Chapter 6

Spectrum Handover Strategies for Cognitive Femtocell Networks

Saba Al-Rubaye
Brunel University, UK

Anwer Al-Dulaimi
Brunel University, UK

John Cosmas
Brunel University, UK

ABSTRACT

Cognitive femtocell is a promising technology for the next generation wireless networks to improve the efficiency of spectrum utilization, coverage, and to attain higher data rates for indoor communications. In this chapter, the new Cognitive Femtocell Switching Unit (CFSU) is proposed to support handover management for 10-20 cognitive femtocells as a local geographical cluster. Thus, CFSU acts as a service coordinator between femtocells and macrocell areas to improve spectrum utilization and coexistence. Then, the chapter presents solutions for spectrum handover to achieve guaranteed quality of radio service, spectrum utilization, and enable an excellent local handover management to reduce unnecessary handovers between femtocell base stations. The challenges and solutions that are presented in this chapter have the ability to maintain services by evaluating the requested quality of services.

1. INTRODUCTION

Femtocells have emerged as a solution to increase both the efficiency and coverage area of next-generation broadband wireless networks, while reducing both capital expenditures and operating expenses. Cognitive femtocells are a key aspect of the necessary technology changes for next generation broadband wireless communication system to permit a reduced amount of limited and more flexible access to radio spectrum. Femtocell integrated with cognitive radio is addressed as an important combination that enables operators to attain a new type of local secondary service, in-
crease capacity, adapt coverage areas, and improve QoS for future cognitive networks.

Femtocell base station (FBS) is a small and low cost base station operating in licensed spectrum with a short range (i.e. 10 to 15 m in radius). It is typically designed to serve fewer than 10 users at home or work, as well as connecting to the macrocell by fiber or DSL cable as shown in Figure 1. However, femtocells have gained a lot of attention recently due to their advantages in terms of infrastructure cost saving, power, capacity, and improved user experience in indoor environments. Several standards bodies, such as 3GPP, WiMax Forum, and IEEE 802.16, have started to develop standard solutions to enable and optimize femtocells operation (Kim et al., 2009). Moreover, there are some technical challenges to the success of femtocell technologies that need to be overcome before they can be deployed on a large scale. In cognitive femtocells there are many challenges, for instance, network architecture, resource management, interference mitigation and handover.

Studies conducted on the current and future traffic pattern, show that more than 40% of the mobile services were used outside the home, and 60% of mobile services were used at home and work. However, this research expects the number of users will increase to reach 75% for both home and work and decline for the number of mobile services outdoors to reach 25% (Saunders et al., 2009). Cognitive radio (CR) is seen as one of the most encouraging approaches to solving the spectrum shortage problem by allowing smart and dynamic spectrum management in future wireless communication systems. CR is characterized as a system able to adapt its transmission or reception functions on the basis of cognitive interaction with the wireless environment in which it operates.

This kind of interaction may involve dynamic spectrum sensing or, in general, autonomous communication and negotiation with other spec-