# CHAPTER I
# INTRODUCTION

Technology is moving so fast. From first generation (1G) to fourth generation (4G), from analogue to digital. Long Term Evolution (LTE) is the name given to a 3GPP project to evolve UTRAN to meet the needs of future broadband cellular communications.

With the standards definitions now available for LTE, the Long Term Evolution of the 3G services, eyes are now turning towards the next development, that of the truly 4G technology named IMT Advanced. The new technology being developed under the auspices of 3GPP to meet these requirements is often termed LTE Advanced.

3GPP's targets for LTE-Advanced were set independently from the IMT-Advanced requirements; it can be seen that some of the 3GPP targets exceed the IMT-Advanced requirements, such as the peak spectral efficiency and the control plane latency targets [3] [16].

With work starting on LTE Advanced, a number of key requirements and key features are coming to light. Although not fixed yet in the specifications, there are many high level aims for the new LTE Advanced specification. These will need to be verified and much work remains to be undertaken in the specifications before these are all fixed. Currently some of the main headline aims for LTE Advanced can be seen below [3]:

1. Peak data rates: downlink - 1 Gbps; uplink - 500 Mbps.
2. Spectrum efficiency: 3 times greater than LTE.
3. Peak spectrum efficiency: downlink - 30 bps/Hz; uplink - 15 bps/Hz.
4. Spectrum use: the ability to support scalable bandwidth use and spectrum aggregation where non-contiguous spectrum needs to be used.
5. Latency: from Idle to Connected in less than 50 ms and then shorter than 5 ms one way for individual packet transmission.
6. Cell edge user throughput to be twice that of LTE.
7. Average user throughput to be 3 times that of LTE.
8. Mobility: Same as that in LTE
9. Compatibility: LTE Advanced shall be capable of interworking with LTE and 3GPP legacy systems.

These are many of the development aims for LTE Advanced. Their actual figures and the actual implementation of them will need to be worked out during the specification stage of the system.

LTE CoMP or Coordinated Multipoint is a facility that is being developed for LTE Advanced many of the facilities are still under development and may change as the standards define the different elements of CoMP more specifically.

LTE Coordinated Multipoint is essentially a range of different techniques that enable the dynamic coordination of transmission and reception over a variety of different base stations. The aim is to improve overall quality for the user as well as improving the utilisation of the network.

Essentially, LTE Advanced CoMP turns the inter-cell interference, ICI, into useful signal, especially at the cell borders where performance may be degraded.

Over the years the importance of inter-cell interference, ICI has been recognized, and various techniques used from the days of GSM to mitigate its effects. Here interference averaging techniques such as frequency hopping were utilized. However, as technology has advanced, much tighter and more effective methods of combating and utilizing the interference have gained support.

## 1.1 Research Background

LTE-A as extension of LTE Release 8 is aimed to improve system data rates and spectral efficiency through the use of a frequency reuse one, allocation system that allocates the same frequency to adjacent cells. As adjacent cells use the same frequency cause interference between adjacent cells which may degrade system data rates, preventing sufficient throughput from being obtained. To improve cell edge performance and also throughput as an important requirement in LTE-A, inter-cell interference coordination (ICIC) is a promising technology [1], [2], [3], [6]. This ICIC could be based on carrier aggregation (CA) or CoMP. Carrier aggregation (CA) allows the concurrent utilization of different frequencies carrier, hence efficiently increasing the bandwidth that can be allocated to end users. Coordinated Multi-Point (CoMP) transmission and reception where multiple cells are able to coordinate their scheduling or transmission to serve users with adverse channel conditions, is also envisioned to notably mitigate outages at the cell edge [2], [4], [5], [7].

## 1.2 Relation between problem and objective

In LTE-A system, Single Carrier Frequency Division Multiple Access (SC-FDMA) is selected as the uplink multiple access scheme. Meanwhile, Orthogonal Frequency Division Multiple Access (OFDMA) is selected as the downlink multiple access scheme. An important characteristic of OFDMA cellular system is that the subcarriers are orthogonal therefore intra-cell interference within a single cell section can nearly be ignored. However, the impact of the same frequency in neighboring cells causes significant interference to the users, especially the cell edge users that may prevent sufficient throughput from being obtained at cell edges.

To overcome this problem we implement ICIC schemes based on CoMP and Carrier Aggregation.

### 1.3 Objective and Hypotheses

The objective of this thesis is to analyze and implement ICIC schemes to increase data rate, cell edges performance and enhanced throughput. With assumption: by using CoMP system will reduce inter-cell interference because CoMP turns the inter-cell interference into useful signal, especially at the cell borders where performance may be degraded.

The scope of this Thesis will only consider in Carrier Aggregation and CoMP system. It used to increase the throughput and have any effect on inter-cell interference coordination techniques and radio resource scheduling algorithms.

The hypotheses of this thesis is interference reduce by using Carrier Aggregation and CoMP System.

Coordinated Multi-Point (CoMP) transmission/reception, also known as Cooperative MIMO is a main element on the LTE roadmap beyond Release 9. CoMP is considered by 3GPP as a tool to improve coverage, cell-edge throughput, and system efficiency. It was introduced in the LTE-A technology to relax performance limitations.

LTE-A CoMP turns the inter-cell interference (ICI) into useful signal, especially at the cell borders where performance may be degraded. There are two types of coordination strategy in CoMP: Joint Processing (JP) and Coordinated Scheduling/Beamforming (CS/CB). JP achieves transmission gain through joint processing, while CS/CB reduces inter-cell interference through coordination [2], [12].

## 1.4 Research Purpose

The purpose of this research is to evaluate the performance ICI of LTE-A system using CA and CoMP techniques.

## 1.5 Thesis Outline

The rest of this thesis is organized as follows:

In chapter II, we present basic theory which is related to Long Term Evolution (LTE) and Long Term Evolution-Advanced (LTE-A). The chapter starts with the studies focused on LTE-an overview. In the following section we present LTE-A with some examples of its technologies (Carrier Aggregation, Coordinated Multipoint) are outlined. Last section we ended up with a comparison between LTE and LTE-A.

In chapter III, we study the problem of inter-cell interference what cause of it. We explained inter-cell interference coordination (ICIC) issue. We started with previous work on ICIC, then we continued with analysis and modeling for SINR estimation and Throughput calculation in macro cell and femto cell, after that we come with system architecture and implemented algorithm.

In chapter IV, we build upon the knowledge gained from the previous chapter. Again we formulate an optimization problem and simulate it by use Conventional scheme, Carrier aggregation and CoMP system.

In chapter V, we summarize the main conclusions of this thesis and present some directions for future study.