Chapter 1 Introduction

Mobile data traffic grew 69 percent globally in 2014. Meanwhile, Global mobile data traffic reached 2.5 exabytes per month by the end of 2014, increasing from 1.5 exabytes per month by the end of 2013. In 2013, mobile data traffic is almost 30 times the size of the entire global internet in 2000 [1]. For the future, the growth in data traffic will continue to increase exponentially [2]. In overall, mobile data traffic is expected to grow 24.3 exabytes per month in 2019, nearly ten-fold increasing over 2014. Mobile data traffic will grow at a CAGR of 57 percent from 2014 to 2019.

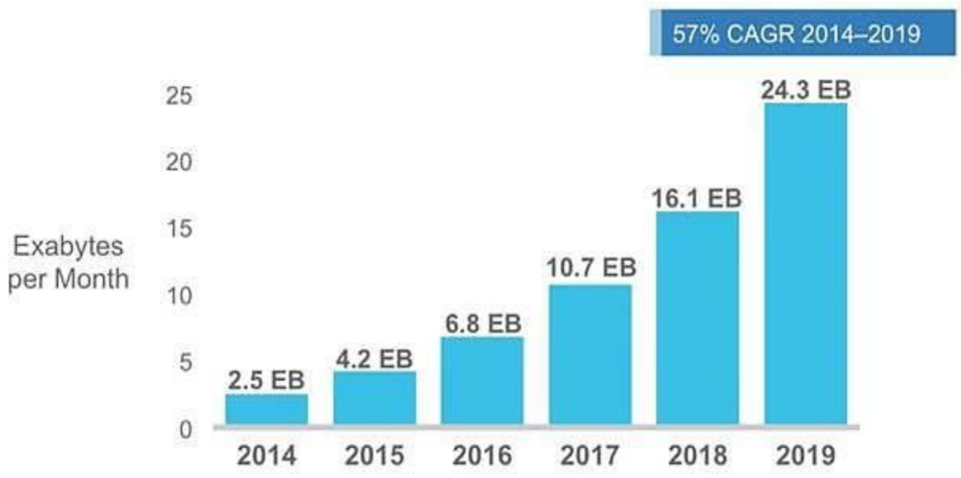

Figure 1. 1 Mobile data traffic and forecast

There are already estimated to be 16 billion connected objects today and this is predicted to reach 40 billion by 2020 [2]. And this pervasively connected technology will create ever more data. IDC estimates that by 2020 people and connected objects will generate 40 trillion gigabytes of data that will have an impact on daily life in one way or another [3].

The increasing demand for mobile broadband services has lead researchers to focus all their attention on the 4th Generation Wireless (4G) of wireless cellular systems. This followed the formal definition of the 3rd Generation Wireless (3G) by ITU-R in 1997, with the launch of the IMT-2000 specifications [4]. 4G systems are expected to have peak rates of 100 Mbit/s for high mobility and 1 Gbit/s for low mobility, with a good Quality of Service (QoS) [5].

In the network topology, heterogeneous networks (Hetnet) has been introduced by 3GPP to increase network capacity in the LTE system. Hetnet composed of macro base stations (BS) in which there are a bunch of low power BS of different types including pico (in the literature is also called small cell), Femto, and relay BS. The Low power BS is mounted on HotSpot zone, that having a lot of number users or high data traffic.

Low power BS offers small area coverage and low-power consumption. Furthermore, these cells can offer better coverage and better data rate services in the zones in which they are deployed, which makes them an interesting technology for the improvement of service in HotSpot zones. Previous studies have shown that (HetNet) can effectively improve overall system performance compared to the traditional homogeneous network (HomoNet) [6].

The more dense networks and a growing number of reuse of spectrum leads to high interference scenarios that need to be taken into account, as the signal of one BS is the noise of the other. Mitigation of the interference has been a subject of huge interest in the last years. In the traditional homogeneous network, the spectrum is divided into several band so that adjacent cell using the different frequency. In Hetnet, the frequency setting between macro base station and small cell can be done through several scenarios in example Orthogonal Frequency allocation (OD), Partially Share Deployment / Overlapped Frequency allocation (PSD) and the co-channel allocation (CCD) [7]. The later research about spectrum allocation including fractional frequency reuse and soft frequency reuse.

Another perspective for interference mitigation is by solving input optimization problem. The input optimization problem for the vector Gaussian multiple-access channel has been studied in the literature for the special cases of inter-symbol interference (ISI) channels and scalar fading channels. Cheng and Verdú stated that the input optimization problem of the gaussian multiple-access channel with ISI can be formulated as problem of finding optimal power allocation over frequency [8].Another studied was by Knopp and Humblet [9] and Tse and Hanly [10]. They found that the scalar ISI channel and the scalar independent and identically distributed (i.i.d.) fading channel are special cases of the vector multiple-access channel.They had the final conclusion that in both cases, the optimal signaling direction is just the direction of the simultaneous diagonalization, and the input optimization problem is reduced to the power allocation problem among the scalar sub-channels. Wei Yu & Wonjong Rhee [11] address the problem of finding the optimal transmitter covariance matrices that achieve the sum capacity. The computation of the sum capacity is formulated in a convex optimization framework. They shown that the sum-rate maximization problem can be solved efficiently using an iterative water-filling algorithm, where each step of the iteration is equivalent to a local maximization of one user's data rate with multiuser interference treated as noise.

In this research, we combine the LTE with interference mitigation technique by using iterative water-filling algorithm. We simulate the input optimization problem by one step waterfilling iteration in frequency re-use 1. The result is in term of network cell throughput. We are studying it by two scenarios. First scenario is done by increasing number of UEs in the network and the second by increasing the UE's speed. We evaluate the network cell throughput as well UE throughput on both scenarios. The use of Iterative water-filling will result in the allocation of power dynamically (adaptive).

1.1 Motivation and Goals

Studies based on wireless technology usage indicate that more than 50% of voice calls and 70% of data traffic are originated indoors. This also suggests that a big percentage of data traffic and voice calls are made in HotSpot zones that in fact are business buildings during the day and inhabited buildings during the night time. These studies motivated the research community to try to find a good way of improving the network coverage in these type of zones. PBSs were chosen as the technology to provide this type of improvement, due to their low-power consumption, low-cost and user deployment. However, the need to share spectrum between MBSs and PBSs creates big problems of co-existence between the two technologies, as the signal of one is the noise of the other.

To deal with the interference, the frequency setting between macro BS and Pico BS have been proposed in 3GPP which includes several scenarios namely Orthogonal Frequency allocation (OD), Partially Share Deployment / Overlapped Frequency allocation (PSD) and the co-channel allocation (CCD). Homonet currently uses Orthogonal Frequency allocation (OD) by dividing the existing frequency into multiple frequency reuses (> 1). With this method, the interference between the BS will can be reduced to get an optimum throughput. When used frequency reuse 1 (or co-channel allocation), interference between the BS will be high so it will degrade network performance.
In the LTE, the network capacity in term of the number of UE can be served by BS as well as the network throughput, depend on the available bandwidth. The more bandwith resulted the more capacity and throughput. Furthermore, the spectrum is a naturally scarce resource. In fact, the addition of frequency spectrum requires a long process and is determined by government policy. The available spectrum needs to be shared and reused among cells. The reuse of the spectrum leads to high interference scenarios that need to be taken into account.

So, these scenarios need to be dynamically treated, in order to offer a better service to all network users.

The purpose of this thesis was to study the effect of interference on frequency usage together (CCD) of the performance of the LTE networks. In this thesis, it will be simulated LTE with the allocation of frequency reuse 1 with iterative water-filling algorithms to solve interference between BS experienced by the UE, while increasing network throughput. The use of Iterative water-filling will result in the allocation of power dynamically (adaptive).

1.2 Structure

A schematic overview of the thesis can be seen in Figure 1.1 In the current chapter the goal of the work developed as well as a contextualization are given. Chapter 2 presents an overall view of the state of the art in interference analysis and interference mitigation. This chapter also focuses on information about LTE/LTE-Advanced. Chapter 3 presents simulation environment to study and the algorithms proposed for the mitigation of the interference. Chapter 3 presents the results obtained. Finally, in Chapter 5 the conclusions withdrawn from this work and future perspectives are presented.

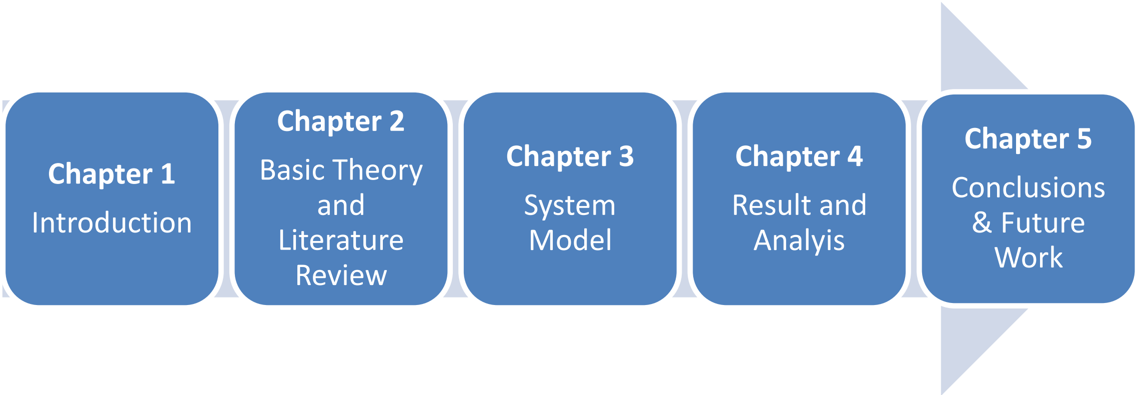

Figure 1. 2 Schematic outline of thesis

1.3 Publication

“Improving LTE Throughput With Iterative Water-Filling Algorithm” accepted on Apwimob conference 2016.