Chapter 11
An Open Service Platform Based on an IP Metropolitan Mesh Network

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ABSTRACT

This chapter proposes an open-service platform based on an IP metropolitan mesh network suitable for multimedia services in an all-IP network environment. To guarantee mobile applications in the metropolitan mesh network simulated, the authors evaluated the five most prominent mobile ad hoc network (MANET) routing algorithms: Ad hoc On Demand Distance Vector (AODV), Dynamic Source Routing protocol for mobile ad hoc networks (DSR), Optimized Link State Routing Protocol (OLSR), Temporally-Ordered Routing Algorithm (TORA), and Geographic Routing Protocol (GRP). The metropolitan mesh network architecture is based on the IEEE 802.16-2004 Standard that supports the IP protocol and the interaction with MANET protocols. The MANET routing protocols are evaluated in terms of delivery ratio, MANET delay, routing overhead, overhead, WiMAX delay, WiMAX load, and WiMAX throughput. Results show that proactive routing algorithms are more efficient than the reactive routing algorithms for the IP metropolitan-mesh network simulated.

INTRODUCTION

Mobile ad-hoc networks have attracted considerable attention and interest from the commercial sector as well as the standards community. The introduction of new technologies such as IEEE 802.11g and IEEE 802.16 greatly facilitate the deployment of ad-hoc technology beyond the military domain (Santos et al., 2010). However, to the best of our knowledge, mobile ad hoc routing algorithms based on IP IEEE 802.16-mesh networks, have been insufficiently unexplored.

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The IEEE 802.16-2004 standard includes a mesh topology which can be used efficiently in Mobile Ad-Hoc Networks or MANETs.

WiMAX (Worldwide Interoperability for Microwave Access) is a wireless communication system that can provide high data rate communications in IP *metropolitan area networks (MANs)*. Over the years, the IEEE 802.16 workgroup has developed a number of standards for WiMAX. The first standard was published in 2001 to support communications in the 10-66 GHz frequency band. In 2003, IEEE 802.16a was introduced to provide additional physical layer specifications for the 2-11 GHz frequency band. These two standards were further revised by the IEEE 802.16-2004 (Chite & Daigle, 2003). Subsequently, IEEE 802.16e was also approved as the official standard for mobile applications. IEEE 802.16m (Ahmadi, 2011) is the current standard for WiMAX, aimed at fulfilling the 4G specification.

In the *physical (PHY)* layer, IEEE 802.16 supports four PHY specifications for the licensed bands. These four specifications are WirelessMAN-SC (single carrier), -SCa, -OFDM (orthogonal frequency – division multiplexing), and *OFDMA (orthogonal frequency –division multiple access)*. In addition, the standard also supports different PHY specifications (-SCa, -OFDM, and –OFDMA) for the unlicensed bands, including wireless high-speed unlicensed MAN (WirelessHUMAN). Most PHY specifications are designed for *non-line-of-sight (NLOS)* operation in frequency bands below 11 GHz, except –SC, which operates in the 10-66 GHz frequency band. To support multiple subscribers, IEEE 802.16 supports *both time-division duplex (TDD)* and *frequency-division duplex (FDD)* operations.

The mobile version of IEEE 80.16 also supports the following features to enhance the performance of the wireless system: 1) *multiple input, multiple output (MIMO)* techniques such as transmit/receive diversity multiplexing and 2) *adaptive modulation and coding (AMC)* is used to better match instantaneous channel and interference conditions. Furthermore, multiple antenna schemes can also be used to improve performance by increasing the transmitted data rates through spatial multiplexing and, importantly, in the *medium access control (MAC)* layer, IEEE 802.16-2004 supports two modes: *point-to-multipoint (PMP)* and mesh. The former organizes nodes into a cellular-like structure consisting of a *base station (BS)* and *subscriber stations (SSs)*. The channels are divided into uplink (from SS to BS) and downlink (from BS to SS), and both uplink and downlink channels are shared among the SSs. PMP mode requires all SSs to be within the transmission range and clear *line of sight (LOS)* of the BS. On the other hand, in mesh mode, an ad hoc network can be formed with all nodes acting as relay routers in addition to their sender and receiver roles, although there may still be nodes that serve as BSs and provide backhaul connectivity.

This chapter proposes a simulation model for an IP metropolitan IEEE 802.16 mesh network which can transmit all-IP services and whose proposed architecture can be deployed in emergency scenarios because it does not require a base station.

The remainder of this chapter is organized as follows: the second section describes the classification of mobile ad hoc routing algorithms. The following section analyzes the state of the art of routing algorithms for wireless mesh networks. There follows an explanation of the simulation model for the IP metropolitan-mesh network. The chapter then discusses the scenario simulated and results obtained, followed by the concluding sections, which summarize our work and propose future research.

MOBILE AD HOC ROUTING ALGORITHMS

Mobile ad hoc algorithms can be categorized into two different categories: non-positional algorithms and positional algorithms. Non-positional algorithms can discover the network topology without

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