Chapter 27
Interference Mitigation in Femtocell using Optimized Power Control

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ABSTRACT

The femtocell network is a new technology that uses the advantage of an Internet backbone to enhance the cellular coverage in residential or small business areas. However, due to the expected random deployment of the Femtocell Access Point (FAP), there is a strong probability of interference among the femtocell nodes and between the femtocells and the macrocell nodes. In this chapter, an interference enhancement for OFDMA systems is developed and designed for two tiered macro-femtocell networks. An adaptive power control is calculated based on selecting the minimum interference channel with the optimized channel gain. In the simulation a number of the FAPs, the distance between the macrocell and the femtocell, and the path loss between the macrocell node and the FAPs are used as design parameters. By using optimized power control performance enhancement the interference degradation ratio can be observed.

INTRODUCTION

Femtocells are low-cost, miniature base-stations intended to improve the indoor coverage in the 3G networks and beyond. Femtocells are the smallest area that the network operator can cover to enhance the data rate in indoor coverage using a small base station. This is also known as a Home Base Station (HBS) or a Femtocell Access Point (FAP). The FAP is connected to an operator through a broadband/Internet network and uses licensed cellular bands. A FAP is small and inexpensive, and can transmit at a low power. It works on the licensed band and can be categorised based on the access method, an open access, where all the user

DOI: 10.4018/978-1-4666-3886-0.ch027

of the same network can access the service and, a close access, where only the authorized personnel can access the service. A femtocell system is expected to increase a system capacity in terms of the number of users per cells or the data rate per user. This enhancement is due to a dedicated and an un-attenuated backhaul link using the fixed broadband (i.e. DSL).

One of the main issues in adopting the femtocells en masse is the surge in interference to the mobile users served by the macrocell arising from unplanned networks and private access, which is similar to WiFi which has been deployed. A WiFi is using an unlicensed spectrum which uses a carrier sense technique while a femtocell is using a licensed cellular spectrum in which it shares the macrocell BS spectrum. In this circumstance, there will be a probability of interference between the macro-famto, and the femto-femto nodes. A femtocell has two access methods, namely, the open access or the close access modes. An open access mode is open for anybody to access the services after an initial authentication, the same as in the public WiFi. The non-authenticated user elements can access the macrocell BS. However, due to the close distance, FAPs can introduce a high interference to these users. The macrocell users can introduce interference to the femtocell users due to the high power usage. This interference reduces the performance of the FAP seriously if not intervened. Therefore, distributed power control mechanisms for the femtocells are essential to shield the existing users of the macrocell as well as to enable the scalable femtocell deployments. In this chapter we discussed the interference problem and introduced an improved power control solution for the FAP to avoid an interference problem.

The objectives of this chapter are to understand the concept of Femtocells system, to distinguish between different types of interferences to Femtocell Base Station (FBS), to investigate the different types of power control schemes and to introduce an optimized power control scheme for interference mitigation in femto-cellular.

BACKGROUND

The Femtocells system like any other cellular communication technologies has a problem of the interference from other neighboring cells such as Macro, Micro and Pico cells. When a signal that is being transmitted from the Femtocell system to the user in the cell. Other users of the same network in other cell such as the Macro user are affected by the signal transmission of that femtocell as well as the other femtocell user.

Femtocell systems are expected to increase the capacity of the system in terms of number of users per cells or data rate per user. This because of the dedicated backhaul through fixed DSL, in opposite to micro and picocells which their backbone is taken directly from the macrocell Base Station (BS). Several challenges femtocells have to solve before they can be deployed, such as, seamless mobility and handover between different cells, spectrum allocation, sharing, and interference problems. The interference is one of the serious challenges that face the femtocell deployment since it affects the quality and the throughput of the system. Femtocell is suffers from interference from other femtocells and macrocell base stations. This due to the large number of FBS would be deployed by the customer in their premises. This interference is reducing the performance of FBS seriously if not tolerated. Interference can be in the form of femto-femto cells or femto-macrocells interference.

There are many scenarios that the femtocell will encounter interference problems because of it. Co-layer interference is one of it and it is described as the unwanted signal received at a femtocell and sent from other femtocells, decreasing thus the quality of its communication thus will cause many problems as follow:

There will be uplink and downlink interference both has a CDMA and OFDMA system. The uplink has noise rise at the FAB in the CDMA and will have Intercarrier interference at the FAB for the OFDMA system. While in the downlink there