Chapter 1

Introduction to Femtocell

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ABSTRACT

Femtocell is a licensed indoor coverage solution served by a residential licensed access point known as FAP or Home node B. Femtocell promises to address the cost and coverage issues of mobile networks and increase cellular network capacity by rising above the impact of wall attenuation on macrocell deployment. The Femto Forum defines femtocell as a low cost access point leveraged on mature mobile technology that operates on a licensed spectrum and utilizes broadband (IP) as backhaul. This chapter gives an overview of the femtocell technology and architecture, standard and business models.

INTRODUCTION

The diverse multimedia applications and ubiquitous Internet access offered by today’s smart phones result in an unprecedented growth of mobile data. The end user is expected to munch through 7Giga Bytes of traffic per month; video is expected to be 66% of mobile traffic by 2014, 5.4 times more than today’s average (Cisco, 2010). Predictions show that indoor environments will be the source of 60% of voice and about 90% of data traffic. This is a major concern of cellular systems operators whose job is to offer high speed connections to end users, and enhance the network’s coverage. However, accommodating this increased demand and granting indoor high connection is very difficult using the traditional macrocellular system due to its limited capacity and wireless signal strength reduction through walls.

Femtocell, also known as ‘Home NodeB’ (HNB), is a low power, small-size, indoor based cellular station that carries any mobile device (e.g. UMTS, CDMA2000, WiMAX, and LTE) by means of standard cellular interfaces. Femtocell technology is a solution that promises to support the increased demand of data traffic and to balance and improve the macrocell coverage in indoor sites.
cost effectively. Femtocell is an integrated solution that aims to bring improved mobile network coverage to dedicated indoor-based voice and data network. This solution provides an opportunity to enable the expected 4G services and provide efficient spectrum use, maintain mobility, extend high-quality indoor coverage, and raise data throughput. Femtocell pledges to provide flexible and scalable end-to-end systems that would soon be available to both the private and commercial markets (Claussen, 2008). The system is designed to act as a home/small business cellular system network as well as further air interfaces, such as Long Term Evolution (LTE) networks.

Femtocells operate in the licensed spectrum of a cellular operator. The radio in the femtocell is controlled by the service provider’s core network, and it operates with standard mobile phones with no special modifications. However, the reuse of the licensed cellular spectrum requires interference management between the femtocells and the umbrella macrocell. Such coordination requires a backhaul network technology such as fiber, DSL, or WiMAX to connect femtocell to the operator’s core network. When a roaming subscriber arrives home, their phone will sense poor macrocell coverage and automatically hand over to the femtocell, passing across calls in progress in a similar fashion to macrocell handovers.

Femtocell development began in the early 2004. The standards and technical requirements of femtocell have been developed by many principal organizations that include the 3rd Generation Partnership Project (3GPP), the Femto Forum, and the Broadband Forum. Due to operator’s interest, integrated femtocell/macrocell is anticipated to be a chief part of IMT-Advanced network architecture. The earliest deployments of femtocell happened in 2008, and as of December 2010, eighteen operators have launched commercial femtocell services, with a total of 30 committed to deployment. 12 million femtocells are expected worldwide by 2014.

**CELLULAR THEORY**

The cellular radio system is fabricated by multiple radio cells that cover different areas based on a planed frequency spectrum reuse concept. The frequency reuse approach of sharing the radio spectrum is the main concept of cellular systems. It enables efficient use of the assigned frequency band, where the radio channels are reused in several cells. A planed frequency spectrum reuse (frequency planning) is employed in cellular systems to avoid the interference issue that would arise in mobile devices that use the same frequency channel in adjacent cells. Interference issues in the cellular system are based on the ratio of the space between cells to the base station transmitting power. Consequently, reducing the cell size (radius) will increase the system capacity and provide superior flexibility in cellular systems to in line and commensurate with the density of users. As users’ density increases, more cells can be added. The cell splitting technique is also introduced in this context. The cell can be split into smaller cells to support user growth in a particular area. Figure 1 shows the different cell sizes in the cellular systems. Macrocell is the largest cell size of cellular systems that provide coverage via a high powered macrocellular base station, typically tens of watts. Generally, macrocells are used for coverage in rural areas or along the highways. Due to the low cell crossing rate, the MSC is able to manage centralized handover in the face of a large number of users. The signal quality is approximately the same for both uplink and downlink. The transition region between the BSs is large; handover techniques should permit some delay to pass up the flip-flopping. Nevertheless, the delay should be kept short enough to protect the signal quality because the interference increases as the user penetrates the new cell. This cell penetration is called cell dragging. Macrocells have relatively gentle path loss characteristics. The averaging interval (i.e., the time period used...
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