Performance Evaluation of AODV protocol in MANET using NS2 Simulator

Nisarg Gandhewar
MTech II Year
Deptt of CSE
RCERT Chandrapur

Rahila Patel
Assistant Professor
Deptt of CSE
RCERT Chandrapur

ABSTRACT

The widespread use of mobile and handheld devices is likely to popularize ad hoc networks, which do not re-quire any wired infrastructure for intercommunication, in which each node can move in any direction & acts as a router. To assist communication in such network, a routing protocol is vital whose primary aspiration is to set up proficient route among pair of nodes, due to this lot of reactive, proactive & hybrid routing protocols have been proposed, Out of which one of most popular one is Adhoc on-demand distance vector routing (AODV) due to its high performance gain compared to other protocols in MANET, therefore its performance needs to be evaluated by making use of various metrics such as end to end delay, packet delivery ratio (PDR) & Packet loss.

So this paper presents simulation result obtained in the form of variations in the values of end to end delay, packet delivery ratio(PDR) & Packet loss for AODV when we vary number of nodes in network, simulation is carried out using widely use simulator NS2, also this paper provides overview of working, features & benefits of AODV compared to others protocols.

Keywords

MANET, AODV, Proactive, Reactive, PDR, NS2.

1. INTRODUCTION

MANET is one of self configuring fastest emerging, due to commencement of economical, small & more powerful wireless devices. It is being used in most of applications, ranging from military to civilian, where each node acts as router. To facilitate communication in adhoc network, a routing protocol is vital whose primary goal is to establish accurate & efficient route between pair of nodes, due to this lot of routing protocols have been proposed for MANET & its success depends on people's confidence in its security.

The routing protocols mainly classified into three major categories proactive, reactive & hybrid. Proactive protocols continuously learns topology of the network by exchanging topological information among network nodes, where each node builds its own routing table which it can be use to find path to destination. If the network topology changes too frequently, the cost of maintaining network might be very high. DSDV, OLSR, CGSR belongs to this category. In reactive routing nodes do not exchange any routing information. A source node obtains path to specific destination only when it needs to send some data to it. AODV, DSR CBRP are some example of this category. Hybrid routing protocols is a combination of both reactive & proactive routing protocols. ADV, ZRP will represent this category [3].

Out of this AODV is a very simple, efficient, and effective routing protocol which is use mostly. This algorithm was motivated by the limited bandwidth that is available in the media that are used for wireless communications. Obtaining the routes purely on-demand makes AODV a very useful and desired algorithm for MANETs.

The routing protocols for ad hoc wireless network should be capable to handle a very large number of hosts with limited resources, such as bandwidth and energy. The main challenge for the routing protocols is that they must also deal with host mobility, meaning that hosts can appear and disappear in various locations. Thus, all hosts of the ad hoc network act as routers and must participate in the route discovery and maintenance of the routes to the other hosts. For ad hoc routing protocols it is essential to reduce routing messages overhead despite the increasing number of hosts and their mobility. Keeping the routing table small is another important issue, because the increase of the routing table will affect the control packets sent in the network and this in turn will affect large link overheads.

The performance of any routing protocol can be realized quantitatively by means of various performance metrics such as PDR packet delivery ratio, end to end delay & packet loss. Simulation result can be obtained by varying number of nodes in the network by using simulator NS2 [1].

The rest of the paper is organized as follows: Section 2 presents overview of AODV protocol describing its working, while section 3 describe evaluation criteria to be consider to evaluate performance of AODV, Where as section 4 depicts simulation model use, while section 5 describes results & its analysis where as section 6 concludes this paper & finally section 7 presents our future work.

2. OVERVIEW OF AODV

AODV is motivated by limited bandwidth that is available in the media that are used for wireless communications is essentially a combination of both DSR and DSDV. It borrows the basic on-demand mechanism of route discovery and route maintenance from DSR, plus the use of hop-by-hop routing, sequence numbers, and periodic update packets from DSDV. The main benefit of AODV over DSR is the source route does not need to be included with each packet. This results in a reduction of routing protocol overhead. Unfortunately, AODV requires periodic updates which consume more bandwidth than is saved from not including source route information in the packets. AODV discovers a route through network wide broadcasting. The source host starts a route discovery by broadcasting a route request to its neighbors [5]. When a node wants to send a packet to some destination node and does not have a valid route in its routing table for that destination, it initiates a route discovery process. It is describe in detail as follow [2].

2.1 Control Messages in AODV

There are four control messages are used by AODV described as below

2.1.1 Routing Request (RREQ)
When a route is not available for the destination, a route request packet (RREQ) is flooded throughout the network which contains the following format [5].

source address	request ID	source sequence No.	destination address	destination sequence No.	hop count

Fig.1 RREQ Format

2.1.2 Routing Reply (RREP)
If a node is the destination, or has a valid route to the destination, it unicasts a route reply message (RREP) back to the source. This message has the following format [9].

source address	destination address	destination sequence No.	hop count	life-time

Fig.2 RREP Format

2.1.3 Route Error Message (RERR)
All nodes monitor their own neighborhood and broadcast message when:

- A node detects that a link with adjacent neighbor is broken (destination no longer reachable).
- If it gets a data packet destined to a node for which it does not have an active route and is not repairing.
- If it receives a RERROR from a neighbor for one or more active routes, to notify the other nodes on both sides of the link about loss of this link.

2.1.4 HELLO Messages
Each node can get to know its neighborhood by using local broadcasts, so-called HELLO messages. Nodes neighbors are all the nodes that it can directly communicate with. Although AODV is a reactive protocol it uses these periodic HELLO messages to inform the neighbors' that the link is still alive. The HELLO messages will never be forwarded because they are broadcasted with TTL = 1. When a node receives a HELLO message it refreshes the corresponding lifetime of the neighbor information in the routing table.

2.2 Working of AODV
When a node wishes to send a packet to some destination
It checks its routing table to determine if it has a current route to the destination
If Yes, forwards the packet to next hop node
If No, it initiates a route discovery process [8].

2.2.1 Route discovery
It begins with broadcasting of RREQ to its neighbors specified for certain destination.
. Once an intermediate node receives a RREQ,
It check its routing table for route to dest
If found send RREP to source
If not found it rebroadcast RREQ to its neighbor nodes by setting up a reverse route path to source node in its route table.
It ignores RREQ if it is processed already [6].
Finally on reaching RREQ to destination node, It unicast RREP to source node by using reverse route to source node
The above procedure can be described visually as follows

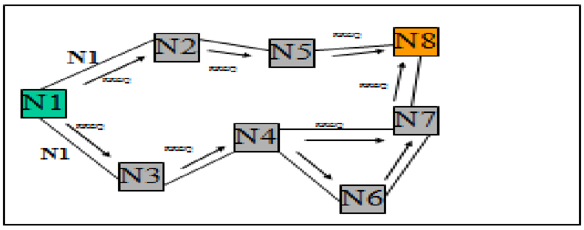

Fig. 3 Route Discovery

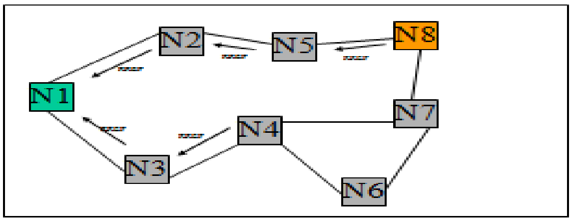

Fig. 4 Route Reply

2.2.2 Route Maintenance Stage
A hello message is broadcasted by *active* nodes periodically.
If no hello message from a neighbor
The upstream node will notify the source with an RERR packet & entire routes based on the node is invalidated.
Source will initialize a new route discovery stage and flood the RREQ packet [8].
Above procedure can be realized in the following figure

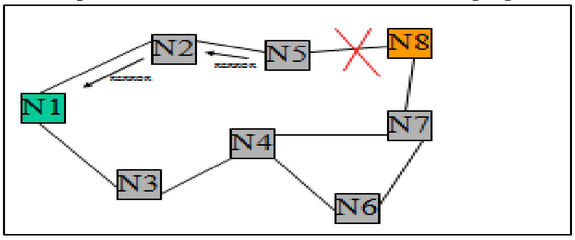

Fig. 5 Propagation of RERR

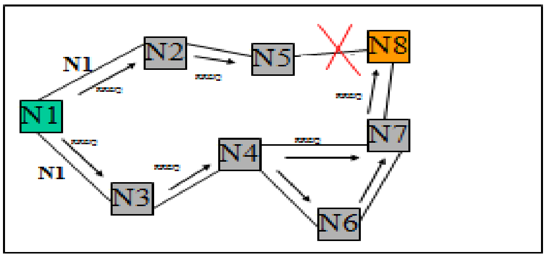

Fig.6 Route Rediscovery

3. EVALUATION CRITERIA
Performance of AODV protocols in MANET can be realized by quantitative study of values of different metrics used to measure performance of routing protocols which are as follows.

3.1 Average end-to-end delay
It is defined as average time taken by data packets to propagate from source to destination across a MANET. This includes all possible delays caused by buffering during routing discovery latency, queuing at the interface queue, and retransmission delays at the MAC, propagation and transfer times The lower value of end to end delay means the better performance of the protocol [4].
End to end delay = Σ (arrive time - send time)

3.2 Packet Delivery Ratio

Its a ratio of the number of packets received by the destination to the number of packets send by the source This illustrates the level of delivered data to the destination. The greater value of packet delivery ratio means better performance of the protocol.

PDR = Σ No of packet receive / Σ No of packet send

3.3 Packet Loss

It is the measure of number of packets dropped by nodes due to various reasons. The lower value of the packet lost means the better performance of the protocol [1].

Packet lost = No of packet send – No of packet received.

4. SIMULATION MODEL

For the simulation of the developed system, latest version 2.34 of NS-2 has been used in this paper. Ns-2 is a discrete event simulator targeted at networking research [6]. It began as a part of the REAL network simulator and is evolving through an ongoing collaboration between the University of California at Berkeley and the VINT project [14].

4.1 Simulation Parameters

There are number of simulation parameters which can be varied, results in change in value of different performance metrics, which can be shown in below table.

Sr No	Parameter	Value
1	Simulator	NS-2 (Version 2.34)
2	Channel type	Channel/Wireless channel
3	Radio Propagation Model	Propagation/ Two ray ground wave
4	Network interface type	Phy/WirelessPhy
5	MAC Type	Mac /802.11
6	Interface queue Type	Queue/Drop Tail
7	Link Layer Type	LL
8	Antenna	Antenna/Omni Antenna
9	Maximum packet	150
10	Area (M*M)	700 * 700
11	Simulation Time	500 sec
12	No of Nodes	10-50
12	Routing Protocol	AODV

Table1. Simulation Parameter

4.2 Simulation Scenario

There can be the possibility of following two scenarios shown in fig 7 & 8 below one is, static where nodes are constant & another is dynamic where nodes are moving continuously which is consider in this paper.

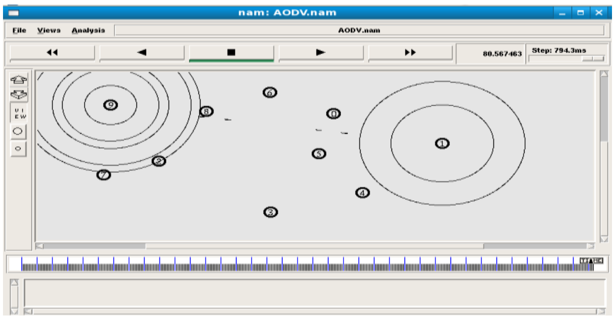

Fig.7 Static Simulation Scenario

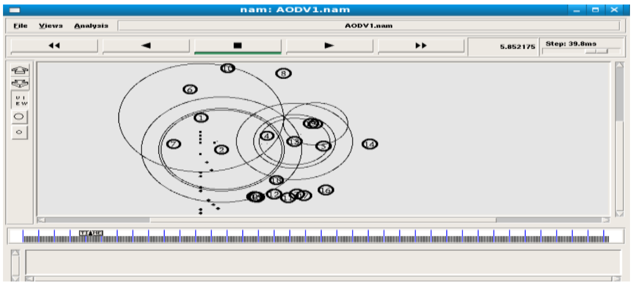

Fig. 8 Dynamic Simulation Scenario

5. RESULT AND ANALYSIS

5.1 For PDR

Sr No	No of Nodes	PDR	Packet Sent	Packet Received
1	10	0.8145	4388	3574
2	20	0.8489	4388	3725
3	30	0.8870	4388	3892
4	40	0.7557	4388	3316
5	50	0.5882	4388	2581

Table 2. Simulation Result for PDR

Analysis:

From above table we can say that value of PDR is not increasing constantly when we vary number of nodes from 10 to 50, & find that it is increasing initially but then it decreases for 40 nodes & finally it increases for 50 nodes.

5.2 For End to End Delay

Sr No	No of Nodes	End to End Delay
1	10	1.0635
2	20	0.8528
3	30	0.2246
4	40	0.8545
5	50	0.4037

Table 2. Simulation Result For End to End delay

Analysis:

From above table we can say that value of end to end delay is decreasing constantly for up to 30 nodes then it suddenly increases for 40 nodes & finally it decreases for 50 nodes.

5.3 Packet Loss

Sr No	No of Nodes	Packet Loss
1	10	814
2	20	663
3	30	496
4	40	1072
5	50	1807

Table 3. Simulation Result For Packet Loss

Analysis:

From above table we can say that value of packet loss is decreasing initially up to 30 nodes constantly when we vary number of nodes from 10 to 50, but then it increases for last two nodes.

6. CONCLUSION

Thus we have evaluated the performance of very popular on demand routing protocol AODV, by means of various performance metrics such as PDR, end to end delay & packet loss, as well obtained simulation results by varying number of nodes in the network & found that there is non linear change in the values of these metrics also we realized working & control massages involved in AODV protocol.

7. FUTURE WORK

Our future work mainly involves to evaluate the performance of AODV under sinkhole attack by finding the variation occurred in the values of these performance metrics when AODV is under sinkhole attack & to perform the comparative analysis of the simulation results obtained for AODV before & after sinkhole attack.

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