Chapter 4

LTE Femtocells: Propagation and Interference Issues

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ABSTRACT

Wireless technology is a fast, flexible, and easy-to-deploy solution to provide broadband access. In this context, the adoption of Femtocell Access Points (FAPs), operating in the licensed cellular bands and typically designed to be used in SOHO, will improve the radio coverage and the building penetration of the existing mobile networks, based on macrocells, especially where the radio propagation is difficult or unavailable.

The tiny cells created by femtocells typically lie inside larger cells served by nearby macrocell base stations. To operate such an underlying network reliably, femtocells need to avoid or strongly mitigate any interference with macrocells. Furthermore, the femtocell deployment must not require any changes to mobile networks and devices.

The growing interest in the possible deployment of mobile cellular networks in the 790-862 MHz frequency band, resulting from the transition process from analogue to digital TV, will pave the way for cutting-edge technology (LTE) and a new interesting market.

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LTE FEMTOCELLS: PROPAGATION AND INTERFERENCE ISSUES

The Femtocells, low-power low-cost user-deployed base stations, are a good solution to improve indoor radio coverage (3G/ WiMax/LTE/4G) and to increase throughput for mobile data services. As a consequence they will lead also to an increased data capacity of the overall system, determined by offloading traffic load from the mobile network towards the fixed one (xDSL connections, and so forth.), as well as a reduction of backhaul, power, and maintenance costs for operators.

The peculiar characteristic of these devices, which consist of an antenna, a signal amplifier and a transmitter/receiver front-end, is that they are able to capture weak wireless signals, and then boost and rebroadcast them across a small area, typically a couple thousand square feet. In fact, a femtocell is basically a personal cell phone base-station, the size of a Wi-Fi router, that reroutes all of users cell calls through a broadband Internet connection -- sort of how VoIP (Voice over Internet Protocol) phones work. The femtocell market, rollout by wireless service providers, is a bit haphazard at the moment, meaning that, what is offered, available and affordable, varies greatly among providers and it is a matter of fact that the plans are often confusing and contradictory.

Mobile owners often complain they have reception problems at home. In the early days of the cell phones service, this lapse of coverage may have been more forgivable since service plans were less expensive and most of us primarily used landline phones for calls from home. That condition has clearly changed now, and the service providers are belatedly and, cautiously, owning up to the failings by offering the innovative solution the femtocell represents.

In general, staying true to form, the wireless providers don’t have a plan of deployment of these network devices yet, and they are doing the job of getting it in the customer’s hands. On the other hand, the mobile owners bristle at the idea that they have to pay extra for a provider’s inability to get service to them. An eccentric proposal might be: distributing these devices for free, and paying customers to install them – in this way the wireless operators get a nationwide coverage upgrade while saving billions.

On the basis of previous considerations, any deployment configuration of these devices should be analysed in details. To this aim, in the present chapter possible network architectures, including macro and femto cells, and the consequent impairments due to their coexistence, has been considered.

Furthermore, in addition to the state of the art of femtocell architectures, an alternative solution, based on an “enhanced femtocell” integrated into a cabled distribution network (for example condominium infrastructure), has been taken into account in extremely critical applications, where the indoor or building nearby outdoor areas suffer a poor radio coverage from macrocell base stations.

In the following, femtocells based on Long Term Evolution (LTE) technology, the latest evolution of 3GPP standards and the most attractive mobile market for their application have been analyzed.

LONG TERM EVOLUTION

The LTE is a wireless technology dedicated to mobile, broadband networks. It lies halfway between the third and fourth generation standards with the objective to achieve wireless data rates higher than 1 Gbps. Moreover it is designed for low latency and high spectral efficiency in cellular networks and should cause less interference when deployed between multiple cells.

LTE is a radical step in the development of Universal Mobile Telecommunications System (UMTS) beyond the original 3rd generation Wideband Code Division Multiple Access (WCDMA) radio access technology.