Performance Evaluation of AODV for Mobile Ad Hoc Network with Varying Probability and Node Mobility

Mohit Yadav[1] , Santosh Kumar[2]

[1,2]BRCMCET, Bahal
[1]luckymohit87@mail.com
[2]santoshkumarthakur1@mail.com

Abstract:
Broadcasting is a common method used for route discovery and service discovery. One of the simple ways of broadcasting methods is simple flooding. Due to this simple flooding, it provokes high number of unnecessary packet rebroadcasts, causing contention, and packet collisions. The high number of redundant broadcast packets due to flooding in MANETs has been referred to as the Broadcast Storm Problem. A probabilistic approach to flooding has been proposed as one of most important suggested solutions to solve the broadcast storm problem. This paper proposed probabilistic method to improve the performance of AODV protocol by reduced the overhead and average end to end delay. This paper is subjected to the on demand routing protocol AODV and evaluated its performance. We investigated the performance metrics namely Control Packet Overhead and Average end-to-end delay and Number of Retransmitting nodes by varying probability and node mobility through simulation using NS-2 network simulator.

Keywords – Broadcasting, Flooding, Overhead, AODV, Simulation and NS – 2

I. Introduction

A Mobile Ad hoc Networks (MANETs) [1] represents a system of wireless mobile nodes that can freely and dynamically self-organize in to arbitrary and temporary network topologies, allowing people and devices to seamlessly communicate without any pre-existing communication architecture. Each node in the network also acts as a router, forwarding data packets for other nodes. A central challenge in the design of ad hoc networks is the development of dynamic routing protocols that can efficiently find routes between two communicating nodes. Our goal is to carry out a systematic performance study of routing protocol Ad hoc On Demand Distance Vector (AODV) [2] [4] for ad hoc networks. Moreover our analysis is based on varying probability and node mobility in the Ad Hoc Network.

II. Broadcasting and Flooding

It is the process in which one node sends packet to all other nodes in network and host on receiving a broadcast message for the first time, has the obligation to rebroadcast the message. In mobile ad hoc network broadcast [2] is used in two ways.

- To broadcast control packet at the time for route discovery.
- To broadcast data packet.

All these protocols uses a simplistic form of broadcasting called Flooding [2], in which each node retransmits each received unique packet exactly one time. The main problems with Flooding are that flooding can be very costly and can lead to serious redundancy, bandwidth contention and collision: a situation known as broadcast storm [3].

Recently, a number of research have proposed more efficient broadcasting techniques [2] whose goal is to minimize the number of retransmissions while attempting to ensure that a broadcast packet is delivered to each node in the network.

III. Probabilistic Scheme

This is similar to flooding [2] except that nodes broadcast the packets with predetermined probability. This scheme [2] is identical to simple flooding when probability of broadcast is 100%. In dense network, the number of nodes in the network is more hence there is more shared coverage. In this case, the probability should be low to achieve the reach-ability. In the sparse network, where the number of nodes are separated with greater distance hence there is less shared coverage. In that case, the probability should be low to achieve the reach-ability.

IV. Ad Hoc On Demand Vector Routing Protocol

AODV [1] is on demand protocol because it initiates the route discovery process only if it has packets to send and destination is unknown. AODV is loop-free due to the destination sequence numbers associated with routes. This sequence numbers determine the freshness of routes. All the routing packets in the networks have their own unique sequence numbers.

A. Route Discovery

The route discovery process starts when source node has the route request packet (RREQ) for destination node. Firstly, source node broadcasts the route query packet to its neighbors. If any of its neighbor any the route to the destination node, then it replies to the query with the route reply packet otherwise neighbor rebroadcast the route request packet. Finally, the packet will reach the destination as shown in figure 1.

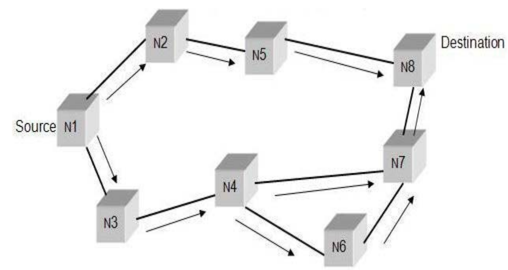

Figure1. Route Request Packet Propagation in AODV

After reaching to the destination, a query is produced as a route reply packet and transmitted to the source node by back tracing the route followed by route request packet.

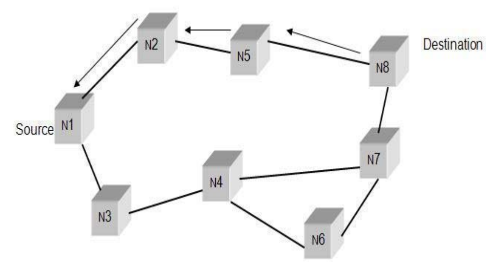

Figure2. Route Reply Packet Propagation in AODV

B. Route Maintenance

When a node detects that a route to a neighbor no longer is valid, it will remove the routing entry and send a link failure message, a triggered route reply message to the neighbors that are actively using the route, informing them that this route no longer is valid. For this purpose AODV uses an active neighbor list to keep track of the neighbors that are using a particular route. The nodes that receive this message will repeat this procedure. The message will eventually be received by the affected sources that can chose to either stop sending data or requesting a new route by sending out a new RREQ.

V. SIMULATION ENVIRONMENT

I have used the ns-2 packet level simulator (v.2.31) [5] to conduct extensive experiments to evaluate the performance of probabilistic flooding. The network considered for the performance analysis of the rebroadcast probability vs. control packet overhead, average end to end delay, and number of retransmitting nodes with fixed number of nodes 100 placed randomly on 400 * 400 m^2,having bandwidth of 2Mbps. The random waypoint model is used to simulate the mobility patterns with retransmission probabilities ranging from 0.1 to 1.0 with 0.1 percent increment per trial. The maximum speeds of 2, 4, 6, 8, 10 meter/second and pause times of 2 seconds are considered for the purposes of this study.

A. Simulation Model:

We consider a network of nodes placing within a 400m X 400m area. The performance of AODV is evaluated by keeping the number of nodes and pause time constant and varying the probability and node mobility. Table 1 shows the simulation parameters used in this evaluation.

Table 1 Simulation Parameters

Simulator	NS 2.31
Protocol	AODV
Simulation Duration	100 seconds
Simulation Area	400m x 400m
Number of nodes	100
Movement Model	Random Waypoint
MAC Layer Protocol	IEEE 802.11
Pause Time	2 seconds
Node Mobility	2 m/s to 10 m/s
Traffic Type	CBR(UDP)
Data Payload	256 bytes/sec
Maximum Probability	0.1 to 1

B. Performance Metrics

While analyzed the AODV protocol, we focused on three performance metrics which are Control Packet Overhead, Average End-to-End Delay and Number of Retransmitting Nodes.

Control Packet Overhead (CPO): It is the number of packets generated by routing protocol during simulation. The generation of overhead will decrease the protocol performance.

Average end to end delay of data packets (AD): The average time from the beginning of a packet transmission at a source node until packet delivery to a destination. This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, re-transmission delays at the MAC, and propagation and transfer times of data packets. Calculate the send(S) time (t) and receive (R) time (T) and average it.

Number of Retransmitting Nodes: It is the number of nodes that retransmit the message to other nodes in the network area.

VI. EXPERIMENTAL RESULTS:

The performance of AODV based on the varying the probability and speed of nodes is done on parameters like control packet overhead, average end-to-end delay and number of retransmitting nodes. “Fig.3”, helps us to see the flow of packets i.e. route discovery between 100 nodes by NAM which is a built-in program in NS-2-allinone package.

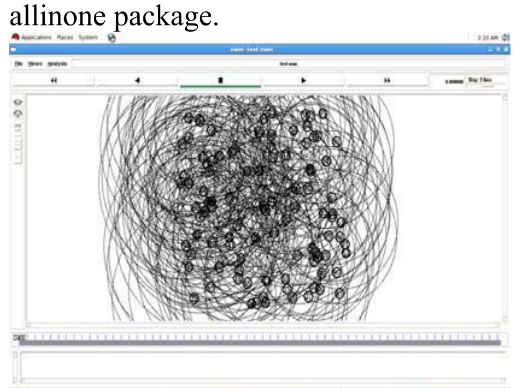

Figure 3 Screenshot of AODV with 100 nodes: Route Discovery

1. Control Packet Overhead vs Probability

"Fig. 4", highlights the relative performance of AODV i.e. it delivers a less overhead at probability 0.7. The redundant packets in network are 891 at highest node mobility 10m/s. It is the least value among all. It is the best result when 70% of nodes are broadcasting with maximum speed and only 891 redundant packets are there in network. The reason for having high probability is to achieve the reach-ability. Reach-ability means that the source packet should reach to the destination. The reach-ability will be good when probability is high i.e. at least 50% to 70% of nodes are transmitting the packets in the network

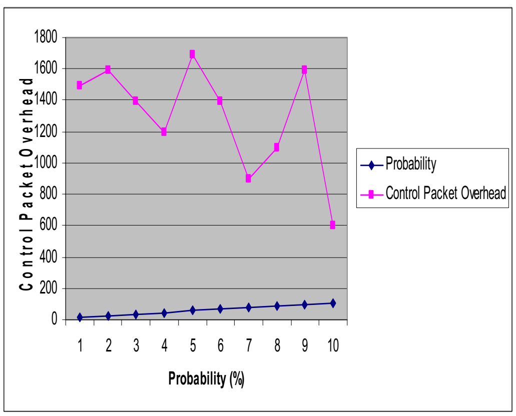

Figure 4 Control Packet Overhead vs Probability with Node Mobility 10m/s

2. Average end to end delay vs Probability:

As node mobility increases, the average delay increases because when node mobility increased, more RREQ packets fail to reach their destinations. In such circumstances more RREQ packets are generated and retransmitted, which lead to higher chance of collision due to the increase in control packets.

As probability increases, average delay increases because as number of broadcasting nodes increases then control packet takes more time to reach the destination. This increased time taken by all the nodes between source to destination is counted as a delay. This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, re-transmission delays at the MAC, and propagation and transfer times of data packets.

Note the value of average delay for probability 0.1 with different node mobility.

Table 2 Effect of Node Mobility on Average Delay

Node Mobility 2m/s	2.76
Node Mobility 10m/s	23.21

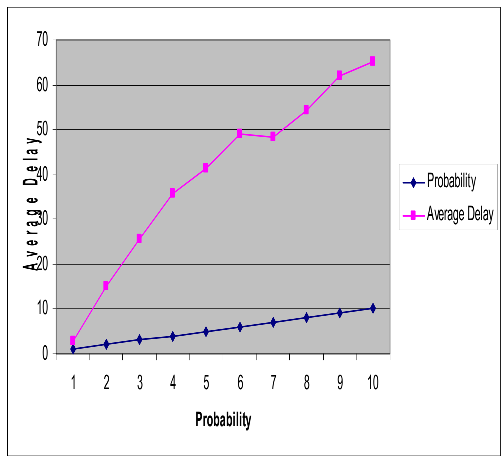

Figure 5 Average Delay vs Probability with Node Mobility 2m/s

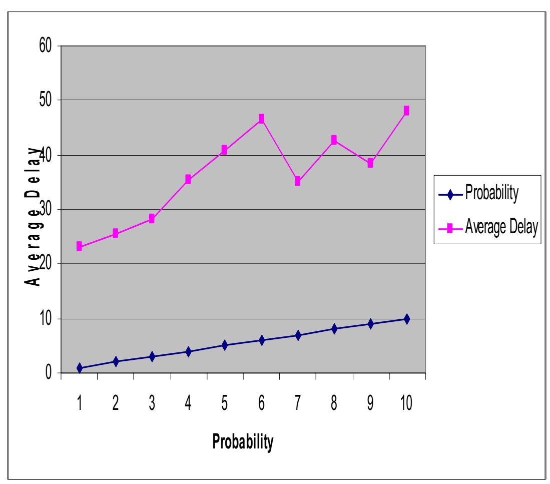

Figure 6 Average Delay vs Probability with Node Mobility 10m/s

3. Retransmitting Nodes vs Control Packet Overhead

As redundant packets increases, the overhead increases with randomly varies probability. The reason of increasing the overhead is increased number of retransmitting nodes in the network.

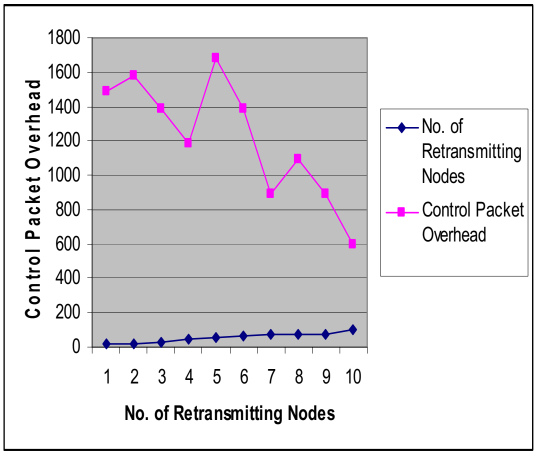

Figure 7 Retransmitting Nodes vs Control Packet Overhead with Node Mobility 10m/s

CONCLUSION AND FUTURE WORK

The AODV routing protocol is evaluated using probabilistic scheme for performance metrics such as Control Packet Overhead, Average end-to-end delay and number of retransmitting nodes with increasing probability and node mobility. Since AODV is a reactive protocol so restriction the flooding to some extent might reduce the delay and also the control packet overhead keeping better reach-ability. Thus on increasing the probability the control packet overhead, average delay and number of retransmitting nodes varies. This is simulated under lower to higher node mobility environment. When probability reaches to one then it defines flooding scenario. Before every flooding scenario, all other cases are the improved one in which there is less overhead and average end to end delay. it would be interesting to analyze the probability for dense and sparse network. In dense networks, multiple nodes share similar transmission coverage then probability should be low. In sparse networks, there is much less shared coverage then probability should be high to achieve reach-ability. As a continuation of this research in the future, we can plan to combine our algorithm with a counter-based approach.

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