Chapter 5
Wireless Mesh Sensor Networks with Mobile Devices:
A Comprehensive Review

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ABSTRACT

Mesh communications is emerging as a popular networking solution. Mesh networks have a decentralized and multihop design. These characteristics arouse interest for the research of the following features: cooperation, task distribution, scalability and communication with limited infrastructure support. This chapter studies relevant solutions in Wireless Sensor Networks (WSNs) with a mesh design that is used with mobile devices. The use of mobile devices on WSNs has recently grown due to: hardware evolution, large number of embedded sensors and daily high utilization of handheld devices. Consequently, novel requisites in the design and implementation of WSNs urge to be satisfied: autonomy of sensors battery and, efficient data exchange amongst sensors and the Internet. A real mesh testbed with two Layer 2 mesh solutions (Open802.11s and B.A.T.M.A.N) was implemented with different topologies. Some relevant results for a mesh network are discussed in terms of its scalability, performance and volatility.

1. INTRODUCTION

Wireless Mesh Networks (WMNs) have today a significant expansion and they are a major research area in wireless networks. The decentralized behavior among the nodes of WMNs arouses interest in features such as: cooperation between nodes, distributed tasks, scalability and communication with limited infrastructure. In addition, the self-organization and self-configuration capabilities reduce the complexity and the maintenance of the network.

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WMNs with Mobile Devices (MDs) is an important field of investigation, because as far as we know, there isn't an explicit standard for WMNs that takes into account the specific limitations of handheld MDs. This creates a huge opportunity to develop interesting research that heightens the use of handheld MDs on WMN.

Wireless Sensor Networks (WSNs) have been used in different areas, from environmental monitoring, to battlefield communication, patient care to smart home system, among other applications. These applications are increasing every day with the availability of new technologies and devices. However, due to the limitations of WSN in terms of communication capability and power supply, the efficient management of data transmission and the battery energy of each sensor are major concerns. Efficient approaches are required to handle these issues associated with the deployment of sensors.

These WSNs can be deployed in a large geographic area where some sensors are located nearby access nodes to the Internet but others are operating at remote and isolated locations. In addition, some sensors are mobile and this mobility pattern can itself change very often the network topology. To support all these new requisites, we advocate the use of a mesh topology in the wireless upload/download communication of data from sensors to some Internet servers. Consequently, new functional requisites in the design and implementation of the WSN architecture are urged to be satisfied, namely in two potentially conflicting aspects: autonomy of each sensor battery and an efficient data exchange among sensors and the Internet.

The utilization of WSNs with MDs has grown in recent years, with the appearance of very useful applications in daily life. Such devices, carries a large number of sensors embedded, like: rotation; location; direction; luminance; camera; humidity; audio; pressure; proximity and temperature; and the possibility to attach other external sensors if necessary. The main advantages of MDs for WSNs are the mobility for monitoring the terminal environment and the daily use by users. The main constraint is very popular in sensor networks and is about the battery consumption.

Due to the characteristics of sensor and WMNs allied with the new paradigm of MDs arouses the area of Wireless Mesh Sensor Networks (WMSNs) with MDs. This chapter studies relevant solutions for WMSNs assuming a tradeoff between network performance and battery energy.

The current chapter has the following structure: Section 2 presents a review of the state of the art for projects that use WMNs with MDs. In Section 3 are discussed various solutions for protocol routing and path selection in WMNs to understand if these solutions are compatible with the operation of sensor networks. In Section 4 was made a study about routing metrics for WMNs. Given the fact that a sensor network has to take into account the energy consumption, Section 5 introduces energy-aware routing metrics and the viability to work on WMNs. Section 6 discusses some relevant results obtained from a real testbed with two different mesh implementations (B.A.T.M.A.N advanced and Open802.11s) to conclude which one is the more suitable for a WMSN. Finally, Section 7 concludes the current contribution.

2. MESH NETWORKS IMPLEMENTED WITH MOBILE DEVICES

WMNs on MDs have been the focus of various projects and feature a wide variety of solutions. It is necessary to analyze and compare relevant solutions, finding out relevant features to be implemented, especially in mesh scenarios with handheld MDs. The implementation of a WMN with MDs can be done at different OSI layers. The standard mesh solution ("802.11s - IEEE Standard for Information Technology," 2011) is implemented at Layer 2. There are also implementations at Layer 2.5 (with additional software between Layers 2 and 3), Layer 3 and Layer 7.