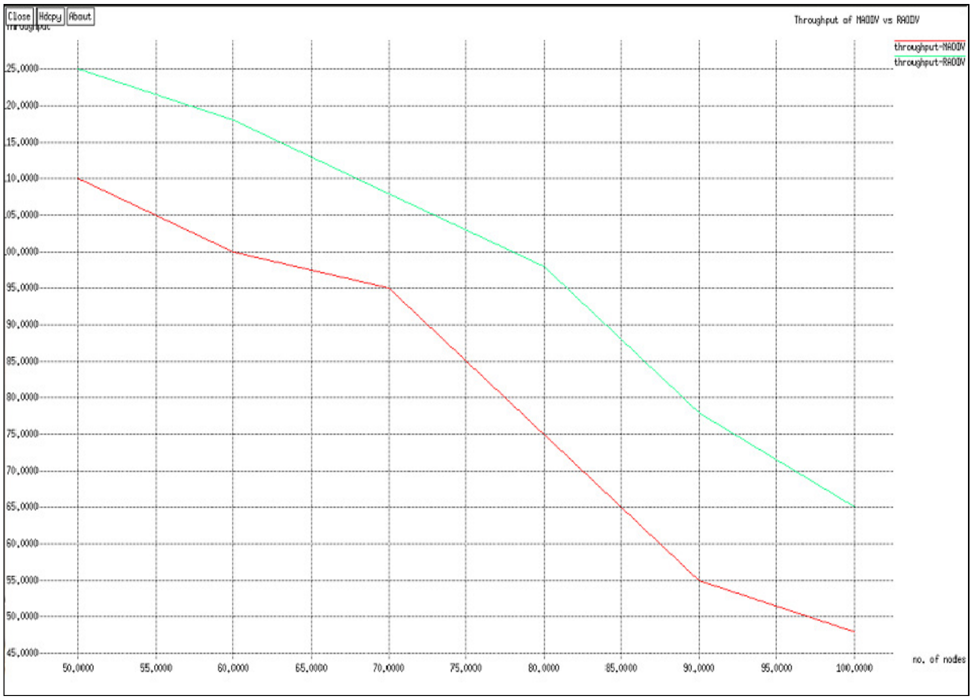

Fig: 3(d) Throughput

5. CONCLUSIONS

This approach can be utilized for determine the routing metric with less scalability and mobility in between two routing protocols, namely reactive routing protocol Multicast Ad hoc On-Demand Distance Vector Routing (MAODV) and Reverse Adhoc On-Demand Distance Vector routing protocol in Tool command language and integrated the module in the ns-2 [13] Simulator. We determine the performance comparison of the two protocols and simulations were carried out with identical topologies and running different protocols on the mobile node in the network. In the routing protocols, performance were considered with respect to metrics like Packet delivery ratio, end to end delay, control overhead, throughput and compared the X-graph between these two protocols. This simulation results illustrate that RAODV provide better packet delivery rate with less route latency and overhead than any other routing protocol like AODV. For denser medium RAODV provides better security to data packets for scrubby and significant security. In RAODV we changed route replay packet configuration of AODV and named it RRREQ.

Our future work includes designing a new routing protocol that takes in to consideration the various challenges under which a routing protocol has to work in a unique and challenging sensor environment. With all these research challenges, we robustly accept as true that we have a very stirring time ahead of us in the area of MANET.

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