# Chapter 14
# Dynamic Resource Management and Optimization in Heterogeneous Wireless Networks under IEEE1900.4 Framework

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## ABSTRACT

*Next generation (xG) wireless networks will contain a number of radio access networks (RANs), which mainly depend on various radio access technologies (RATs). Meanwhile, the subscribers in the current networks will be equipped with multi-mode, reconfigurable, and cognitive equipments, with or without multi-homing abilities. This chapter looks at the definition, principle, architecture, optimization objective, specific approach, and optimization of resource for such a composite network /hybrid network context under IEEE1900.4 framework. First, the challenges of spectrum scarcity, and the requirements of a novel resource management framework in the limited resource scenario are summarized. Second, the authors focus on the techniques of resource management and optimization architecture. After a simple description of the basics of IEEE P1900.4, a novel double cognition cycle (DCC) design in the fashion of utility function theory is proposed in this chapter. The DCC contains two cognition cycles corresponding to the terminal and network side, respectively, and is uniformed in the frameworks of network utility maximization (NUM). Third, the authors capture the challenges of resource management protocols of the current developing heterogeneous networks and investigate the dynamic churning behaviors, where the subscribers are equipped with intelligent terminals with the aid of cognitive radios.*

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## 14.1 INTRODUCTION

A dynamically interactive resource management mechanism/protocol between multiple RANs and subscribers is presented via network utility maximization approach under the IEEE P1900.4 architecture framework. Specifically, from the network centric/user centric perspectives, we design the interactive protocol between the (Terminal Reconfiguration Manager) TRM and (Network Reconfiguration Manager) NRM entities and the corresponding distributed algorithms, e.g., the best link selection. Finally, simple tests verify the performance improvement of our proposed resource management approach and the feasibility of the presented protocol.

The rapid development of wireless services over the past decades has illuminated the growing demands for radio spectrum, which however is limited, valuable and increasingly congested. On the other hand, recent spectrum measurement campaigns indicate that most of the licensed spectrum has been under-utilized (Haykin, S., 2005). To deal with the seemingly contradictory problem between spectrum congestion and spectrum underutilization, cognitive radio (CR) technology has been proposed and advocated (Akyildiz, I. F., Lee, W.-Y., Vuran & M. C., Mohanty, S., 2006), which can well improve the utilization of the spectrum. However, with the further development of wireless networks, the scarcity of spectrum resource is faced with more severe challenges. Specifically, future networks may comprise multiple heterogeneous wireless access networks, which are unified in a management framework with the aid of CR technology (Akyildiz, I. F., Lee, W.-Y., Vuran & M. C., Mohanty, S., 2006). Given the more and more applications of the intelligent terminal equipments, various dynamic behaviors, different kinds of service diversity and more harsh wireless context, there is no doubt that the shortage of resources is getting even worse.

As a promising development trend of future networks, heterogeneous wireless access networks have undergone many significant changes in profound, where a number of radio access networks (RANs) coexist. Moreover, these networks tend to use different radio access technologies (RATs), such as second generation or third-generation access technology: GSM, GPRS, EDGE, UMTS, HSDPA, 3GPP-LTE, IEEE 802.11x, etc.. As a result, it urgently calls for new generation of resource management system, architecture and technology to achieve seamless resource switching and dynamic spectrum access technology to achieve higher transmission rate (Marojevic, V., Salazar, J., Revés, X. & Gelonch, A., 2008). We expect a unified management structure, which can support a greater range of business types, such as online gaming, video conferences and, more importantly, further improve the spectrum efficiency. In addition to these developments of the current heterogeneous network, the reconfigurable multi-mode mobile terminals provide subscribers with the ability of choosing among multiple access networks. These terminals will be equipped with the cognitive module to achieve dynamic spectrum access, and to allow of different modes of communication between different systems for real-time dynamic spectrum sharing. Moreover, reconfigurable multi-mode mobile terminal is of a wide range of applications; as a result, user equipment may be of different operations. All these also lead to the urgent need of the novel management architecture to support a wide range of wireless interface (Buljore, S. Merat & V. Harada, H., 2008). As a result of these changes, there is a need to develop a standard that addresses the requirements and leverages the opportunities posed by such a versatile radio environment. To this end, IEEE P1900.4 aims to standardize the overall system architecture and information exchange between the network and mobile devices, which will allow these communication elements to be optimally choose from available radio resources. In other words, the standard facilitates the distributed dynamic optimization of the usage of spectrum offered by the heterogeneous wireless network,