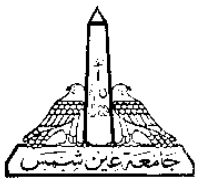

AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Electronics Engineering and Electrical Communications

Interference Mitigation in Heterogeneous Networks Using Fractional Frequency Reuse

A Thesis submitted in partial fulfilment of the requirements of the degree of

Master of Science in Electrical Engineering

(Electronics Engineering and Electrical Communications)

by

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Bachelor of Science in Electrical Engineering

(Electronics Engineering and Electrical Communications)

Faculty of Engineering, Ain Shams University, 2012

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Cairo - 2017

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Date: 22 June 2017

Statement

This thesis is submitted as a partial fulfilment of Master of Science in Electrical Engineering Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Thesis Summary

Recently, the mobile data traffic has grown at a rate that no one could predict. This data explosion required innovative solutions to be able to face the continuous increase in the data growth of the mobile users. Long Term Evolution (LTE)-Advanced comes as a promising solution to solve the data explosion problem. The recent researches demonstrate that most of the data traffic is created indoors where the macrocell coverage decreases due to the increased path loss indoors. Also, the macrocell coverage deteriorates at the cell edges. Therefore, solving these coverage problems is the key for the successful deployment of LTE-Advanced (LTE-A).

Femtocells are the rising new technology aiming to enhance the coverage for LTE-A networks. Femtocells are either consumer-deployed to enhance the indoor coverage or operator-deployed to enhance the coverage at the cell edges. When the femtocells are randomly deployed by the consumers, the precise planning of the mobile network is severely damaged and multiple problems arise that could deteriorate the performance of the whole mobile network if they remained unsolved. One of these problems is the interference between the macrocells and femtocells. This problem can be a huge obstacle against deploying the femtocells on a large scale if it was not effectively solved.

One of the promising solutions to solve the interference problem is Fractional Frequency Reuse (FFR). FFR splits the frequency band up to multiple sub-bands, and different sub-bands are allocated to the center and edge regions of the cell. Consequently, the intra-cell interference is eliminated, the inter-cell interference is considerably minimized and the system throughput is greatly improved. Multiple FFR schemes have been previously proposed such as FFR-3, FFR-6 and adaptive FFR to minimize the interference between the macrocells and the femtocells.

The main objective of this thesis is to present a new interference mitigation scheme in LTE-A Heterogeneous Networks (HetNets) using FFR. The frequency band is equally split up to twelve sub-bands and the various frequency sub-bands are assigned to each sector at variable transmission powers. Using the proposed scheme, the macrocell adopts a reuse factor of six for both the center and edge

zones. This significantly reduces the interference levels for the users in both the center and edge regions. This is because each macro user in either the center zone or the edge region of the macrocell suffers from interference from only one macrocell in the first tier, which greatly improves the system performance. Meanwhile, the femtocell selects the unutilized sub-bands in the macrocell sub-area where the femtocell is situated, to mitigate the interference for the users in the femtocell as well. By this, all the users in the system would suffer from less interference. The spectral efficiency is also improved as the frequency spectrum is used by both the macrocells and femtocells.

Simulation results demonstrate that the proposed scheme reduces the outage probability and ameliorates the throughput of the overall network than the conventional FFR schemes (26%, 10.3% improvement compared to FFR-3 and FFR-6, respectively). Furthermore, the modulation schemes of the users in the network are being investigated and it is shown that the proposed scheme has higher percentages of users who use higher order modulation which improves the data rates of the overall system and this is a target for LTE-A.

Keywords:

Femtocells, Fractional Frequency Reuse (FFR), Interference mitigation, LTE-Advanced.

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