Chapter 6
Interference Suppression Capabilities of Smart Cognitive-Femto Networks (SCFN)

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ABSTRACT

Cognitive Radios are considered a standard part of future heterogeneous mobile network architectures. In this chapter, a two tier heterogeneous network with multiple Radio Access Technologies (RATs) is considered, namely (1) the secondary network, which comprises of Cognitive-Femto BS (CFBS), and (2) the macrocell network, which is considered a primary network. By exploiting the cooperation among the CFBS, the multiple CFBS can be considered a single base station with multiple geographically dispersed antennas, which can reduce the interference levels by directing the main beam toward the desired femtocell mobile user. The resultant network is referred to as Smart Cognitive-Femto Network (SCFN). In order to determine the effectiveness of the proposed smart network, the interference rejection capabilities of the SCFN is studied. It has been shown that the smart network offers significant performance improvements in interference suppression and Signal to Interference Ratio (SIR) and may be considered a promising solution to the interference management problems in future heterogeneous networks.

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INTRODUCTION

In this chapter, the interference management capabilities of future generations of wireless communication networks are explored. The contribution of this chapter will create a strong impact on the infrastructure developments for future generations of wireless networks, which facilitate the wireless high quality broadband access to everyone especially to the population residing in sparsely populated areas. Furthermore, the theme of the chapter is fully aligned with the European manifesto which ensures that everyone must have access to good broadband to a minimum of 2 Mb speed service by 2015. The proposal is fully aligned with Race Online 2012 manifesto, along with several other European projects under seventh framework (FP7) such as COGEU, QOSMOS, CROWN, SECARA, ARCOPILIS, WHITESPACECENTER, W-GREEN, and EARTH. The theme of this chapter is also aligned with several projects under COST actions such as IC0804-Energy for distributed systems, IC0905-TERRA, IC0902-HETNETS (Cost Europe, 2012; European Commission, 2012).

In this section, the technology behind the cognitive radio networks is presented, with a deep insight on its applications and trends along with an overview of the several spectrum sensing methods that are currently used. Then, the concept behind heterogeneous networks is introduced with a discussion on Small Cell Networks (SCN), its employment, benefits, problems and challenges.

The rest of the contributions of the chapter is organized as follows. Section 2.1 defines the Smart Cognitive-Femto Networks by recasting the two tier Heterogeneous network into the framework of the Cognitive Enabled Femtocell Network. Section 2.1.1 defines the environment in which the proposed system is being tested. Section 2.1.2 presents the network layout of such system; Section 2.1.4 presents the system model. Later in Section 2.1.5, interference suppression capabilities of the smart network are presented. Next, in Section 2.2, simulation results are presented to show the efficacy of the proposed smart network. Directions for future research are described in Section 3. Finally, conclusions are drawn in section 4.

1. BACKGROUND

1.1. Cognitive Radio Networks

1.1.1. Technology and Forecast

According to the Federal Communications Commission (FCC), the radio spectrum is highly underutilized (Stotas & Nallanathan, 2011), which makes its usage inadequate and its availability limited since one or more users are allocated one fixed band of the spectrum. For instance, in US, the radio spectrum is utilized only 6% most of the time (Cheng, Zhang, & Zhang, 2011) and based on measurements made by Office of Communications (Ofcom) in UK and Spectrum Policy Task Force (SPTF) in USA, many pieces of the licensed spectrum are not utilized for long period of time (Arshad, Imran, & Moessner, 2010). This results in spectrum pieces that are allocated to licensed users but are unused for certain time and at a particular location, and these are referred to as spectrum holes. In addition to being underutilized for most of the time, the radio spectrum has been fully allocated, the fact that initiated an extensive research on how to efficiently reuse the spectrum and resolve the problem of spectrum unavailability. Over the last decade, significant work has been done to explore new radio resources and new technologies which focus more on improving the spectrum and energy efficiency of wireless mobile networks. This highly ambitious goal provides mean for improving end-user data rates, reducing spectrum requirements, and lowering the power consumption/transmission in the network by intelligent utilization of the available spectrum resources. Dynamic Spectrum Access (DSA) is a technique where a fixed band in the spectrum