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Simulation of AODV Routing Protocol & Proposed a New Routing Protocol (E-AODV) To Enhance Throughput

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Abstract; *A Mobile Ad-hoc Network (MANET) is a dynamic wireless network that can be formed without the need for any pre-existing infrastructure in which each node can act as a router.In this paper we compare & implement two types of on-demand routing protocols, AODV& AOMDV with E-AODV in terms of throughput. We have also proposed an Enhanced-AODV protocol for MANET to improve throughput of network [8] [10]. The paper also included the goal to generate a simulation environment that could be used as a platform for further studies within the area of ad-hoc networks (MANET).*

Keyword:*MANET, ROUTING PROTOCOLS, AODV, AOMDV,SIMULATION, NS, E-AODV.*

1. Introduction

Wireless communication between mobile users is becoming more popular than ever before. There are two distinct approaches for enabling wireless communication between two hosts. The first approach is to let the existing cellular network infrastructure carry data as well as voice. The major problems include the problem of handoff, which tries to handle the situation when a connection should be smoothly handed over from one base station to another base station without noticeable delay or packet loss. Another problem is that networks based on the cellular infrastructure are limited to places where there exists such a cellular network infrastructure.

The second approach is to form an ad-hoc network [2] among all users wanting to communicate with each other. Ad-hoc networks do not rely on any pre-established infrastructure and can therefore be deployed in places with no infrastructure. This is useful in disaster recovery situations and places with no existing or damaged communication infrastructure where rapid deployment of a communication network is needed. Ad-hoc networks have several advantages compared to traditional cellular systems. These advantages include:

- On demand setup
- Fault tolerance
- Unconstrained connectivity

2. Wireless Network

A wireless ad-hoc network is a collection of mobile nodes with no pre established infrastructure, forming a temporary network. Each of the nodes has a wireless interface and communicates with each other over either radio or infrared. Nodes in the ad-hoc network are often mobile, but can also consist of stationary nodes, such as access points to the Internet.Wireless networks can be classified in two types.

2.1 Infrastructure Network

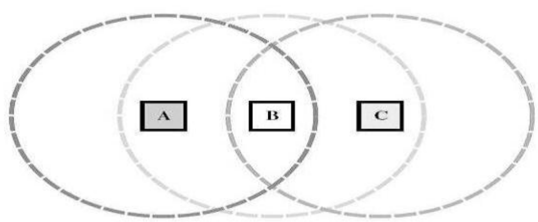
Infrastructure network consists of a network with fixed and wired gateways. A mobile host communicates with a bridge in the network (called base station) within its communication radius. The mobile unit can move geographically while it is communicating. When it goes out of range of one base station, it connects with new base station and starts communicating through it. This is called handoff. In this approach the base stations are fixed.

2.2 Infrastructure Less (AD HOC) Networks

In ad hoc networks all nodes are mobile and can be connected dynamically in an arbitrary manner. All nodes of these networks behave as routers and take part in discovery and maintenance of routes to other nodes in the network. An ad-hoc network uses no centralized administration. This is to be sure that the network would not collapse just because one of the mobile nodes moves out of transmitter range of the others. Nodes should be able to enter/leave the network as they wish.

3. MANET

A MANET [3] is an autonomous group of mobile users that communicate over reasonably slow wireless links. The network topology may vary rapidly and unpredictably over time, because the nodes are mobile. The network is decentralized, where all network activity, including discovering the topology and delivering messages must be executed by the nodes themselves. Hence routing functionality will have to be incorporated into the mobile nodes.



(Fig. 3.1)Example of a simple ad-hoc network with three participating nodes

The mobile nodes can directly communicate to those nodes that are in radio range of each other, whereas others nodes need the help of intermediate nodes to route their packets. These networks are fully distributed, and can work at any place without the aid of any infrastructure. This property makes these networks highly robust. In fig. 3.1, nodes A and C must discover the route through B in order to communicate. The circles indicate the nominal range of each node‘s radio transceiver. Nodes A and C are not in direct transmission range of each other, since A‘s circle does not cover C.

4. ROUTING

Routing is the act of moving information across an internetwork from a source to a destination. Along the way, at least one intermediate node typically is encountered.
Routing protocols are protocols that implement routing algorithms.

The routing protocol has two main functions, selection of routes for various source destinations pairs and the delivery of messages to their correct destination. The second function is conceptually straightforward using a variety of protocols and data structures (routing tables).

4.1ON DEMAND ROUTING PROTOCOLS

On-Demand routing protocols work on the principle of creating routes as and when required between a source and destination node pair in a network topology. Our discussion is limited to two on-demand ad-hoc routing protocols, AODV and AOMDV, as follows.

4.1.1 Ad-hoc On-Demand Distance Vector Routing (AODV)

AODV [4] is a reactive protocol that discovers routes on an as needed basis using a route discovery mechanism. It uses traditional routing tables with one entry per destination. Without using source routing, AODV relies on its routing table entries to propagate an RREP (Route Reply) back to the source and also to route data packets to the destination. AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to prevent routing loops. All routing packets carry these sequence numbers. AODV maintains timer-based states in each node, for utilization of individual routing table entries, whereby older unused entries are removed from the table. Predecessor node sets are maintained for each routing table entry, indicating the neighboring nodes sets which use that entry to route packets. These nodes are notified with RERR (Route Error) packets when the next-hop link breaks. This packet gets forwarded by each predecessor node to its predecessors, effectively erasing all routes using the broken link. Route error propagation in AODV can be visualized conceptually as a tree whose root is the node at the point of failure and all sources using the failed link as the leaves. The advantages of AODV are that less memory space is required as information of only active routes are maintained, in turn increasing the performance, while the disadvantage is that this protocol is not scalable and in large networks it does not perform well and does not support asymmetric links.

4.1.2 Ad-hoc On-demand Multipath Distance Vector Routing(AOMDV)

Ad-hoc On-demand Multipath Distance VectorRouting (AOMDV) [4] protocol is an extension to the AODV protocol for computing multiple loop-free and link disjoint paths. The routing entries for each destination contain a list of the next-hops along with the corresponding hop counts. All the next hops have the same sequence number. This helps in keeping track of a route. For each destination, a node maintains the advertised hop count, which is defined as the maximum hop count for all the paths, which is used for sending route advertisements of the destination. Each duplicate route advertisementreceived by a node defines an alternate path to the destination. Loop freedom is assured for a node by accepting alternate paths to destination if it has a less hop count than the advertised hop count for that destination. Because the maximum hop count is used, the advertised hop count therefore does not change for the same sequencenumber. When a route advertisement is received for a destination with a greater sequence number, the next-hop list and the advertised hop count are reinitialized. AOMDV can be used to find node-disjoint or link-disjoint routes. To find node-disjoint routes, each node does not immediately reject duplicate RREQs. Each RREQs arriving via a different neighbor of the source defines a node-disjoint path. This is because nodes cannot be broadcast duplicate RREQs, so any two RREQs arriving at an intermediate node via a different neighbor of thesource could not have traversed the same node. In an attempt to get multiple link-disjoint routes, the destination replies to duplicate RREQs, the destination only replies to RREQs arriving via unique neighbors. After the first hop, the RREPs follow the reverse paths, which are nodedisjointand thus link-disjoint. The trajectories of eachRREP may intersect at an intermediate node, but each takes a different reverse path to the source to ensure linkdisjointness. The advantage of using AOMDV is that it allows intermediate nodes to reply to RREQs, while still selecting disjoint paths. But, AOMDV has more messageoverheads during route discovery due to increased flooding and since it is a multipath routing protocol, the destination replies to the multiple RREQs those results are in longer overhead.

5. Need Of New Routing Protocols

In Ad Hoc networks, we need new routing protocols because of the following reasons:

- Nodes in Ad Hoc networks are mobile and topology of interconnections between them may be quite dynamic.
- Existing protocols exhibit least desirable behavior when presented with a highly dynamic interconnection topology.
- Existing protocols are dependent on the centralized control node.
- Existing routing protocols place too heavy a computational burden on each mobile computer in terms of the memory-size, processing power and power consumption.
- Existing routing protocols are not designed for dynamic and self-starting behavior as required by users wishing to utilize Ad-Hoc networks.
- Existing routing protocols like Distance Vector Protocol take a lot of time for convergence upon the failure of a link, which is very frequent in Ad Hoc networks.
- Existing routing protocols suffer from looping problems either short lived or long lived.
  Methods adopted to solve looping problems in traditional routing protocols may not be applicable to Ad Hoc networks.

6. Proposed work (Enhanced AODV)

We propose the E-AODV to avoid RREP loss and improve the performance of routing in MANET. E-AODV uses precisely same procedure of RREQ of AODV to deliver route reply message to source node. We call the route reply messages turn-around route request. E-AODV protocol can respond from destination to source if there is at slightest one path to source node. In this way, E-AODV put offs a large number of re-transmissions of route request messages, and hence diminish the overcrowding in the network. Moreover, E-AODV will get the better routing performance such as packet delivery fraction, throughput and end-to-end delay.

6.1 Algorithm for Proposed E-AODV Protocol

The enhanced AODV (E-AODV) routing protocol discover out routes on-demand using a turn-around route request 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 broadcast area. When the source node receives first TA-RREQ message, then it starts packet broadcast, and late arrived TA-RREQs are put aside for future prospect. It reduces route fail alteration messages and gets good performance than the accessible AODV.
There are some steps of E-AODV:

STEP-1 In E-AODV Route request message have following fields like source IP address, end IP address, hop add up, broadcast ID, source sequence number, request time and destination sequence number to uniquely recognize this route request message.

STEP-2 When the destination node gets initial route request message, it makes turn around route request (TA-RREQ) message and transmits it to neighbor nodes within broadcast area.

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

STEP-4 If intermediate node received the similar TA-RREQ message, the message is dropped, else forwards the message to succeeding nodes.

STEP-5 When the source node get hold of first TA-RREQ message, then it starts distribution packet.

STEP-6 Late TA-RREQs are reserved for further use as transaction route.

STEP-7 The transaction routes can be used when the main route breaks connections.

6.2 Implementation Code For E-AODV

The following modification is done in original AODV code for E-AODV routing protocol in Route Reply, small proposed code snippet is shown:

```
void EAODV::recvTurnAroundRouteRequest(Packet *p) {
structhdr_ip *ih = HDR_IP(p);
structhdr_EAODV_reply *rp =
HDR_EAODV_REPLY(p);
structhdr_EAODV_request *rq =
HDR_EAODV_REQUEST(p);
eaodv_rt_entry *rt;
#ifdef DEBUG
fprintf(stderr, "%d  - %s : received a RQREP \n",
index,      __FUNCTION__);
#endif // DEBUG
if(rp->rp_src == index)
{
#ifdef DEBUG
fprintf(stderr, "%s: got my own REQUEST\n",
__FUNCTION__);
#endif // DEBUG
   Packet::free(p);
return;   }
eaodv_rt_entry *rt0;
     rt0 = rtable.rt_lookup(rp->rp_src);
if(rt0 == 0) {
    rt0 = rtable.rt_add(rp->rp_src);    }
  rt0->rt_expire = CURRENT_TIME
+ACTIVE_ROUTE_TIMEOUT;
if(id_lookup(rp->rp_src,rp->rp_bcast_id))
{
id_insert(rp->rp_src,rp->rp_bcast_id);
ih->saddr()=index;
ih->daddr()=IP_BROADCAST;
rp->rp_count+=1;
Packet::free(p);
return;
}
if(rt0)
{
rp->rp_dst_seqno=max(rt0->rt_seqno,rp-
>rp_dst_seqno);
forward((eaodv_rt_entry*) 0,p, NO_DELAY);
}
else
{
if(((rt0->rt_seqno<rp->rp_dst_seqno) || (((rt0-
>rt_seqno == rp->rp_dst_seqno))
&& (rt0->rt_hops>rp->rp_hop_count))) && (rt0-
>rt_nexthop == ih->saddr())) {
#ifdef MDEBUG
fprintf(stderr, “Adding new router or updating
existing route: %i\n”, rt0->rt_order);
#endif//DEBUG
rt0->rt_expire =max(rt0->rt_expire,
(CURRENT_TIME+REV_ROUTE_LIFE));
rt_update(rt0, rp->rp_dst_seqno, rp->rp_hop_count,
ih->saddr(),
            max(rt0->rt_expire, (CURRENT_TIME +
REV_ROUTE_LIFE)) );
if (rt0->rt_req_timeout> 0.0)
{
      rt0->rt_req_cnt = 0;
      rt0->rt_req_timeout = 0.0;
      rt0->rt_req_last_ttl = rp->rp_hop_count;
```

```
    rt0->rt_expire = CURRENT_TIME +
ACTIVE_ROUTE_TIMEOUT;
   }
   }
}}
```

7. Performance Evaluation

Implementation of wireless ad-hoc networks in the real world is quite hard. Hence, the preferred alternative is to use some simulation software which can mimic real-life scenarios. Though it is difficult to reproduce all the real life factors such as humidity, wind and human behavior in the scenarios generated, most of the characteristics can be programmed into the scenario.
To compare two on-demand ad-hoc routing protocol,it is best to use identical simulation environments for their performance evaluation.

7.1 Simulation Environment

Network simulator	NS-2.35
Network size	800m*800m
Pause time	0 s
No. of nodes	30,50,100
MAC layer	802.11
Mobility model	Random way pt. model
Traffic Model	Continuous bitrate(CBR)
Routing protocols	AODV , AOMDV
Simulation time	10 sec
Transmission range	250m.

Our simulation is based on simulation of varying nodes (30, 50, 100) moving about over a square (800* 800) flat space for 10s of simulated time .A square space is chosen to allow free movement of nodes with equal density. In our simulation, we use random way pt. model. Node chooses a random destination in 800m* 800m simulation space and moves there at a uniform speed. A pause time of 0sec. correspond to continuous motion& a pause time of 10 sec corresponds to no motion.

7.2 Performance Evaluation Metrics

Figure 7.1 shows packet delivery ratio (PDR) of each protocols on varying number of nodes [9]. In all cases, E-AODV shows better performance in packet delivery ratio. As number of nodes increased, PDR decreased but E-AODV shows better performance than AODV.

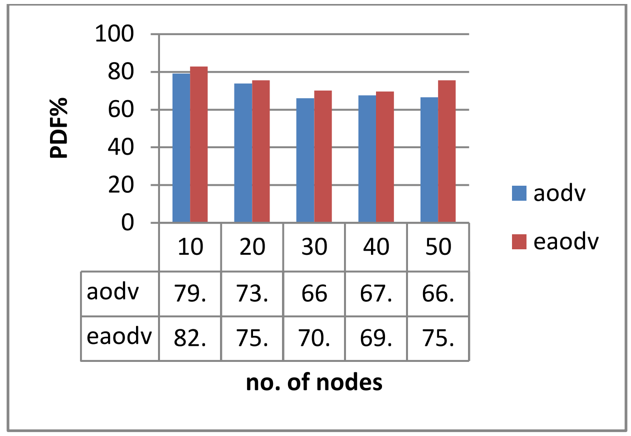


Fig 7.1: PDF Vs Number of Nodes in AODV & E-AODV

Fig. 7.2 shows the variation in Number of nodes and Throughput, as the number of nodes increased, throughput decreased in both AODV and E-AODV protocols. But the E-AODV's throughput is higher than the AODV.

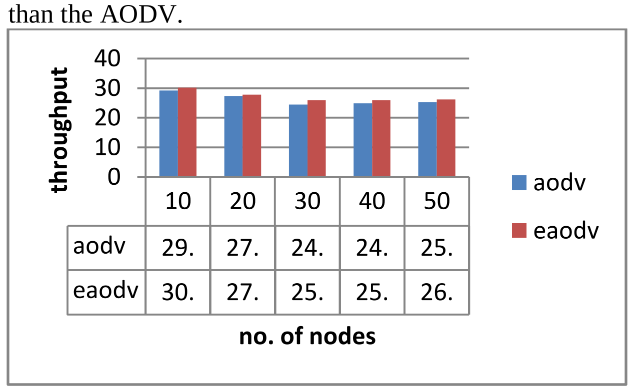


Fig 7.2: Throughput Vs Number of Nodes in AODV & E-AODV

Figure 7.3 shows the average end-to-end delay of both protocols. Delay is considered for the packets that actually arrive at the destinations. Delay increased as the number of nodes increased. From figure it is clear 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.

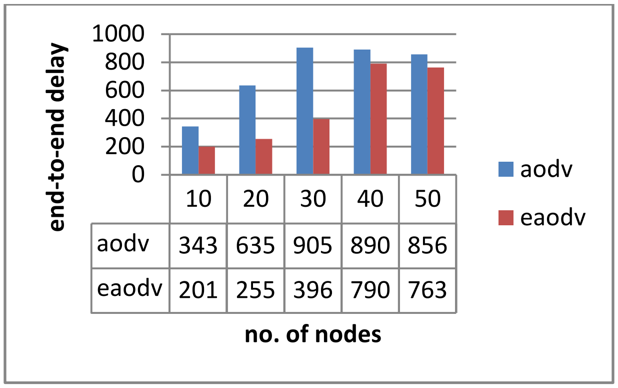


Fig 7.3: End-to-End Delay Vs Number of Nodes in AODV & E-AODV

7.3 Analysis Based on Varying Number of Nodes of AOMDV & E-AODV

From fig 7.4, 7.5 and 7.6, it is clear that in terms of throughput and PDF both protocols show approximately similar performance. But in case of end-to-end delay E-AODV is better than AOMDV.

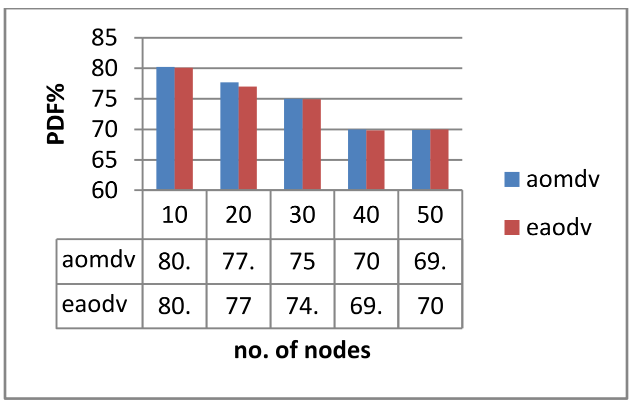


Fig 7.4: PDF Vs Number of Nodes in AOMDV & E-AODV

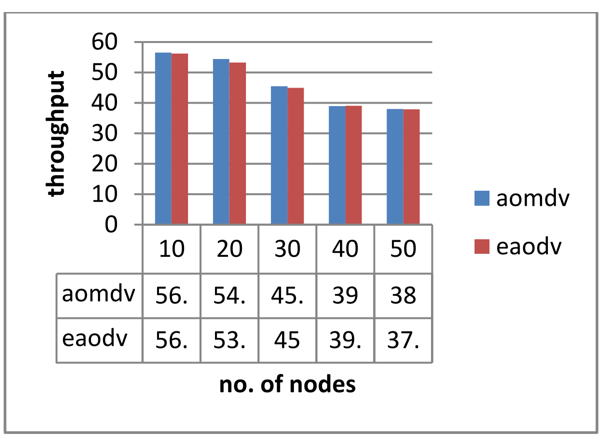


Fig 7.5: Throughput Vs Number of Nodes in AOMDV & E-AODV

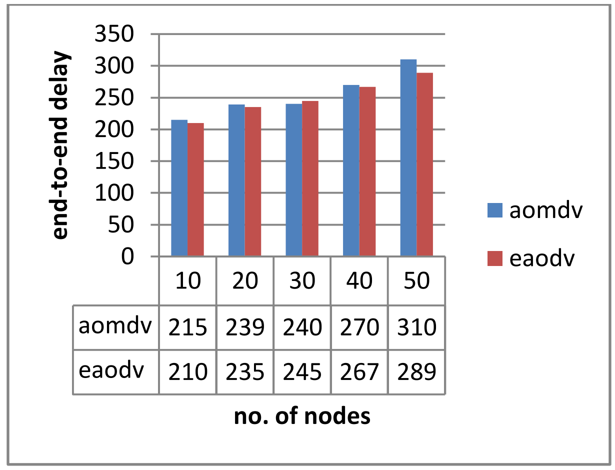


Fig 7.6: End-to-End Delay Vs Number of Nodes in AOMDV & E-AODV

8. Conclusion

In AODV routing protocol route reply messages are extremely important for ad hoc networks to send messages. The loss of route replies causes destruction on the routing performance. This is since the rate of a route reply is very high. If the route reply is lost, a large quantity of route discovery effort will be wasted out. In addition, the source node has to re-initiate another route detection to establish a route to the end. In this it is proposed that the ideAa of enhanced-AODV protocol, which attempts turn around route request (TA-RREQ). E-AODV route detection succeeds in smaller amount tries than AODV. We conducted widespread simulation study to evaluate the performance of existing AODV and AOMDV routing protocol and compared with E-AODV using Ns-2 simulator. The results show that E-AODV improves the performance of AODV in most metrics, as the packet delivery fraction, average throughput and end to end delay.

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