# A Review of Power Conservation in Wireless Mobile Adhoc Network (MANET)

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**Abstract**

In wireless mobile ad hoc net-works, (MANET), Power conservation is a critical issue as energy resources are limited at the electronic devices (Nodes), since each node in a wireless ad hoc network operates on battery power and battery energy is a rare resource. The less of energy in nodes can affects the communication activities in net-work. For MANETs, optimization of energy consumption has greater impact as it directly corresponds to lifetime of networks. The various components of energy related costs include transmission power as well as the reception power. Power consumption can be reduced at device level, at transmission level or by using power aware routing protocol. In this article we give an overview of various power control approaches and various power saving techniques that have been proposed in the literature.

***Keywords:*** *MANET, Transmission power, Battery Power consumption, Power conservation.*

## 1. Introduction

A mobile ad hoc network (MANET) [1][2], is a dynamic distributed system of wireless mobile nodes in which the nodes can move in any direction, independent of each other. The mobile nodes in such network can communicate with each other through direct wireless links or multi-hop routing. It is used in a wide range of applications such as Battle Fields and Rescue operations, etc. Figure 1.1, shows a general structure of MANET. MANETs have several operating constraints [11] such as limited battery charge per node, limited transmission range per node and limited bandwidth. Generally routes in MANETs are often multi-hop in nature. Power consumption in ad hoc network is directly proportional to route length i.e. if route length is increased the power consumption is also increased to route a packet. A node consumes its battery power of each transmission and reception of data packet, as more as it will transmit or receive data packet, power consumption will also be increased. Nodes forward packets for their peers in addition to their own, in other words, nodes are forced to expend their battery charge for receiving and transmitting packets that are not intended for them. Because of MANETs have the limited energy budget [11] for communication among mobile nodes, thus usage of the energy resources of a small set of nodes at the cost of others can have an adverse impact on the node lifetime as well as network lifetime.

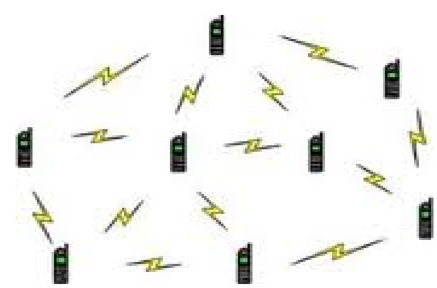

Figure 1.1 Mobile Ad hoc Network

The rest of the paper is organized as follows:
Section-2, describe the power consumption mode of Mobile Nodes in MANET. Section-3, gives briefly review of power Minimizing Techniques for ad hoc networks. The Literature review of the Power conservation is given in Section-4. Section-5 gives comparative conclusions of the Power minimizing Techniques.

## 2. Power Consumption Mode

The mobile nodes in wireless mobile ad hoc network are connected to other mobile nodes. These nodes are free to transmit and receive the data packet to or from other nodes and require energy to such activity. The total energy [13], [5], [11], [7], [19], [4], of nodes is spent in following modes: (1) Transmission Mode (2) Reception Mode (3) Idle Mode and (4) Overhearing Mode. These modes of power consumption are described as:-

### 2.1 Transmission Mode

A node is said in transmission mode when it s ends data packet to other nodes in network. These nodes require energy to transmit data packet, such energy is called Transmission Energy (Tx) [19], [14], of that nodes. Transmission energy is depended on size of data packet (in Bits), means when the size of a data packet is increased the required transmission energy is also increased. The transmission energy can be formulated as:

$$Tx = (330 * P\mathit{length}) / 2*10^6$$

And

$$P_T = Tx / T_t$$

Where Tx is transmission Energy, $P_T$ is Transmission Power, $T_t$ is time taken to transmit data packet and P*length* is length of data packet in Bits.

### 2.2 Reception Mode

When a node receives a data packet from other nodes then it said to be in Reception Mode and the energy taken to receive packet is called Reception Energy ($R_x$), [19], [12]. Then Reception Energy can be givan as :

$$R_x = (230 * P\mathit{length}) / 2*10^6$$

And

$$P_R = R_x / T_r$$

Where $R_x$ is a Reception Energy, $P_R$ is a Reception Power, $T_r$ is a time taken to receive data packet, and P*length* is length of data packet in Bits.

### 2.3 Idle Mode

In this mode, [13], generally the node is neither transmitting nor receiving any data packets. But this mode consumes power because the nodes have to listen to the wireless medium continuously in order to detect a packet that it should receive, so that the node can then switch into receive mode from idle mode.

Despite the fact that while in idle mode the node does not actually handle data communication operations, [4], it was found that the wireless interface consumes a considerable amount of energy nevertheless. This amount approaches the amount that is consumed in the receive operation. Idle energy is a wasted energy that should be eliminated or reduced. Then power consumed in Idle Mode is:

$$P_I = P_R$$

Where $P_I$ is power consumed in Idle Mode and $P_R$ is power consumed in Reception Mode.

### 2.4 Overhearing Mode

When a node receives data packets that are not destined for it, then it said to be in over-hearing mode [7], and it may consume the energy used in receiving mode. Unnecessarily receiving such packets will cause energy consumption. Then power consumed in overhearing mode is:

$$P_{over} = P_R$$

Where $P_{over}$ is power consumed in Overhearing Mode and $P_R$ is power consumed in Reception Mode.

## 3. Power Optimizing Techniques

As wireless ad hoc networks do not have a f ixed infrastructure, instead it follows individual nodes that may have to rely on limited power sources [14]. Therefore the energy conservation schemes become important issues of research in wireless ad hoc networks. Many existing schemes for conserving power in wireless ad hoc networks take the reduction of power used by the radio transceiver [20]. Thus, there can be following techniques to optimize the power consumption in MANET.

- Power conserving by controlling trans-mission power [15], [18].
- Power conserving by using power management Technique [17], [16], [13].
- Power conserving by using minimized power aware routing protocol [10], [3], [9].
- □ Power conserving at mobile nodes [14]

### 3.1 Power Conserving by Controlling Transmission Power

Power control in wireless mobile ad hoc networks is very common issue of researches. The main aim of power saving is to reduce the total power consumed in packet transmission and increase network lifetime by increasing the residual power of battery. In general, it is assumed that the minimum transmission power required for keeping the network connected and obtaining the optimal performance of an ad-hoc network. Since transmission power used by mobile nodes determines the network topology, and the topology in turn has considerable impact on the throughput performance of the network. In such type of power conservation schemes, transmission power of mobile nodes is set according to the signal-to-interference-and-noise ratio (SINR) of the transmitting or receiving nodes [18], and based on the distance [15], between transmitter and receiver.

## 3.2 Power Conserving by using Power Management Technique

In wireless environment Power management technique is used to minimize the power consumed of battery-powered based mobile devices. The efficient power management policies are required to measure various performance posed by different application such as throughput, latency and other performance metrics.
The main idea of Power management technique is to triggered mobile nodes to the low-power mode (Sleeping Mode) from high-power mode, when they are in inactive mode or idle mode. Since the mobile nodes should be allowed to sleep for power saving. Therefore in power management, the communication mobile nodes require distributed coordination between communicating mobile nodes, as all the mobile nodes have to be in the active mode for a successful communication. When a m obile node is in sleeping mode and the arrival pattern of communication events is not known ,then a control message is required to inform a r emote sleeping node to wake up for data packets transmissions.
The power management technique in wireless ad hoc networks is used to achieve the following decisions:

- Which set of nodes should perform power management.
- When a act ive-mode node switches to the low power state and
- When a inactive-mode node switches from the low-power mode to the active mode.

An efficient power conserving management technique, for wireless ad hoc networks, consists the following properties:

- It should transmit data packets between source and destination with minimum delay than if all mobile nodes were awake.
- For making local decision to each node the algorithm used for awake the mobile nodes should be distributed.
- It should allow as many mobile nodes as possible to turn off their radio receivers m ost of the time because even a node is idle in receive mode can consume almost as much energy as an active transmitter.

## 3.3 Power Conserving by using minimized Power Aware Routing Protocol

In wireless ad hoc network, Routing is the process of moving packets through an internetwork [16], such as the Internet. Routing consists of two separate but related tasks:

- Defining and selecting path in the network
- Forwarding packets based on the defined paths from a designated source node to a designated destination node.

One of the most important objectives of MANET routing protocols is to maximize energy efficiency, network throughput, energy efficiency, network lifetime, and to minimize delay. Since nodes in MANETs depend on limited energy resources. In MANETs, the network throughput is usually measured by packet delivery ratio while the most significant contribution to energy consumption is measured by routing overhead which is the number or size of routing control packets. There are several power aware routing protocols have been defined in MANET, such as: DSR [16], AODV [20], DSDV, [10].

Routing Efficiency Metrics**:-** We compare ad hoc routing protocols reporting the following parameters:

- The relative routing overhead, which is the ratio of the number of control packets over the number of delivered data packets,
- The delivery ratio, which is the number of packets delivered over the total number of packets sent, and
- End-to-End delay, which is average of delays between each pair of a data communication session.
- The average number of hops and optimal hops.
- The normalized hops, which is the ratio of the average hops over the optimal hops, and
- The plot of delivered packets versus average number of hops.

Power Aware Routing enables the nodes to detect misbehavior like deviation from regular routing and forwarding by observing the status of the node. By exploiting non-random behaviors for the mobility patterns that mobile user exhibit, state of network topology can be predicted and perform route reconstruction proactively in a timely manner.

One distinguishing feature of Power aware ad hoc routing protocols is its use of Power for each route entry. Given the choice between two routes to a d estination, a requesting node is required to select one with better power status and more active. Thus the Power aware Routing has been proven an efficient power saving technique by [3], [16], [9], [20].

### 3.4 Power Conserving at Mobile Nodes

In MANET, all the mobile nodes are a hardware device. Mobile nodes [14], [21], [22], consume power even in their sleep mode For example, in mobile phones, even if they are not in use, there is a constant power drain because the trans-receiver is constantly hearing for signals to itself. A lot of efforts are currently going on to reduce the power consumed in each and every aspect of mobile nodes. Now we give a brief description of some of these methods:

•Memory Allocation: Memory is the most important resource of mobile nodes. In mobile nodes, memory instructions are the greater consumers of power [14]. Some of the memory devices like Direct Rambus DRAM (RDRAM) have come out with a D RAM that allows the individual devices to be in different power states. These devices are in decreasing order of power states and increasing order of access times: Active, Standby, Nap and Power down.

• Hard Disk scheduling: The operating system of a machine is responsible for using hardware efficiently, for the disk drives, this means having a fast access time and disk bandwidth[21], [22]. Access time has two major components seek time and Rotational latency. Seek time is the time for the disk arc to move the heads to the cylinder containing the desired sector. Rotational latency is the additional time waiting for the disk to rotate the desired sector to the disk head. Disk bandwidth is the total number of bytes transferred, divided by the total time between the first request for service and the completion of the last transfer. One method of energy conservation in mobile devices is to spindown a disk in its idle time. The spindown delay is the amount of time the disk is idle before it s pins down. A quantitative analysis of the potential costs and benefits of spinning down a disk in its idle time is shown in[14], [21], [22]. The conclusion is that the maximum power savings were obtained by using a spindown delay of two seconds as opposed to the 3-5 minutes recommended by most manufacturers. To justify this claim, the authors presented two points: frequency of sleep and length of sleep. They claim that, with shorter delays, the disk gets to sleep for a longer time and hence save more power. The drawback of spinning down a disk after such short delays is the time and energy needed to spinup the disk, which results in user delay. Traces used by the authors show that the spindown occurs 8-15 times an hour. This translates to 16-30 seconds of user delay per hour, which is reasonable compared to the power savings incurred.

• CPU Scheduling: Multi-programmed operating systems require CPU scheduling for efficient multiprogramming. By switching the CPU among processes, the operating system can make the machine more productive. The power consumed by a processor is directly proportional to the supply voltage, the switching capacitance of the various devices and the frequency of the clock. Gates in CMOS CPU's switch state at every clock cycle, which lead to a short circuit between the power-supply and ground. As a result more power is wasted with higher frequency. The power [14], [21], [22], required by the CPU is CV2F, where C is the total capacitance of the wires, V is the supply voltage and F is the operating frequency. There are various algorithms proposed for adjusting the clock frequency in idle time. The main idea behind it is to balance the CPU usage between bursts of high utilization and idle times. Task or process scheduling can be an effective way of accomplishing this. Almost all processes have a deadline by which they need to be executed. when the processor is operating at the worst case, in scheduling the tasks, there is some idle time. This idle time [21],[22] is called the slack time. This slack time can be used to conserve energy by slowing down the processor and reducing the voltage. These techniques are known as, static slowdown and voltage scaling. We can reduce or eliminate the idle time by reducing the voltage to operate the processor such that, the process takes longer to finish but is completed before its deadline.

## 4. Literature Review

There are several researches have been done for Power Conservation in wireless ad hoc network. In this section, we discuss some proposed work given by the researchers:
In [4], authors K.Arulanandam and B.Parthasarathy, given an approach to minimize power consumption in Idle mode of mobile nodes. He given an idea to change mode of the mobile nodes from Idle to Sleep, because when nodes neither transmitting nor receiving data packets but in Idle mode consume power as consume in receiving mode. They taken two ad hoc o n-demands routing protocol and performed this approach and given that power consumed by these protocols, with this mechanism is less than power consumed without this. It saved power up to 60% of than earlier.

In [7], author Canan A ydogdu and Ezhan Karasan proposed an analytical model for the IEEE 802.11 DCF in multi-hop wireless networks that considers hidden terminals and accurately works for a large range of traffic load that are used to analyze the energy consumption of various relaying strategies. They gave fact of the existing analytical models of IEEE 802.11 DCF systems were inadequate for an energy efficiency analysis in wireless multi-hop networks. They took major attributes of the proposed DCF model together with the limitations and assumptions of the previous DCF models. They concluded that this analytical model is accurate in predicting the energy-efficiency over a w ide range of scenarios. The given results show that the energy efficient routing strategy depends not only on the processing power but also depends on the traffic load.

Seung Hwan Lee and his colleagues, in [8], proposed an energy efficient power Control mechanism for base station in mobile communication systems and a ef ficient sector power control based on distance between base station and mobile node. They also proposed a sleep mode energy control mechanism. In sleep mode energy saving protocol, each sector monitors the number of user in sector cell. They proposed, if number of mobile node falls down a given threshold in sector cell, base station shuts down power. They also proposed an algorithms and demonstrated the tradeoff between energy saving and cell coverage in order to enhance efficient use of base station Transmission power.

## 5. Conclusion

In this paper, we have given an review of Power conservation in wireless mobile ad hoc networks and investigated the power consumption mode and power saving techniques. We have studied current power saving techniques used at different levels. Power saving at routing protocols level is much easier as compared to, power saving at mobile nodes level or transmission level. Each of these techniques saves some energy of mobile device and if we use these different techniques in a combined in a manner it saves lot of energy and increase the lifetime of network.

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