

# Modeling, Implementation and Performance investigation of Efficient-AODV Routing Protocol in MANET using Data Rate

G. L. Saini<sup>1</sup>, Deepak Panwar<sup>2</sup>, Vijander Singh<sup>3</sup>

<sup>1,2,3</sup>Amity School of Engineering & Technology, Amity University Rajasthan, Jaipur, India

---

**Abstract:** In mobile ad hoc networks, there is no fixed infrastructure to observe or assign the resources used by the mobile nodes. The nonexistence of any essential controller makes the routing a versatile one compared to cellular networks. The Ad hoc On Demand Distance Vector (AODV) routing algorithm is a routing protocol intended for ad hoc mobile devices. Due to quick changes of network structure the route reply may not arrive to the source node resulting in sending numerous route request messages and decreasing the performance of the routing protocol. To defeat these all problems, an efficient AODV (E-AODV) routing protocol is proposed. In E-AODV the destination a node accepts first route request message (RREQ), it produces turn-around route request (TA-RREQ) message and floods it to neighbor nodes within communication range. When the source node receives very first TA-RREQ message, then it starts packet transmission, and late entered TA-RREQs are reserved for future use. It decreases route fail alteration messages and gets good performance in compare to existing AODV.

**Keyword:** AODV, E-AODV, MANETs, NS-2, RREQ, RREP, TA-RREQ, RERR, pause time, mobility.

---

## INTRODUCTION

A Mobile ad hoc network (MANET) is a collection of wireless nodes that can enthusiastically structure a network to exchange information without using any fixed network infrastructure. These are generally mobile and that's why it is called as Mobile Ad hoc NETWORKS. MANETs are defined as a "mobile ad hoc network" is an autonomous system of mobile associated by wireless links the union of which built an arbitrary topology [1]. The routers are free to move arbitrarily and arrange themselves randomly, that's why the network wireless topology can be change rapidly and randomly such a network may operate in an impartial way. If two nodes are not within the transmission range of each other, other nodes are needed to serve as midway routers for the communication between sources to destination node.

Furthermore, mobile devices wander separately and communicate via enthusiastically changing network. Thus, numerous change of network topology is a hard challenge for many important issues, such as routing protocol robustness, and performance ruin resiliency. Proactive routing protocol requires nodes to exchange routing information occasionally and compute routes constantly between any nodes in the network, regardless of using the routes or not This means numerous network resources such as energy and bandwidth may be washed out, which is not desirable in MANETs where the resources are very important. On the other hand, on-demand routing protocols do not swap routing information occasionally [10][11]. Instead, they find out a route only when it is required for the communication between two nodes. Because of this dynamic change of network on ad hoc networks, links between nodes are not fixed. In occasions, a node can't send packets to the intended next hop node and this will lost the packets. Loss of packets may influence on route performance in many ways. Along with these packet losses, loss of route reply brings much additional problems, because source node needs to reinitiate route discovery procedure to send packets. A disadvantage of existing on-demand routing protocols is that their main route discovery systems are not well concerned about a route reply message loss. More specifically, most of today's on demand routing is based on single route reply message. The vanished of route reply message may cause an important waste of performance [2].

In this paper we proposed efficient AODV which has a new feature contrasted to other on-demand routing protocols on ad-hoc networks. In E-AODV, route reply message is not uni-cast, destination node uses turn around RREQ (TA-RREQ) to find source node. It decreases route path fail modification messages and can improve the performance. Thus, success rate of

route discovery may be increased even in high node mobility situation. The simulation results show our proposed algorithm improves performance of AODV [9] in most metrics, including packet delivery fraction, average end to end delay and average throughput especially in high speed mobility of nodes [2].

### LITERATURE REVIEW

#### Ad-Hoc on Demand Distance Vector Routing Protocol (AODV)

Royer et.al.[3] The Ad-hoc On-Demand Distance Vector routing Protocol (AODV), is one of more studied routing algorithm in ad hoc networks and is based on the rule of discover routes as required. AODV routing algorithm is a famous method for building routes paths between network nodes. The request is made on-demand not in advance, to account for the repeatedly changing network topology, which is probable to in validate routing tables over time. In AODV [10], when a source node desires to send packets to the destination but no route is available, it begins a route discovery operation. In the route discovery operation, the source transmits route request (RREQ) packets (Fig 1). The routing table stores information about next hop to the destination and a sequence number which is obtained route request packet to its neighbors. The RREQ has following fields: source address, source sequence number, destination address, broadcast ID, destination sequence number and hop count. When middle nodes obtain a RREQ, they revise their routing tables for a turnaround route to the source and like this process, when the middle nodes receive RREP they revise the forward route to the destination.

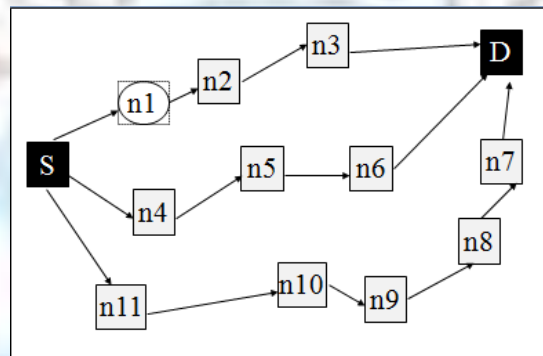


Fig 1: Route Request in AODV to find Route

The RREP contains the following fields: source address, destination address, hop count and lifetime. AODV protocol uses sequence numbers to identify the timeliness of each packet and to avoid formation of loops. Once the RREQ reaches the destination, the destination or intermediate node responds by uni-casting a route reply (RREP) packet reverse to the neighbor from which it first received the RREQ (Fig 2).

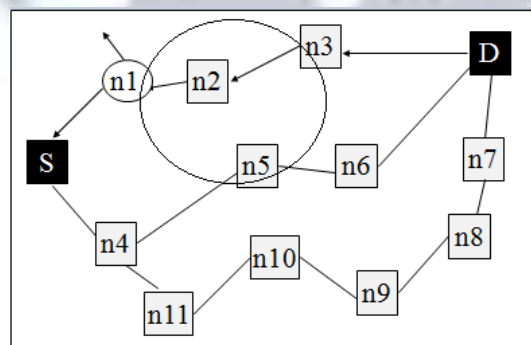


Fig 2: Path of Route Reply to the source in AODV

As the RREP [8] is routed rear along the reverse path, nodes along this path set up forward route entries in their routing tables which point to the node from which the RREP came. These forward route entries indicate the present forward route. The route timer is used to deletion of the entry if it is not used within the particular lifetime. Since, the RREP [5] is forwarded along the path formed by the RREQ. Routes are maintained as follows. If a source node moves from its original position to other place, it is able to reinitiate the route discovery process to find another route to the destination. If a node

along the route moves, its upstream neighbor observe the move and shows a link failure notification to each of its lively upstream neighbors to inform them of the removal of that part of the route. These nodes in turn propagate the link failure information to their upstream neighbors, and so on until the source node is reached. The source node may then choose to re-initiate route discovery for that destination if a route is still required. AODV algorithm uses Route Error Message (RERR) [7] route failures and link failures propagated by using RERR message from a broken link to the source node of the matching route. When the next hop link fails, RERR packets are sent by the starting node of the link to a set of neighboring nodes that communicate over the failed link with the destination node [4].

### PROBLEM STATEMENT

AODV and most of the on demand ad hoc routing protocols in MANETs use single route reply along reverse path. Quick change of network topology causes that the route reply could not arrive to the source node, i.e. after a source node sends numerous route request messages; the node obtains a reply message, especially on high speed mobility. This causes decrease routing performance, like, long end-to-end delay, low packet delivery fraction and average throughput. Therefore, we are considering how simply to decrease the failure of RREP messages. We can see a situation in Fig 2, where S is a source node, D is a destination node and others are intermediate nodes. In traditional AODV, when RREQ is broad D-n3-n2-n1-S is built [6].

This reverse path is used to deliver RREP message to the source node S. If node 1 moves towards the arrow direction and goes out of range of node 2, RREP lost will occur and the route discovery process will be hopeless. We can easily know that several alternative paths built by the RREQ message are ignored.

### PROPOSED EFFICIENT-AODV (E-AODV)

#### PROPOSED PROTOCOL OVERVIEW

We propose the E-AODV to avoid RREP loss and improve the performance of routing in MANET. E-AODV uses exactly same procedure of RREQ of AODV to deliver route reply message to source node. We call the route reply messages turn around route request (TA-RREQ). E-AODV protocol can reply from destination to source if there is at least one path to source node. In this manner, E-AODV prevents a large number of retransmissions of route request messages, and hence diminishes the congestion in the network. Moreover, E-AODV will improve the routing performance such as packet delivery fraction, throughput and end-to-end delay especially in high speed mobility.

Let's see the same case of AODV, we have mentioned, in Fig 3. In E-AODV, destination does not uni-cast reply along pre-decided shortest reverse path D-n3-n2-n1-S

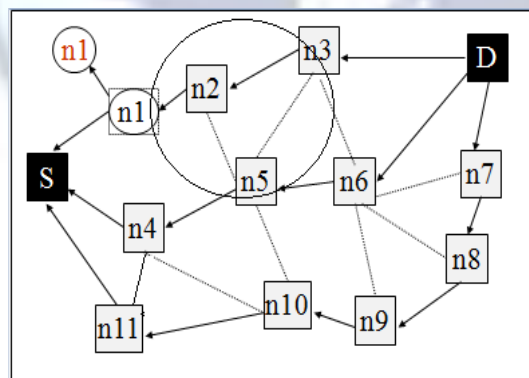


Fig 3: Turn-Around Route Request in E-AODV

It floods TA-RREQ to find source node S. And forwarding path to destination is built through this TA-RREQ. Following paths might be built: S-n4-n5-n6-D, S-n11-n10-n9-n8-n7-D, and etc. Node S can choose best one of these paths and start forwarding data packet. So RREP delivery fail problem on AODV does not occur in this case, even though node 1 moves from transmission range.

## IMPLEMENTATION

AODV and efficient AODV are tested on NS-2.34 which is a discrete event simulator targeted at networking research work. It provides considerable support for simulation of TCP, routing and multi-cast protocols on wired and wireless networks both. It consider of two simulation tools. The ns-2 simulator has several features that make it suitable for experimental result.

Ns-2 is an object-oriented simulator which is written in C++ and OTcl. The simulator supports a class hierarchy in C++ and a similar class hierarchy within the OTcl interpreter. There is a one-to-one association between a class in the interpreted hierarchy and one in the compile hierarchy. The reason to use two different programming languages is that OTcl is suitable for the programs and configurations that demand frequent and fast change and C++ is suitable for the programs that have high demand in speed. Ns-2 is highly extensible. It not only supports most commonly used IP protocols but also allows the users to extend or implement their own protocols. It also provides powerful trace functionalities, which are very important in our research since lot of information need to be logged for investigation.

### ALGORITHM FOR PROPOSED E-AODV PROTOCOL

The efficient AODV (E-AODV) routing protocol finds out routes on-demand using a turnaround route discovery mechanism. In E-AODV the destination node receives first route request message (RREQ), it generates turn around route request (TA-RREQ) message and broadcasts it to neighbor nodes within transmission area. When the source node receives first TA-RREQ message, then it starts packet transmission, and late arrived TA-RREQs are saved for future use. It reduces route fail correction messages and gets good performance than the existing AODV.

**STEP 1:** In E-AODV Route request message contain following fields like source IP address, destination IP address, hop count, broadcast ID, source sequence number, request time and destination sequence number to uniquely identify this route request message.

**STEP 2:** When the destination node obtains initial route request message, it generates turn around route request (TA-RREQ) message and transmits it to neighbor nodes within transmission area.

**STEP 3:** In E-AODV turn around route request message contain following fields like broadcast ID, destination IP address, Destination Sequence Number, Source IP address, Reply Time and hop count.

**STEP 4:** When transmitted TA-RREQ packet arrives to middle node, it will check for duplicate messages.

**STEP 5:** If it previously received the similar message, the message is dropped, else forwards the message to subsequent nodes.

**STEP 6:** When the source node obtains first TA-RREQ message, then it starts sending packet.

**STEP 7:** Late arrived TA-RREQs are kept for further use.

**STEP 8:** The alternate routes can be used when the main route breaks communications.

## EXPERIMENTAL SETUP

The performance is analyzed against parameters such as mobility, density. For the performance analysis of the protocol extensions, a usual well-behaved AODV network is used as a reference. The investigational results are being studied under NS-2 Simulator. Research has been carried out in order to evaluate performance of MANETs.

**Table 5.1: Simulation parameters**

Parameter	Values
Number of Nodes	30
Simulation Time	900sec
Pause Time	20sec
Environment Size	1000*1000 meter <sup>2</sup>
Traffic type	CBR
Packet Size	512 bytes
Maximum Speed	30 m/sec
Simulator	NS-2.34
Mobility Model	Random Waypoint
Data Rate	2.0, 4.0,6.0, 8.0 packet/sec

The aim is to reduce end to end delay and increase PDF and throughput. AODV and Proposed E-AODV are simulated in same settings of parameters and scenarios. Experiments are run on 6 different mobility speeds and also on different number of nodes. The mobility model is Random Waypoint model of 1000 \* 1000 meters area size. It has focused more attention on the evaluation of network performance in terms of throughput, and packet delivery fraction and end to end delay of a mobile ad-hoc network. Following parameters are set for experiments on network simulator ns2.

### RESULT ANALYSIS OF AODV AND E-AODV BASED ON DATA RATE

In this section the experimental results is shown for mobility based performance of AODV routing protocol and proposed E-AODV. The Simulations are conducted with four different data rates of 2.0, 4.0, 6.0 and 8.0 packets/second having a pause time of 20 seconds. We compare them using three metrics:

The end to end delay: is defined as the time a data packet is received by the destination minus the time the data packet is generated by the source.

- Average End-to-End Delay of 1st Data Packet =  $(T\_DataR - T\_DataS)$   
Where,  $T\_DataR$  = Time 1st data packets received at destination node  
 $T\_DataS$  = Time 1st data packets sent from source node
- Packet delivery fraction: The ratio of the data packets delivered to the Destinations to those generated by the constant bit rate sources. Packets delivered and packets missing are taking in to reflection.  
 $PDF = (DataR / DataS) * 100$   
Where,  $DataR$  = Data packets received by the CBR agent at destination node  
 $DataS$  = Data packets Sent by the CBR agent at source node
- Throughput: There are two symbols of throughput; one is the amount of data transferred over the period of time expressed in kilobits per second (Kbps).
- Packet Loss: Packet loss happens when one or more packets being transmitted across the network fail to arrive at the target. It may be due to path breaks caused by the mobility of nodes and node failure due to a drained battery. It is defined as the number of packets dropped by the routers through transmission.

Figure 4 shows the average end-to-end delay of each protocol. It should be noted that the delay is considered for the packets that actually arrive at the destinations. E-AODV shows lowest delay of 104. 81 seconds with respect to mobility at high data rate (8 packets/sec.) with AODV showing maximum delay at data rate 2. It is observed that when data rate increase than average end to end delay is decreased respectively. We can see that E-AODV has lower delay than AODV. The reason is that AODV chooses route earlier, E-AODV chooses recent route according to turn around request. Especially E-AODV gives lower delay in high speed data rate.

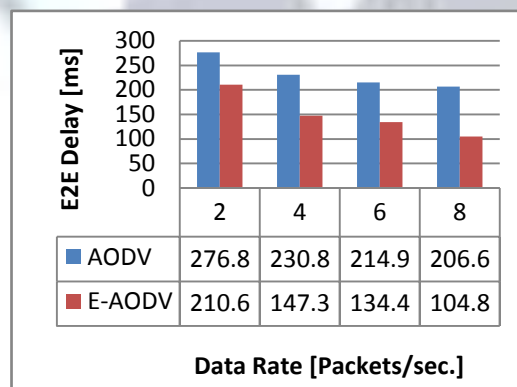


Fig 4: Data Rate Vs End to End Delay

Figure 5 shows similar performance of protocols as we discussed earlier. It shows drop in packet delivery fraction of AODV (PDF falls to 85.58%) and E-AODV (PDF falls to 89.07%) at higher loads of 8 packets/s. In almost all cases, E-AODV shows better performance in packet delivery fraction.

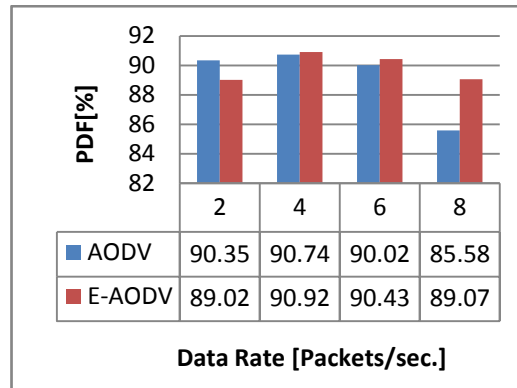


Fig 5: Data Rate Vs Packet Delivery Fraction

From Figure 6 it is clear that at data rate 2.0 packets/sec onwards E-AODV outperforms than AODV because as the throughput of AODV decreases with node velocity.

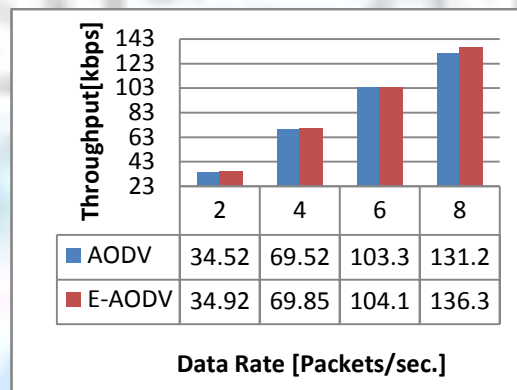


Fig 6: Data Rate Vs Average Throughput

Figure 7 shows that by increasing the data rate at a constant pause time of 20 seconds loss of packets also got increased in both types of protocols; maximum packet loss 14.28% is observed in AODV by increasing the data rate up to 8 packets /sec.

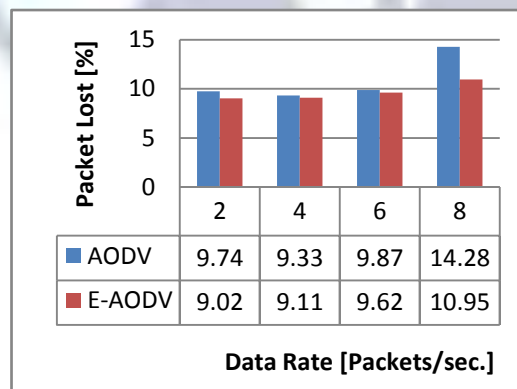


Fig 7: Data Rate Vs Packet Lost

### CONCLUSION

In AODV routing protocol route reply messages are very important for ad hoc networks for send messages. The loss of route replies causes serious destruction on the routing performance. This is because the rate of a route reply is very high. If the route reply is lost, a large amount of route discovery effort will be washed out. Furthermore, the source node has to re-initiate another route discovery to establish a route to the destination.

In this paper it is proposed that the idea of efficient AODV, which attempts turn around route request (TA-RREQ). E-AODV route discovery succeeds in fewer tries than AODV. We conducted extensive simulation study to evaluate the performance of E-AODV and compared it with that of existing AODV using NS-2 simulator. The results show that E-AODV improves the performance of AODV in most metrics, as the end to end delay, packet delivery fraction, average throughput and packet loss especially in high data rate.

Our Future work is to apply the proposed algorithm on different routing protocols like DSR and Hybrid protocols.

## REFERENCES

- [1]. S.K. Sarkar, T.G. Basawaraju and C Puttamadappa, Ad hoc Mobile Wireless Networks: Principles, Protocols and Applications, Auerbach Publications, pp. 1, 2008.
- [2]. C.E. Perkins and E.M. Royer, "The Ad hoc On- Demand Distance Vector Protocol," In C. E. Perkins, editor, Ad hoc Networking. Addison-Wesley, 2000, pp. 173-219.
- [3]. Elizabeth M. Royer, C-K Toh. "A Review of Current Routing Protocols for Ad-Hoc Mobile Wireless Networks", 168-175, 2004, ISSN 1682-6027, IEEE 2009, pp 46-55.
- [4]. Yi Lu, Weichao Wang., Yuhui Zhong, Bharat Bhargava, B.: "Study of Distance Vector Routing Protocols for Mobile ad hoc networks"; Proceedings of the First IEEE International Conference 2003, pp187-194.
- [5]. C.Perkins, E. Belding-Royer "Ad hoc on-Demand Distance Vector (AODV) Routing", RFC 3561 July 2003.
- [6]. Rachit Jain, Naresh B.Khairnar,Laxmi Shrivastava, "Comparative Study of Three Mobile Ad-hoc Network Routing Protocols under Different Traffic Source " presented at International Conference o Communication Systems and Network Technologies . © 201, pp 104-107.
- [7]. V. Bharathi and T. Poongkuzhali, "A Performance Enhancement of an Optimized Power Reactive Routing based on AODV Protocol for Mobile AD-HOC Network", International Journal of Technology And Engineering System(IJTES):- Vol.2, No.1, March 2011, pp 39-44.
- [8]. Rendong Bai and Mukesh Singhal, "Salvaging Route Reply for On-Demand Routing Protocols in Mobile Ad-Hoc Networks" in MSWIM 205, Montreal, Quebec, Canada. Oct 2005 pp 53-62.
- [9]. G.L. Saini and Deepak Dembla "Performance Analysis of DSDV, AODV and DSR Routing Protocols in MANET's- A Technical Perspective", IJCSIT, vol 4(2) 2013, pp 278-284.
- [10]. Deepak Dembla, Dr.Yogesh Chaba,"Modeling and Analysis of an intelligent AODV Routing Protocol based on Route Request Retransmission Strategy in MANETs", International Journal of Computer Applications (0975-8887) Volume 30-No.11 pp 6-13, September-2011.
- [11]. C.K. Toh, "Ad Hoc Mobile Wireless Networks Protocols and Systems", First Edition, Prentice Hall Inc, USA 2002.