Chapter 17

Energy Conservation Issues and Challenges in MANETs

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ABSTRACT

Energy efficiency is a major issue of concern in wireless ad hoc networks as mobile nodes rely on batteries, which are limited sources of energy, and, in many environments, it is quite a cumbersome task to replace or recharge them. Despite the progress made in battery technology, the lifetime of battery powered devices continues to be a key challenge, requiring additional research on efficient design of platforms, protocols, and systems. Many tangible efforts are made by many researchers to reduce the power consumption at protocol level by designing an energy efficient protocol to prolong the lifetime of the networks. The main focus of this chapter is to present a comprehensive analysis of energy efficient techniques in wireless ad hoc networks, integrating various issues and challenges to provide a big picture in this area. This chapter addresses energy management techniques in wireless ad hoc networks, especially in decentralized ad hoc environments.

1. INTRODUCTION

Energy efficiency is the most crucial design criteria for mobile ad hoc networks (MANETs), as mobile nodes are battery operated. If a node runs out of battery, its ability to route the traffic of other nodes gets affected which in turn affects the life time of the overall network negatively. Life period of a network can be enhanced by maximizing the battery power of nodes, and by minimizing total power consumption in the network. Despite the progress made in battery technologies in the recent times, it has not achieved as much as expected in comparison to semiconductor technology. This difference creates a gap between the amount of energy needed to operate in a wireless environment and a battery capacity that powered the nodes. Hence, energy efficiency appears to be an extremely important property for new protocols in MANETs. In recent years, numerous energy
efficient techniques such as, dynamic transmission power adjustment, topology control, multipath routing, adaptive sleeping, directional antennas, etc. have been proposed in literature. However, they suffer from their own pitfalls. For example, a protocol that reduces energy consumption by selecting an energy efficient path in the network may lead to quicker network partition, due to some overloaded node routing heavy traffic of other nodes. This may disturb the whole network leading to its early disconnection.

Therefore MANET protocols must try to choose a path that balances between the energy consumption of all the nodes and maximize the lifetime of network as a whole. It is also important to maintain a tradeoff between the energy consumed and other metrics, such as: throughput, end-to-end delay, reliability of the links, network capacity, etc. Researchers have made studies on exclusive layers of the protocol stack as well as on cross layer optimization to conserve energy.

This chapter explores different approaches to reduce energy consumption in wireless ad hoc networks and focused on issues involved in it. The chapter opens with a brief introduction to energy efficiency in wireless network. Second section discusses about energy management in ad hoc network. The third section categorically presents some energy aware protocols with their strength and weakness. Conclusions are made in fourth section.

2. BACKGROUND INFORMATION

In this section we detail on different energy management issues such as: need of energy managements, causes of energy wastes, energy consumption, radio energy model, etc. This helps us in understanding energy issues, challenges and requirements in MANETs.

2.1. Need for Energy Management

Now a day’s energy efficiency has become a pervasive issue in all layers of communication protocols, and in a wide range of technological applications spanning from simple microelectronic systems to more complex vehicular ad hoc networks. Until now, research and development in the field of communication networks was mainly targeted at their functionality and performance, but for battery-driven devices, such as mobile and sensor nodes, energy efficiency is a significant consideration. The intensity of its importance increases due to the massive use of such devices in public, professional, and private life, coupled with the increasing cost of energy and with the recognition of the critical need to reduce carbon dioxide (CO2) emissions. These economic and ecological drivers have induced a new research area with “energy efficient of communication networks” as the main objective. The primary reasons behind the energy management in ad hoc networks are as follows:

- **Limited Battery Power:** Nodes in MANETs are battery operated, and in many applications like disaster management, battle field communication, environment monitoring, etc., it is difficult to replace and recharge them. Since the capacity is limited, some energy management techniques need to be performed to prolong the network lifetime.

- **Increasing Demand of Battery Operated Devices:** Massive use of battery operated devices in communication, personal and professional life, demand more requirements of battery. Devices operated by battery are omnipresent in the form of cell phone to micro sensor nodes.

- **Relay Traffic:** Nodes in ad hoc network act as a source as well as router to relay the traffic from other nodes in the network. These relay nodes play a vital role in defining the life time of the network. If the pro-