# Power scheme for Ad-hoc on Demand Distance Vector routing for Mobile Ad Hoc Networks

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## Abstract

*The communication within a mobile AdHoc network requires an efficient routing protocol to discover routes between mobile nodes. Power is one of the most important design criteria for AdHoc networks as batteries provide limited working capacity to the mobile nodes. Power failure of a mobile node not only affects the node itself but also its ability to forward packets on behalf of others and hence affects the overall network lifetime. In this paper, we propose a power scheme for AdHoc on demand routing protocol which maximizes the network lifetime by minimizing the power consumption during the source to destination route establishment. PAODV reduces the energy consumption of the nodes in a network by routing packets on routes that consume the minimum amount of power to get the packets to their destination. The proposed algorithm has been compared with the existing AODV protocol and its simulation result shows that proposed protocol performance is better as compared to AODV in terms of packet delivery ratio*

**Key words:** Mobile Ad hoc networks, On- demand routing, Power, AODV.

## 1. Introduction

Mobile ad hoc network is a collection of independent mobile nodes that can communicate to each other via radio waves. The mobile nodes can directly communicate to those nodes that are in radio range of each other, whereas other nodes need the help of intermediate nodes to route their packets.

Each node operates not only as a node, but also as a router to forward the packets. The nodes are free to move and organize themselves into a network. These networks are fully distributed, and can work at any place without the aid of any infrastructure. This property makes these networks highly robust.

Since nodes in the MANET are running on the limited battery power, power conservation and efficiency is an important issue that needs to be addressed. This paper presents a new power scheme through routing algorithm to address this power efficiency issue with main focus on the power conservation.

Conventional ad hoc on-demanding routing protocols, such as AdHoc on-demand distance vector routing (AODV) aim to find the shortest route between the source and the destination. Since no power consumption is taken into account in these protocols, the nodes along the shortest route may be overused and exhaust their batteries quickly which may lead to network partitioning and a reduced network lifetime. The proposed PAODV protocol is the enhancement of the existing AODV protocol. In this extension the control message used for AODV is modified. The source node attempts first to discover a path with low power level i.e the transmission radius of 125m. If it is unable to find the path with this power level, then it attempts further with high power level i.e transmission radius of 250 m. Simulation results show that the PAODV consumes less power as compare to AODV.

Rest of the paper is organized as follows: section 2 describes the existing power aware routing protocol; section 3 describes the power consumption model used for this study. In section 4 working of PAODV is dealt and Section 5 presents simulation results.

## 2. Literature Survey

Wireless ad-hoc network consist of mobile battery operated devices those are communicated over the wireless medium[1]. The energy efficient protocol is an important issue due to limited battery power of nodes. So PAOD aims to maximize the system life time. In this PAOD, each node on the route makes the energy reservation according to the traffic. Both shortest hop and maximum-life time is considered in route selection. Some filter mechanisms based on energy threshold function are used to filter out the lower power nodes and decrease the broadcast operation.

Nodes in the MANET are running on limited battery power[2]. The protocol PAW-AODV(Power-Aware Ad hoc On-demand Distance Vector routing protocol) is proposed for efficient power routing. PAW-AODV could use the limited power resources efficiently as it routes are based on power-based cost function. The cost function of the overall route is the sum of the cost functions of the individual nodes along the route where the cost function of a node is dependent on the node's available battery power.

Energy Aware on demand routing protocol focus on choosing a stable path based on the energy status and distance between nodes to avoid frequent route rediscovery [3]. The basic idea of this algorithm is to find the neighbouring nodes with an active route to the destination, having energy above than a threshold value. Only those neighbouring nodes that have energy levels higher than the threshold are eligible to participate in route discovery.

Power Aware Routing (PAR) algorithm maximizes the network lifetime and minimizes the power consumption during route establishment from source to destination [4]. This protocol is efficient for both real time and non-real time data transfer.

Energy Saving Ad-hoc On-demand Distance Vector (ESAODV) routing exchange energy information among neighbouring nodes through already-existed signalling packets in AODV and introduces a new network parameter as the comparison threshold, called current average energy of the network (CAEN), which can approximate the average energy of the network[5]. Each intermediate node determines whether to forward rreq packet by comparing its remaining energy with CAEN. The ESAODV protect the energy- overused nodes and increases the life time of the network.

The Cross-layer design of Energy-aware Multicast Ad hoc On-Demand Distance Vector (CEMAODV)[7] routing protocol adopts cross-layer mechanism and energy-aware metric to modify AODV routing protocol to reduce the energy consumption of the route to construct a source based tree.

Energy Conservation for Ad Hoc Routing [10] reduces the energy consumption in an ad-hoc network. It selects the node equivalent from the routing perspective by turning off the unnecessary nodes.

To prolong the lifetime of routing, it is important to select the nodes with sufficient energy in routing discovery phase. An Energy-based QoS Routing Protocol (EQRP)[11] is proposed. The key idea of EQRP is it selects the nodes that have largest of the remaining energy in routing discovery and routing maintenance phases. The simulation results show that EQRP has a higher data delivery rate and reduce the number of routing reconstructions**.**

The nodes in the network which do not satisfy to the QoS requirements of maximum delay and minimum power levels, are eliminated from the route of communication, during query phase [11]. Each intermediate node on receipt of the query packet determines whether to forward it or not, depending on the QoS requirements. At the destination, an update packet is generated.

Conditional max-min battery capacity routing (CMMBR) protocol implements two different approaches in selecting the routes[12]. A route is selected if all the nodes along the route have the residual power level larger than a predefined threshold. If all the nodes along the route possess battery power level more than the threshold, then routes with the lowest battery power level are avoided.

Energy Conserving Routing in Wireless Ad-hoc Networks will select an optimal route that minimizes the total sum of link costs along it[13]. Here, the initial and remaining battery power of a mobile node can be taken into account in order to calculate the link cost.

The effective total transmission energy[14], which includes the energy spent in potential retransmissions, is the proper metric for reliable, energy-efficient communications The energy-efficiency of a candidate route is thus critically dependent on the packet error rate of the underlying links, since they directly affect the energy wasted in retransmissions. A Retransmission-energy Aware Routing (RAR) protocol is proposed in , which uses the link error rate to determine the optimal transmit power.

## 3. Power Consumption Model used for this Study:

This section explain the energy model[15] used for this study. The power expanded in sending a data packet of size D bytes over a given link can be represented as,

$$E(D,P_t)=K_1 P_t D + K_2 \qquad (1)$$

Where D is the size of the data packets, $P_t$ s the minimum transmit power level required for transmission of a packet, $K_1$ & $K_2$ are the constants with value $k_1$=4μ s/byte & $k_2$=42μ j. This model is used in rest of the paper.

By using (1), communication take place using low power level and connectivity should be maintained. A distance between nodes and multiple hop route is considered to reduce the energy consumed by the existing ad-hoc routing protocols. The transmitting node employs the power control when the communicating nodes are close to each other. So that the for a given threshold power $P_r$, the minimum transmit power required for successful reception can be represented as,

$$P_t(d)=P_r\, d^n/k \qquad (2)$$

Where d is the distance between two nodes, n is the path loss exponent and K is a constant. Typically n takes the value of 4.
Substituting the equation (2) in equation (1) we get

$$Emin=K_3Dd^4/K_2 \quad (3)$$

Where k3=$2.8*10^{-10}$ μj/bytes

Total power consumed for h number of hops in minimum power routing is given as,

$$E_{t=\sum i=1}^{h} Emin \quad (4)$$

For minimum hop routing protocol the transmission energy is fixed for fixed data packet of size D bytes and can represented as,

$$Emax=K_4D+K_2 \qquad (5)$$

Where k'=has the value of 1.162 μj/bytes
Total power consumed for H number of hops IS represented as,

$$Etot= Emax*H \quad (6)$$

The energy savings that can be obtained by using the minimum transmit power instead of the fixed maximum power for the data-packet transmission is given as

$$S(D,d)=Emax-Emin \qquad (7)$$

## 4. Power scheme for Ad-hoc on Demand Distance Vector routing:

The PAODV routing protocol is an enhancement of the existing AODV protocol. The basic idea of PAODV is the nodes in network should control the transmit power in order to maintain the network connectivity. PAODV employs two power levels in the route discovery process i.e 125 m and 250m. The source node first finds the route with low power level .if it unable to find with low power level, then it attempts further with a high power level.

A route discovery process is initiated whenever a source node needs to communicate with a destination node for which it has no routing information in its table. The source node will broadcast a route request (RREQ) packet to its neighbours. It uses the same control packet as AODV protocol but the difference is that the a new field is added that contains the power values. The initial value of this field is zero when the RREQ is initiated by the source and its content is built up node by node as the sum of the costs of the nodes through which the RREQ passes as it propagates in the network. If the RREQ packet reaches the destination, meaning no intermediate nodes have the forward route information, the destination node will reply with a RREP packet. The RREP packet contains all the necessary AODV forward route information.

## 5. Simulation Results:

The PAODV is simulated using the OMNet++ simulator. During this implementation the performance of PAODV is compared with that of AODV[3] under different scenario.

**Packet delivery ratio:**

Even in case of a complete random scene the performance of PAODV is better then simple AODV as number of nodes increased in the network as shown in Figure [1]..

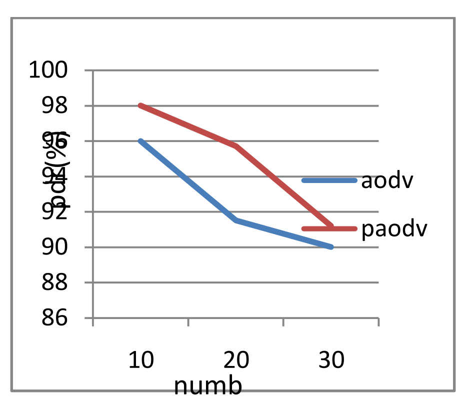


Fig. 1: Packet Delivery Ratio for Random Scene.

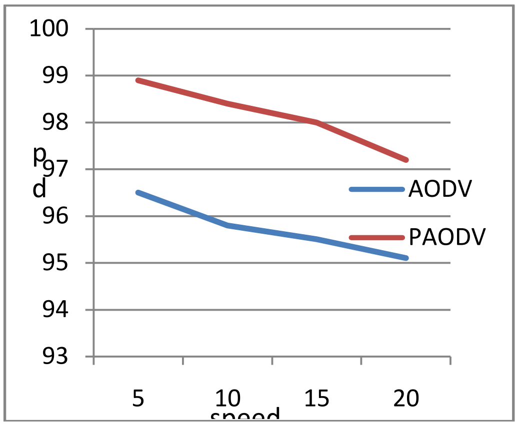


Fig 2. Packet Delivery Ratio for 50 nodes at different speed.

The packet delivery ratio using speed as a parameter for AODV and PAODV protocol has been illustrated in Figure 2. The results are on the basis of 50 mobile nodes. Speed has been varied from 5 meter/second to 20 meter/second. The results show that, the PAODV outperforms the AODV protocol irrespective of speed.

## Conclusion:

In this paper, we proposed the power aware ad hoc on-demand distance vector routing protocol to address the power efficiency issues in MANET. The simulation result shows that the PAODV increases the packet delivery ratio. PAODV decreases the power consumption of data packets .The performance depends on the size of the network. As an future extension the idea can be verified for the other on-demand routing protocols.

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