Chapter 1

Introduction

Chapter 1

Introduction

The 3GPP Long Term Evolution (LTE) is designed to achieve a high data rate, support multi antennas configurations and high mobility. New configurations like MIMO (multi input-multi output) and OFDMA are used in the LTE design network. The multiplexing techniques (OFDMA in the down link and SC-FDMA in the uplink) are higher robust in frequency selective fading channels, fast fading and inter symbol interference [1].

In LTE receiver, we need to synchronize with the symbol timing start and the carrier frequency fast to achieve a high latency, make fast and successful initial access (cell search and cell selection).We should overcome the high frequency sensitivity for the OFDM due to the carrier frequency offset, phase noise and sampling clock misalignment to achieve a good frequency offset estimation. We should also apply good symbol timing start estimation, where the error is much smaller than the cyclic prefix.

Time and frequency synchronization depend on the synchronization channel (SCH) which is specified in [2]. The primary synchronization sequence which is used to determine the sub-frame start (with uncertainty between sub-frame 0 and sub-frame 5) and the physical-layer identity within the physical-layer cell-identity group is transmitted in sub-frame 0 and 5. The secondary synchronization sequence which is used to determine the accurate sub-frame start and the physical-layer cell-identity group is transmitted in sub-frame 0 and 5 also, as will be shown in chapter 3.

The main problems of the conventional method and the proposed methods of time synchronization presented in the previous researches (explained in chapter 4) are the high complexity and the effect of the frequency offset in the receiver used to detect the symbol timing and the cell-ID.

Here we focus in our novel method on solving the high complexity problem to simplify the used receiver.

Time and frequency synchronization methods have been proposed in [3] using a hybrid detection algorithm for repetitive synchronization signals and in [4] using cyclic prefix based method using ML (Maximum Likelihood) estimation as in [5] to get the symbol timing and the fractional carrier frequency offset and use the sector and cell search algorithm to get the total cell ID.

We also presented some previous researches in symbol timing synchronization in time domain in the same chapter.

In this thesis a new technique has been proposed to derive the symbol timing and the physical-layer identity within the physical-layer cell-identity group. This method is performed in frequency domain, so we can exploit the good frequency domain properties of the primary and secondary synchronization sequences and decrease the system complexity.

In chapter 2 we will introduce the 3GPP LTE system and its new features [(1)].We will also present the LTE frame and the DL signals and channels. In chapter 3 we will introduce the synchronization system used in 3GPP LTE. In chapter 4 we will define the time and frequency synchronization problems, introduce some recent researches on timing synchronization and cell search. We will introduce the new system model in the same chapter and explain the effect of the novel method on the system complexity. Frequency synchronization and sector and cell search are considered in this chapter.

The performance of the system with various channels of 3GPP LTE (Extended Pedestrian A channel, Extended Vehicular A channel and Extended Typical Urban model [6]) has been evaluated in chapter 5. We will introduce the system complexity in details.

Finally in chapter 6 conclusion and future work are presented, including the necessary developments might be applied to the system to improve the final results.

(1) We will focus in our thesis on the DL FDD LTE.