

# Performance Evaluation and Analysis of Energy Efficient Routing Protocols in Mobile Ad Hoc Networks

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**Abstract—** The advent of mobile and hand – held devices is likely to popularize the use of Ad Hoc Networks. A Mobile Ad Hoc Network is a collection of Wireless Mobile nodes forming a Network without a wired infrastructure for the intercommunication. The wireless communication medium is unpredictable and variable in its nature. Thus, routing protocols are vital to set proficient routes among the nodes. Thus, lot of routing protocols have been propose, among them AODV and DSR are popular as it renders high performance compared to other protocols. This paper presents the results of performance comparison of energy, throughput and variations in values of the protocols. Simulation is obtained from widely used NS2 Simulation.

**Keywords—**AODV; DSR; MANET; NS2.

## I. INTRODUCTION

Mobile Ad Hoc Network is a group of wireless mobile device which can dynamically reconfigurable the network. MANets are mainly battery powered and eventually energy in node depletes then the node drops out the network. Unless the nodes are replaced and recharged network becomes partitioned [1]. Another feature of Mobile Ad Hoc Networks is that the routes are discovered by the nodes itself thus routing functionality must be incorporated in to the nodes. The participating nodes acts as routers, free to move randomly, manages themselves thus arbitrary and changing topology is created. Mobile Nodes can directly communicate to other nodes that are in radio range [3] of each other, whereas other nodes need to help intermediate nodes to route their packets. AODV and DSR are the popular routing protocols with high performance, thus their performance need to be evaluated using different metrics. Thus this paper presents the results obtained from the NS2 Simulation, comparing the performances of these two protocols.

## II. PROTOCOL OVERVIEW

### A. DSR (*Dynamic Source Routing*)

Dynamic Source Routing is efficient routing protocol specially designed for multi – hop Mobile Ad Hoc Networks. This routing protocol has two phases, Route Discovery and Route Maintenance. These two phases help nodes to maintain best routes from source to destinations [4]. This protocol

enables loop free routing as the intermediate nodes do not require up-to-date routing information, as it maintains routing information in a cache in every node. The key feature of this routing is source routing. That is, the sender knows the complete hop-to-hop routing path from source to destination. The data packets carry the source route in the header. When the node attempts to send the packets from source to destination, for that it does not already know the route, it uses source routing and dynamically discovers the route. Route discovery works by flooding the network with Route Request (RREQ) packets [2]. Each node receiving an RREQ rebroadcasts it, unless it is the destination or it has a route to the destination in its route cache. Such a node replies to the RREQ with a route reply (RREP) packet that is routed back to the original source. RREQ and RREP packets are also source routed. The RREQ builds up the path traversed across the network. The RREP routes itself back to the source by traversing this path backward. The route carried back by the RREP packet is cached at the source for future use. If any link on a source route is broken, the source node is notified using a route error (RERR) packet.

### B. AODV (*Ad Hoc On-Demand Distance Vector*)

AODV is another Reactive Protocol which can quickly adapt to dynamic link conditions. And it is motivated by limited bandwidth available in media. AODV does not discover and maintain any route until two nodes needs to communicate. The main difference of AODV from DSR is the source route does not need to be included with each packet [9]. When a node wishes to send a packet in AODV to some destination it checks its routing table to determine whether it has current route to the destination. If Yes, forward the packet to the next hop node. If No, AODV initiates the route discovery process. Route Discovery works by broadcasting the RREQ to its neighbors specified for certain destination [7]. Once an intermediate node receives a RREQ, It checks its routing table for route to destination 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. Finally, on reaching RREQ to destination node, It unicast RREP to source node by using reverse route to source node [10].

### III. 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 [5] which are as follows.

#### A. 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 [4], 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.

$$\text{End to end delay} = \Sigma (\text{arrive time} - \text{send time})$$

#### B. Packet Delivery Ratio

It's a ratio of the number of packets received by the destination to the number of packets send by the source [8]. This illustrates the level of delivered data to the destination. The greater value of packet delivery ratio means better performance of the protocol.

$$\text{PDR} = \Sigma \text{No of packet received} / \Sigma \text{No of packet sent}$$

#### C. Packet Loss

It is the measure of number of packets dropped by nodes due to various reasons.[6] The lower value of the packet lost means the better performance of the protocol.

$$\text{Packet lost} = \text{No of packet sent} - \text{No of packet received.}$$

#### D. Energy

It is the measurement of network life time. Performance of Network lifetime is better by increasing number of nodes because destination nodes able receive higher energy routes[9].

$$\text{Energy} = \text{Power} * \text{Time}$$

### IV. 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. It began as a part of the REAL network simulator.

#### A. 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
13	Routing Protocol	AODV
14	Time of Simulation End	150

Table1. Simulation Parameter

#### B. Simulation Scenario

There can be the possibility of following two scenarios shown in fig 1 & 2 below one is, static where nodes are constant & another is dynamic where nodes are moving continuously which is considered in this paper for AODV and DSR.

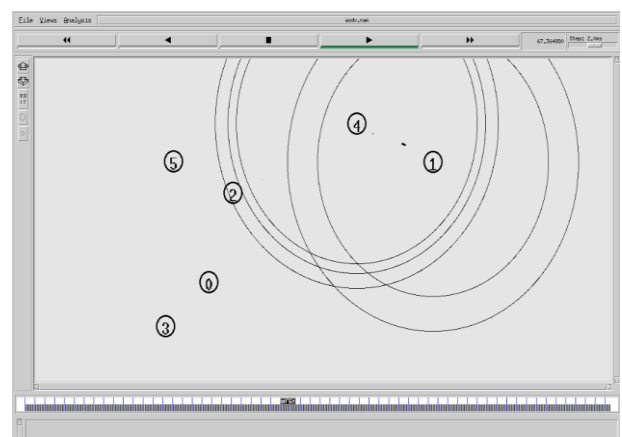


FIG.1 STATIC SIMULATION SCENARIO OF AODV

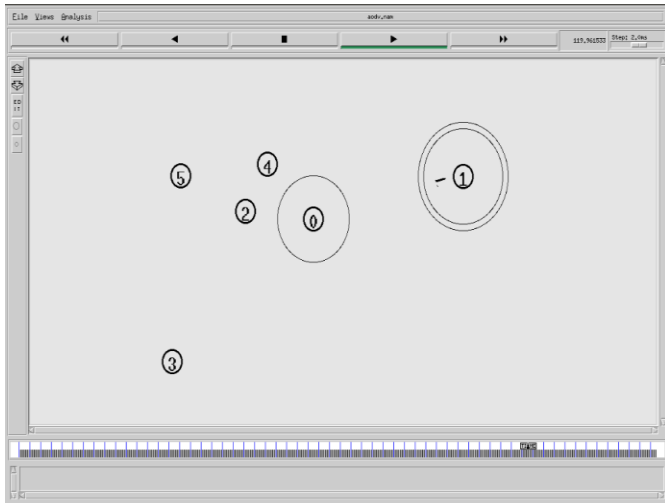


FIG.1 DYNAMIC SIMULATION SCENARIO OF AODV

C. Result and Analysis

• 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.

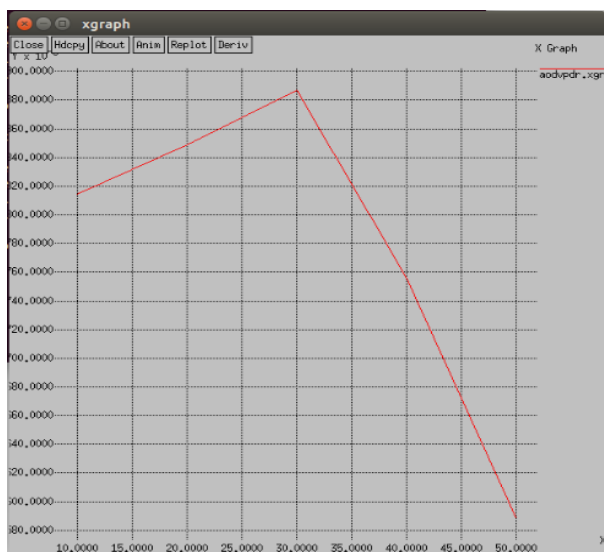


FIG.3 X-GRAPH FOR PDR ANALYSIS OF AODV

• 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 3. 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.

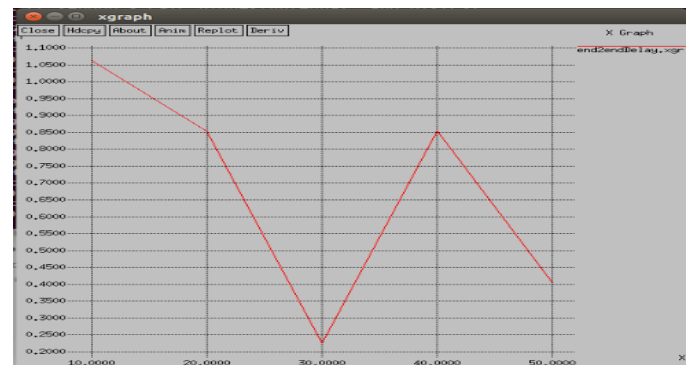


FIG.4 X-GRAPH FOR END TO END DELAY OF AODV

• 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 4. 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.

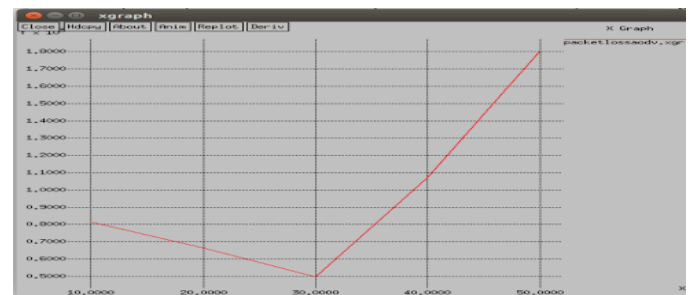


FIG.5 X-GRAPH FOR PACKET LOSS ANALYSIS OF AODV

- Energy

Sr.No	Number of Nodes	Network Life Time
1	10	5.04
2	20	9.04
3	30	9.6
4	40	9.55
5	50	9.55

Table 4. Simulation Result for Network Life Time

*Analysis:*

The simulation is conducted with 10 to 50 nodes for comparing performance of AODV protocol separately. Figure 6 has shown 10-50 nodes simulation result separately under the 1 m/s speed. Every node has random initial energy. Table 4 shows that the survival time of AODV. We also can conclude that the performance of network lifetime is better by increasing number of nodes because destination node able to receive higher energy routes thus energy saving routing protocol has prolonged the node's lifetime.

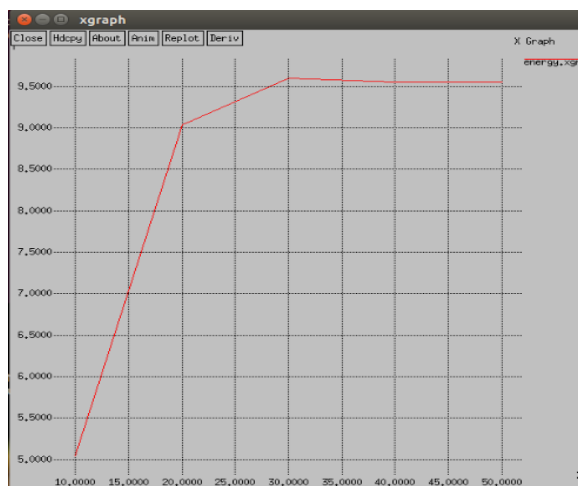


Fig.6 x-graph FOR Network Life Time ANALYSIS OF AODV

### V. 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 nonlinear change in the values of these metrics also we realized working & control messages involved in AODV protocol.

### VI. 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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