

# Energy Efficient OAODV Routing Protocol in Mobile Ad-Hoc Network

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## Abstract

Mobile ad hoc networks are collection of mobile devices connected by wireless links to perform some computational tasks. This temporary arrangement does not have any infrastructure hence lacking in permanent source of energy. To fulfill this requirement these independent mobile devices are entirely dependent on battery power. The aim of this paper is to design and evaluate the performance of an energy aware routing protocol, called OAODV (Optimized Ad Hoc On Demand Distance Vector) which is derived from AODV protocol. This protocol is based on the remaining energy of intermediate nodes to maintain the connectivity of the network as long as possible. The result obtained using the Network Simulator NS-2 demonstrates how little changes in the principle of the AODV protocol can competently balance the energy utilization among mobile devices of the network which increases the packet delivery ratio as well as increases the throughput.

**Keywords** - Ad hoc Network, AODV, OAODV, MANET, Energy Efficiency.

## 1. Introduction

Mobile ad hoc networks are collection of mobile nodes which can move without restraint and communicate with each other by means of a wireless physical medium. Consequently, dynamic topology, unbalance links, restricted energy capacity and lack of fixed infrastructure are individual features for MANET when compared to wired networks. MANET does not have central controllers, which makes it different from conventional wireless networks [1]. MANETs, locate applications in several areas. A number of of them are: military applications, mutual and distributed computing, emergency operations, wireless mesh networks, wireless sensor network, and hybrid wireless network architectures. MANET routing protocols could be generally classified into two main categories based on the routing information update method. Proactive protocols constantly study the topology of the network by exchanging topological information among the network nodes. Therefore, when there is

require for a path to a destination, such route information is available instantly. But the network topology changes too regularly, the cost of maintaining the network might be very high. If the network movement is small, the information about real topology might still not be used such as DSDV, WRP, CGSR, etc. The reactive routing protocols are based on a number of sort of query-reply dialog. Reactive protocols continue for establishing route to the destination only when the need arises. They do not require cyclic transmission of topological information of the network e.g. DSR, AODV, TORA, etc. Frequently reactive or proactive characteristic of a particular routing protocol might not be sufficient; as a substitute a mixture might yield better solution. Thus, in the current days, a number of hybrid protocols are also proposed. In reactive protocols (also called "on-demand" routing approach) routing paths are discovered only on demand. A route discovery task invokes a route-determination procedure and which terminates when either a route is found or there is no possible route available. Because of nodes mobility, active routes may be disconnected and therefore route maintenance is important in reactive routing protocols. A reactive routing protocol has less control overhead as compared to the proactive routing protocol and therefore a reactive routing protocol has better scalability than a proactive routing protocol. However, source nodes may suffer from long delays for route discovery in reactive approach. Dynamic source routing and ad hoc on-demand distance vector routing are admired reactive routing protocols for MANET.

The individuality [2] of MANETs has led to intend of MANET definite routing protocols. These protocols are mostly classified as proactive and reactive. Proactive protocols are table driven i.e., nodes preserve information about the routes. Reactive routing protocol locate the routes only when they are

needed i.e., on-demand. Reactive protocols have gained more significance as they decrease routing overhead and use less energy [4]. Energy is a limited resource in ad hoc wireless networks [3]. Every node has the functionality of substitute as a router along with being a source or destination. Therefore the breakdown of some nodes process can greatly slow down performance of the network and even influence the basic accessibility of the network, i.e., routing, accessibility, etc. Consequently it is of principal magnitude to use energy efficiently when establishing communication patterns. Energy organization is classified into battery power management, transmission power management and system power management. There are four energy cost metrics based on which we can make a decision the energy efficiency of a routing protocol. They are communication power, remaining energy capacity, estimated node lifetime and combined energy metrics. The totality of routing protocols, suggested by the Mobile Ad hoc Network group (MANET) of the Internet Engineering Task Force (IETF), use the same routing metric which is the shortest path. The paths are computed based on the minimization of the number of intermediate nodes between the source and the destination. Consequently, a number of nodes become dependable for routing packets from many source destination pairs. Later than a short period of time, the energy resources of those nodes get exhausted, which leads to node breakdown. It is consequently important that the routing protocols designed for ad hoc networks take into account this problem. Certainly, a better choice of routes is one wherever packets get routed through paths that may be longer but that include only nodes that have sufficient energy. Routing protocols in MANETs like AODV and DSR, usually intend to find a single path between a source and destination node.

## 2. Related Works

The exertion done in this background could be grouped into two main groups; the first describes methods for dropping energy consumption in the AODV protocol with diversifying the routing approach, and the second present's methods to decrease numbers of control messages in order to decrease the cost of consumption of energy. AODV is a reactive routing protocol as a substitute of proactive. It minimizes the amount of broadcasts by creating routes based on demand, which is not the

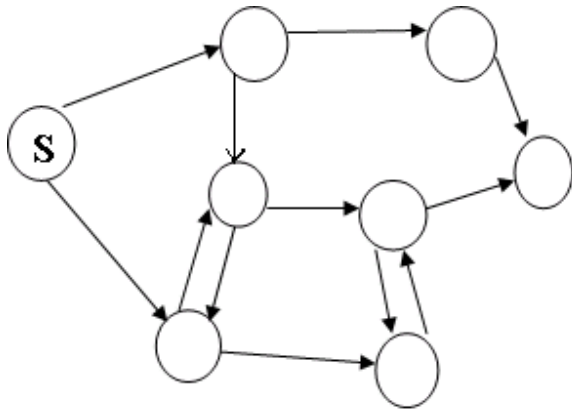
case for DSDV. While any source node wants to send a packet to a destination, it broadcasts a route request (RREQ) packet. The neighboring nodes in turn broadcast the packet to their neighbors and the method continues until the packet reaches the destination. Throughout the process of forwarding the route request, intermediate nodes record the address of the neighbor from which the first copy of the broadcast packet is received. This record is stored in their route tables, which helps for establishing a reverse path. But supplementary copies of the same RREQ are later received, these packets are discarded. The reply is sent by the reverse path. In support of route maintenance, when a source node moves, it can reinitiate a route discovery process. If some intermediate node moves within a particular route, the neighbor of the drifted node can detect the link failure and sends a link failure warning to its upstream neighbor. This procedure continues until the crash notification reaches the source node. Based on the received information, the source might come to a decision to reinitiate the route discovery phase.

## 3. AODV Operation

This section describes the scenarios under which nodes generate Route Request (RREQ), Route Reply (RREP) and Route Error (RERR) messages

### 3.1 AODV Route Discovery

When source node wants to communicate with destination and if path is not available to destination then source floods or broadcasts RREQ i.e. request packet to all its neighbours in the network. This RREQ message contains source and destination node's IP address, sequence number of destination, its current sequence number, hop count and RREQ ID. RREQ ID is monotonically increasing number. It gets incremented after each node initiates new RREQ. Figure 1 illustrates this flooding procedure.



**Fig 1: RREQ Broadcast**

When intermediate node receives RREQ, they create reverse link to previous node. They first of all check whether, valid route to destination is present or not. If, valid route is present then another condition must hold i.e intermediate node's sequence number should be at least as great as destination sequence number in RREQ packet. If both conditions hold, then that node generates RREP i.e. reply packet. If valid route is not present then RREQ is further forwarded. As RREQ is forwarded, hop count is incremented. While sending RREQ, intermediate nodes start a timer. If reply doesn't come within that time means, there is no more active route or link failure has occurred . RREP contains IP address of source as well as destination, and destination sequence number. Once the node creates the forward route entry, it forwards the RREP to the destination node. The RREP is thus forwarded hop by hop to the source node. Once the source receives the RREP, it can utilize the path for the transmission of data packets .

### 3.2 AODV Route Maintenance

As MANET is dynamic i.e. mobility and topology of nodes always change, link break occurs. When path breaks, both the nodes inform their end nodes about link failure, who were using that path by sending RERR i.e. error message as illustrated in Figure 3. End nodes delete their entries from route table, as path is no longer useful. If source node still wants to communicate with destination, it reinitiates RREQ broadcasting or path finding process or repair broken link.

## 4. Optimized Ad Hoc On Demand Distance Vector Routing Protocol (OAODV)

When a source node wants to reach a destination node, it starts the route discovery process and broadcasts the route request packets (RREQ), as in AODV. But when an intermediate node receives this request, there is an additional step that it has to do before sending the packet: it must compare its remaining energy of one node with that of the other node . It finds the node that has maximum energy and it rebroadcasts the request to that particular neighbour node.

As soon as the destination receives the first RREQ packet, it transmits a RREP towards the source. The treatment of these RREP packets by the source is identical to that of AODV. But we have modified this scenario by using the concept of remaining maximum energy of nodes. When a source node wants to communicate with destination then in route discovery process the route request packet will be sent to that node which has maximum remaining energy so that the path found will have that maximum energy and can survive for a longer time.

### 4.1 Algorithm

Begin

1. Initialize source and destination
2. Find neighbors of source node
3. Select the node which has maximum remaining energy.
4. Find remaining energy of neighboring node using the formula  
 $\text{Remaining energy} = \text{Initial energy} - \text{Energy Used}$
6. Store it in a lookup table
7. Find  $\max\{\text{Remaining energy}\}$
8. Send RREQ to that neighbor node
9. Repeat step 2-7 until request is reached at the destination.
10. Reply via same path on which request is reached.

End

## 5.Simulations



The existing work AODV is compared with the proposed work OAODV using Network simulator2 (NS-2). The topology have used in the experiments is shown. The total band-width considered is 2 Mbps and the radio range of each node is 250 meters. A first TCP connection is established between nodes S and D. A new communication has been set up that connects node-0 to node-1. The results are shown in figure 2 and 3. At first the energy consumption of the network is taken, when using the original routing protocols, AODV. The same experiment carried out with OAODV leads to a very different result

Network Simulator 2 (NS2) is used to evaluate the performance of OAODV. To compare OAODV with prior work in routing AODV, this uses flooding. CBR traffic flows was selected, originating from randomly-selected sending nodes. Each CBR flow uses 512-byte packets. Each simulation lasts for 20 seconds of simulated time. The following aspects of OAODV are emphasized:

- Energy Consumed.
- Packet Delivery Ratio.
- Throughput.

#### Simulation parameters

- Range transmission : 300 meter
- Carrier sensing range : 300 meter
- Simulation time : 20 sec
- Number of nodes : 25
- Topology area : 700m x 700 m
- Mobility model : Random way point
- Traffic type : TCP
- Maximum speed : 10 m/s
- Packet size : 512 bytes for TCP
- Initial energy : 100 Joules
- Pause time : 2 sec
- Type of antenna : Omni directional
- Channel type : Wireless channel

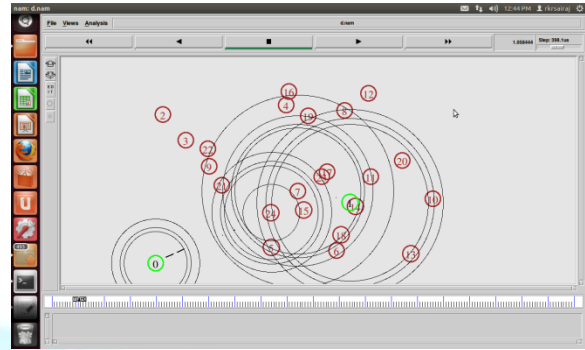


Figure 2: Network Topology

The number of packets originated by the source at application layer to number of packets received by the destination node, which also known as the packet delivery ratio. Figure 3 (a) shows that the delivery ratio in which result is shown between packet ratio and Time.



Figure 3 (a): Packet Delivery Ratio Vs time

The next result shows energy consumed by AODV as well as OAODV in which it shows that the proposed protocol performs better than AODV. The energy consumed in AODV is higher than OAODV.

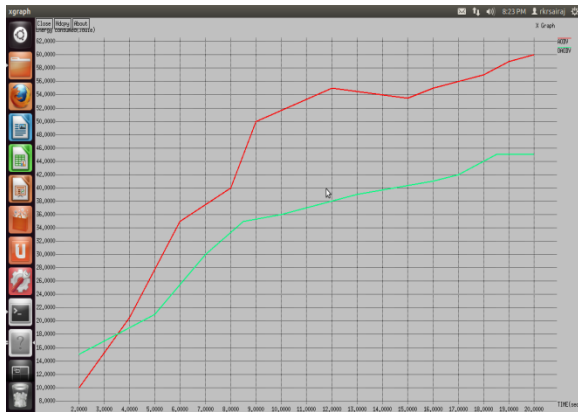


Figure 3 (b): Energy Consumed Vs Time

The next result shows throughput of AODV as well as OADV in which it shows that the proposed protocol performs better than AODV. Throughput is the ratio of number of packets delivered to received time minus sent time.



Figure 3 (c): Throughput Vs Time

## 6. Conclusion

This paper provides an overview of MANETs and discusses how energy is one of the most important constraints for these types of networks. The objective of the proposed work is to develop an energy efficient AODV routing algorithm in a way which allows researchers to choose the most appropriate routing algorithm. this work can be extended proposing more efficient methods as well as can be implemented this work on sensor network.

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