ENERGY MANAGEMENT SYSTEM IN ADHOC WIRELESS NETWORKS

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Abstract: Wireless adhoc networks can be used to provide services anywhere and anytime. Ad hoc networks enable users to spontaneously form a dynamic communication system. They allow users to access the services offered by the fixed network through multihop communications, without requiring infrastructure in the user immediacy. Wireless networks are beset by insufficiency of communication bandwidth and therefore a key issue is to satisfy user requests with minimum service delay. Network nodes have limited energy resources; the energy expended for transferring information across the network has to be minimized. Adhoc wireless networks are constrained by limited battery power, which makes energy management an important issue. Adhoc Networks are more perceptive to these issues where each mobile device is act like a router and consequently, routing delay adds considerably to overall end-to-end delay. In this paper we are focusing on energy management schemes, energy efficient routing Protocol which tries to meet the challenge of using battery power efficiently.

Keywords: Adhoc Networks, Energy Management, Routing Protocols

I. INTRODUCTION

In the last few years, there has been an explosive growth of interest in mobile computing [11], as well as in delivering World Wide Web content and streaming traffic to radio devices. There is a huge potential market for providing personal communication systems with access to airline schedules, weather forecasts, or location-dependent information. However, to offer high-quality and low-cost services to ad hoc network nodes, several technical challenges still need to be addressed. Energy management deals with efficient battery management and transmission power management.

A. Why Energy Management is needed in Ad hoc Networks

In adhoc wireless networks, mobile computation devices are usually battery powered. A limited energy budget constrains the computation and communication capacity of each device. Energy resources and computation workloads have different distributions within the network. Devices that expend all their energy can only be recharged when they leave the network. In wireless networks, the ratio of computation energy consumption to communication energy consumption varies in a wide range, depending on application type. In some applications like micro sensor networks, communication dominates energy consumption. In other application domains and applications like simulation, artificial intelligence, target detection, handwriting recognition, and voice recognition computation energy consumption generally dominates communication energy consumption.

B. Reasons for energy management in ad hoc networks

1) Limited energy reserve: The ad hoc networks have limited energy reserve. The improvement in battery technologies is very slow as compared to the advances in the field of mobile computing and communication.

2) Difficulties in replacing the batteries: In situations like battlefields, natural disasters such as earthquakes, and so forth, it is very difficult to replace and recharge the batteries. Thus, in such situations, the conservation of energy is very important.

3) Lack of central coordination: Because an ad hoc network is a distributed network and there is no central coordinator, some of the nodes in the multihop routing should act as a relay node. If there is heavy relay traffic, this leads to more power consumption at the respective relay node.

4) Constraints on the battery source: The weight of the nodes may increase with the weight of the battery at that node. If the weight of the battery is decreased, that in turn will lead to less power of the battery and thus decrease the life span of the battery. Thus, energy management techniques must deal with this issue; in addition to reducing the size of the battery, they must utilize the energy resources in the best possible way.

5) Selection of optimal transmission power: The increase in the transmission power increases the consumption of the battery charge. Because the transmission power decides the reachability of the nodes, an optimal transmission power decreases the interference between nodes, and that in turn increases the number of simultaneous transmissions [17].

II. CLASSIFICATION OF ENERGY MANAGEMENT SCHEMES

To increase the life of an ad hoc wireless network, a better understanding of the capabilities and limitations of the energy resources of the nodes is maintained. A longer lifetime of the node can be achieved by increasing the battery capacity. Increasing the capacity of the battery at the nodes can be achieved by either battery management, which concerns the internal characteristics of the battery, or power management, which deals with utilizing the battery capacity to the
maximum possible extent. The Figure 1 shows an overview of Energy management system.

The battery management system can be divided into three categories:
- Battery management system
- Transmission power management
- System power management

The system power management can be further subdivided into the following categories:
- Device management schemes
- Processor power management schemes

### III. ENERGY MANAGEMENT IN AD HOC NETWORKS

The energy management in ad hoc networks is a very important aspect of the overall management of ad hoc networks [2]. The mobile wireless sensor nodes in the field need to conserve energy and use it optimally in order to play the assigned role in an ad hoc network for a longer period of time. Energy can be managed at various levels: **Component level, system level and network level.**

#### A. Component Level Energy Management

Component level energy management (CEM) [3] gives an opportunity to control the energy utilization by various components of a system. There are several components that are part of a system that get used during initialization, and other components that get used at irregular intervals. By a suitable design, if the energy consumed by these components during idle time can be reduced close to zero, the main operation of the system can be better sustained.

#### B. System Level Energy Management

Adhoc wireless networks carrying different kinds of traffic. A node in such a network is the system under consideration and considers a scenario in which multiple tasks handle traffic of different kinds. If we use the available energy in appropriate way it may be better to trade-off low priority traffic so as to be able to handle high priority traffic [10].

#### C. Network Level Energy Management

The issues related to energy management are dealt at Network level. The objective is to conserve energy at network level by cooperating loading of neighboring nodes.

### IV. POWER MANAGEMENT OF AD HOC NETWORKS

The equipment in ad hoc networks always uses exhaustible energy as their power supply such as batteries [16][17]. Despite the fact that mobile computing is evolving rapidly with advances in wireless communications and devices getting smaller and more efficient, advances in battery technology have not yet reached the stage where a mobile computer can operate for days without recharging[18]. Therefore, advanced power conservation techniques are necessary. A variety of techniques can be used to cope with power scarcity. The Table 1 shows the power management at various protocol layers.

<table>
<thead>
<tr>
<th>Protocol Layer</th>
<th>Power Conservation Techniques</th>
</tr>
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<tbody>
<tr>
<td>Data-Link Layer</td>
<td>Avoid unnecessary retransmission. Avoid collision in channel access whenever possible. Put receive in standby mode whenever possible. Use or allocate contiguous slots for transmission and reception whenever possible. Turn radio off (sleep) when not transmitting or receiving.</td>
</tr>
<tr>
<td>Transport Layer</td>
<td>Avoid repeated retransmissions. Handle packet loss in a localized manner. Use power-efficient error control schemes</td>
</tr>
<tr>
<td>Application Layer</td>
<td>Adopt an adaptive mobile quality of service (QoS) framework. Move power-intensive computation from a mobile host to the base station. Use proxies for mobile clients. Proxies can be designed to make applications adapt to power or bandwidth constraints. Proxies can intelligently cache frequently used information, suppress video transmission and allow audio, and employ a variety of method to conserve power.</td>
</tr>
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</table>

### TABLE 1: POWER MANAGEMENT AT VARIOUS LAYERS

### V. ENERGY EFFICIENT PROTOCOL

Energy efficiency is a major challenge in wireless networks. To facilitate communication, most wireless network devices are portable and battery-powered, and thus operate on an extremely constrained energy budget. However, progress in battery technology shows that only small improvements in battery capacity can be expected in the near future. Furthermore, because recharging or replacing batteries is costly or, under some circumstances, impossible, it is desirable to keep the energy dissipation level of devices low. An Adhoc network is a collection of two or more nodes equipped with wireless communications and networking capabilities without central network control, namely, an
Infrastructure less mobile network. Energy-efficient design in ad hoc networks is more important and challenging than with other wireless networks. First, due to the absence of an infrastructure, nodes in an ad hoc network must act as routers and join in the process of forwarding packets. Therefore, traffic loads in ad hoc network are heavier than in other wireless networks with fixed access points or base stations, and thus ad hoc network have more energy consumption. Second, energy-efficient design needs to consider the trade-offs between different network performance criteria. Third, no centralized control implies that energy-efficient management must be done in a distributed and cooperative manner, which is difficult to achieve [5] [7]. In the wireless interface, energy consumption in idle mode is only slightly less than in transmit mode and almost equal to that of receive mode. Therefore, a network protocol is needed to maximize the time a device is in sleep mode and also maximizes the number of wireless devices that can be in sleep mode. Many protocols have been proposed to deal with this challenge. Here we are discussing about the Energy Efficient Medium Access Control Protocol.

A. Energy-Efficient Medium Access Control (EE-MAC) Protocol

The Energy-Efficient Medium Access Control (EE-MAC) Protocol is based on the fact that most applications of ad hoc networks are data driven, which means that the sole purpose of forming an ad hoc network is to collect and disperse data. Hence, keeping all network nodes awake is costly and unnecessary when some nodes do not have traffic to carry [7]. The protocol conserves energy by turning on and off the radios of specific nodes in the network. The goal is to reduce energy consumption with out significantly reducing network performance. The key idea of EE-MAC is to select master nodes from all nodes in the network. Master nodes stay awake all the time and act as a virtual backbone to route packets in the ad hoc network. Other nodes, called “slave nodes,” remain in an energy efficient mode and wake up periodically only during signal intervals to check whether they have packets to receive [5].

B. Features of EE-MAC Protocol: In EE-MAC the masters don’t operate in power saving mode and forward packets all the time, the packet delivery ratio and packet delay can be improved. The features of EE-MAC are

- Entering Sleep Mode Earlier
- Priority processing of packets to slaves
- Prolonging the sleep period for slaves

Performance: Our main concern is energy efficiency; energy level is given higher weight than connectivity. We consider some metrics to evaluate the network performance which will differ from those used by others.

- Data Packet Delivery Ratio
- End-to-end delay
- Energy efficiency

VI. CONCLUSION

In this paper, we addressed how to manage energy efficiently in wireless ad hoc networks. Because the nodes are mobile and can be used for emergency purposes like military or natural disasters, each node should utilize its battery efficiently. Some of the problems which are faced while managing energy and are limited energy reserve, difficulties in replacing batteries, lack of central coordination, and constraints on the battery source. We also presented energy management in Ad hoc Networks at various levels like Component, System and Network, as well as the energy management schemes, power management in Ad hoc Networks. The challenge is not to provide each node with higher battery power but to utilize the available battery power in a very efficient manner. We dealt with Energy-Efficient Medium Access Control (EE-MAC) Protocol which tries to meet the challenge of using battery power efficiently.

REFERENCES