

A survey on battery conservation approaches in MANET

Yogita Sangwan

Assistant Professor, Department of Computer Science & Applications, Kurukshetra University,
Kurukshetra, Haryana

Email: yogita15september@gmail.com

Pooja

Ph.D Scholar, Department of Computer Science & Applications, Kurukshetra University,
Kurukshetra, Haryana

Email: poojasingh59@ymail.com

ABSTRACT

MANET is a network having mobile nodes communicating with each other without any fixed topological structure or centralized administration. These mobile devices operate on batteries which may be homogeneous or heterogeneous depending upon the scope of network. Efficient power consumption is therefore a major indicator for maximizing network lifetime. To maximize the lifetime of MANET, it is quite important to maximize the life time of communicating nodes in order to make them active by minimizing their transmission as well as processing power consumption. Ad hoc network undergoes various challenges like less memory space, limited bandwidth, battery backup limitation, route discovery and selection, data forwarding etc. Power is consumed basically in processing(routing, forwarding etc.) and transmission(sending, receiving). We will focus our attention towards various energy efficient techniques which can be used to maximize the lifetime of MANET and minimizing the power consumption through routing, sleep time effect etc.

Keyword - **ad hoc network, energy efficient routing, power consumption, sleep time.**

1. Introduction

Today Wireless Ad hoc network is gaining popularity in research . Ad hoc networks are very easy in installation and in use. This type of network does not require any extra establishment cost and can be deployed anytime anywhere [3]. Ad hoc mode works in decentralized manner. This type of network is useful in situations where temporary network is required such as in disaster, law enforcement, battlefield etc. In Ad hoc mode there is no access point or centralized device. Topology of wireless Ad hoc network changes rapidly and re-organizes them-selves in an arbitrary fashion. Any transmission in MANET from sender to receiver is done via various intermediate nodes which forward data to the next node in current route [4]. There may be many possible routes available between two nodes over which data can flow having available capacity that may meet the quality of service. The resources available at a node in wireless Ad hoc network are

in scarce. Ad hoc network undergoes various challenges like less memory space, limited bandwidth, battery backup limitation, route discovery and selection, data forwarding etc. The general structure of mobile ad hoc network is shown in Fig.1:



Figure 1: structure of MANET

Power management in wireless networks remains to be an important issue. A source node after data

transmission consumes power and may reach to a threshold level. If the battery power of a node reaches to threshold value, then node is not having sufficient power to either accept the data or send the data to other nodes in the network, so battery consumption is the major factor effecting the life time of network and any node in network as well [5]. Mobility is another issue in MANET where nodes keep on changing their positions and network changes its topology. Power is consumed in data transmission, maintaining active and optimal route, gathering information about neighbors and updating routing tables and in data forwarding in order to gain good quality of service. Routing can be a important factor for efficient energy consumption which may lead to follow optimal path. This paper discuss various ways to improve battery conservation i.e. energy efficient routing algorithm, sleep effect, mobility model, node quality, heterogeneous and homogeneous network etc.

Rest of the paper is discussed in following sections: In section 2, limitations of MANET in context of battery backup are discussed. In section 3, we will discuss various ways by which we can improve the life time of a node and network as well, which further includes subsections describes any of the techniques or protocol. Section 4 of the paper will discuss some related work (Literature survey). Section 5 will explain the conclusion.

2. Limitations in MANET

2.1. Battery consumption

Devices in MANET are mobile and operated through batteries which consumes power in various tasks (sending, receiving, forwarding, processing, listening etc.). The gap between power consumption and power availability is increasing day by day so as to make the node or network alive batteries should have sufficient power [1]. Node in network may go to dead state and results in connection breakup (route failure) which means network in disconnected state.

2.2. Battery replacement

It is very difficult to replace or recharge batteries in harsh environment like battle fields etc. because node is mobile and busy in processing [1] every time except in sleep mode.

2.3. Battery size

Due to use of batteries, the size of mobile node is increased which consumes high energy. Small batteries consumes less power which is not appropriate for network life time.

2.4. Atmospheric Factors

Chemical reactions internal to the battery are driven either by voltage or temperature. The hotter the battery, the faster chemical reactions will occur. High temperatures can thus provide increased performance, but at the same time the rate of the unwanted chemical reactions [10] will increase resulting in a corresponding loss of battery life. Pressure also results in increase in temperature which incurs decays battery.

3. Power conservation in MANET

3.1. Energy efficient routing algorithm

Routing is a process by which optimal path is identified in order to improve performance and QoS. In routing, lots of power is consumed (identifying neighbour information, updating routing tables as topology changes, sending various acknowledgement etc.). Depending upon the nature of network an energy efficient routing can be done so as to conserve energy.

3.1.1. Minimum Battery Cost Routing

This routing depends upon the remaining battery capacity of a node. We know that transmission power is important in successful transmission but it cannot be considered paramount important for maximizing network life time. If minimum total transmission power is considered in routing and the route follow the same node, the battery of node

get exhausted or dead which may result in disconnected network. Therefore remaining battery capacity is more important and accurate in selecting route. In this routing we observe battery capacity is inversely proportional to battery cost function [8] in any path selection procedure. In this node willingness to forward packet is the function of its remaining battery. Let f_i is the battery cost function (unwillingness to forward) and c_i is remaining battery capacity then

$$f_i \propto 1 / c_i \quad (1)$$

In order to select route with maximum remaining battery capacity we have to select the route with minimum battery cost function. Since remaining battery capacity is considered in routing, this metric prevents host to be overused by increasing life time of node and avoid network partitioning.

3.1.2. BeeAdhoc

BeeAdhoc routing algorithm [9] is based upon foraging principle on honeybees. There are two types of agents in algorithm scouts and foragers for performing routing in MANET. It is a reactive source routing algorithm and consumes less energy because it utilizes less control packets in routing. This algorithm is very simple and has two types of messages. The scouts discovers new routes to destination and foragers on demand, which is responsible for transporting data packets and evaluating the quality of discovered routes simultaneously. This simple approach results in less control packets in path identification as a result this algorithm is energy efficient.

3.2. Sleep effect

The goal of efficient routing is not only to find efficient route but also prolong the life time of MANET. This can be achieved by minimizing the power consumption of node during active communication and in inactive state as well [11]. Sleep mode is that mode in MANET at which the node is not participating in any communication or processing. Due to sleep mode very less battery is consumed by the node which is considered as

negligible [6]. As the communication proceeds a node changes its modes (active, overhear, idle, sleep). Energy consumed during this can evaluated as following where E is used for energy consumption during various modes:

$$E_{TOTAL} = E_{PathDiscovery} + E_{PacketTrans} \quad (2)$$

$$E_{PacketTrans} = E_{Idle} + E_{Active} + E_{Overhear} + E_{Sleep} \quad (3)$$

$$E_{Active} = E_{Recv} + E_{Trans} \quad (4)$$

$$E_{Sleep} \cong 0 \quad (5)$$

This shows that energy consumption in sleep mode is almost zero. This is also called low power mode/power-down mode. The main idea behind sleep effect is to switch the mobile node from high power mode to low power mode so that it can conserve its power for future communications. This switching is done when node is in inactive or idle mode [7]. Since for energy conservation mobile nodes should be allowed to sleep. There should be a distributed coordination between active nodes (communicating nodes) so that all participating nodes have to be active for successful transmission. During sleep mode node does not have any information about arrival pattern, so it should be informed to wake up by sending some control messages. The node having idle mode is selected for sleep effect. The different modes of node are shown in Fig.2:

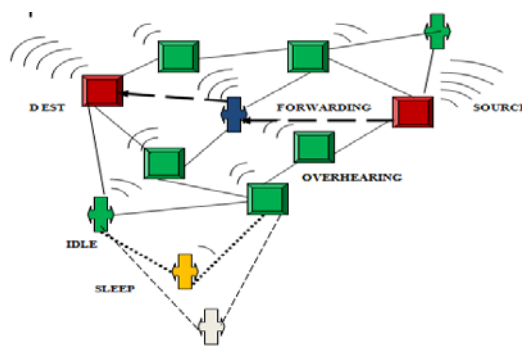


Figure 2: showing modes of node

3.3. Mobility model

The main feature of MANET is mobility, means nodes keep on changing their positions hence network changes topology. So as to maintain the routing and load distribution efficiently a node has

to keep information about its neighbours, incoming paths as well as outgoing paths (routing information etc.). In order to collect information various control packets are sent which incurs power consumption [2]. Mobility models are proposed to collect information about the possible future positions of nodes so that routing decision can be made in advance. Routing protocols directly effects the battery consumption because it may lead path failure, unsuccessful transmission, packet collision, retransmission of data etc. which results in lots of power consumption again and again.

3.4. Power conserving node

Mobile devices in MANET are hardware devices performing various processing tasks. These devices consumes power in sleep mode too which is only hearing for signals. Devices on network also have their own resources like memory, CPU, disk, operating system etc. These resources consume power while processing [7]. Memory instructions are also consumers of power while execution. A node should have sufficient memory to hold incoming packets when its outgoing path is congested otherwise it will discard the packets and will need retransmission which again require power consumption. Efficient CPU scheduling also plays important part in conserving energy at node. There should be a proper balance between CPU burst and I/O burst. Slack time can be used to conserve energy by processor slow down and reducing the voltage. Effective hard disk scheduling also effects the battery consumption because seek time and latency are the factors affecting access time.

3.5. Heterogeneous and Homogeneous network

MANET can be installed with heterogeneous or homogeneous [5] nodes. The network having all devices equipped with same type of batteries is called homogeneous network. These types of networks usually take their routing decision depending upon parameters like distance, number of hops, load on the link etc. with taking into account the remaining battery capacity of node on

the path. Heterogeneous networks are those in which devices are equipped with different types of batteries. Routing is done on the basis of other important parameters as well as power capacity of nodes on path. High power batteries can tolerate heavy traffic and network life time can be increased by using high batteries at most active places where load distribution is high.

4. Related work

A lot of research has been done on conservation of energy in MANET. In this section we discuss some proposed work given by researchers. In paper [1], author has discussed about various problems regarding battery life in MANET. This paper explained power saving issues in MANET. An article "Battery life (and death)" [10] have explained the atmospheric factors (temperature ,pressure) effecting battery life. In paper [8], author has discussed maximum battery life routing (Minimum Battery Cost Routing) which takes remaining battery capacity of node to direct routing decision. Which avoids a node from being over-exhausting. Paper by [9] has explained an algorithm based upon bee behavior which can be used to perform battery efficient routing in order to prolong network life time. It requires less control packets to be sent so as to conserve power. Quality of routes is also identified by agents used. In paper [11], various modes of node with their energy consumption are explained so that appropriate routing can be done. In paper [6], author explained how sleep mode consumes negligible energy as compared to another modes. It is efficient to switch to sleep mode when node is in idle mode. Authors in paper [2] have explained various mobility models and how using these models we can conserve resources. In Paper [7] author have discussed about the energy conservation at node so that it consumes less energy in its own processing. Importance of CPU scheduling, disk scheduling, slack time to turn down are discussed in order to improve energy conservation. In paper [5] author

has discussed energy efficient routing based upon nature of network (Heterogeneous or Homogeneous). He proposed two energy efficient algorithms taking into account whether devices are of same capacity or different.

5. Conclusion

MANET consists of mobile nodes communicating with each other without any fixed structure. Each node in MANET is free to move anywhere. These types of networks do not have ample amount of resources (bandwidth, memory, transmission range, battery etc.). The major drawback of ad-hoc networks is battery backup which effects the life time of a node as well as network. In this paper we have discussed about various ways to conserve power for proper functioning of network. We have studied various approaches to minimize power consumption in MANET which is a biggest challenge today. Each node in network consumes power in any of the mode it has. Our goal is to consume efficient energy so that it can remain in active mode as long as possible. We can apply these ways for efficient consumption of battery so that network life time can be increased.

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