THE IMPACT OF EXTENDED SYNCHRONIZATION SIGNALS ON LTE ACCESS PROCEDURE IN DENSE FEMTOCELL DEPLOYMENT

By

Ahmed Mohammed Abdel-Fattah Abdel-Rahman

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
ELECTRONICS AND COMMUNICATIONS ENGINEERING

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2015

THE IMPACT OF EXTENDED SYNCHRONIZATION SIGNALS ON LTE ACCESS PROCEDURE IN DENSE FEMTOCELL DEPLOYMENT

By

Ahmed Mohammed Abdel-Fattah Abdel-Rahman

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In

ELECTRONICS AND COMMUNICATIONS ENGINEERING

Under the Supervision of

Prof. Mohammed F. Abu-Elyazeed

………………………………..…

Professor,

ELECTRONICS AND COMMUNICATIONS
ENGINEERING DEPARTMENT
Faculty of Engineering, Cairo University

Dr. Ahmed H. Zahran

………………………………..…….

Assistant Professor,

ELECTRONICS AND COMMUNICATIONS
ENGINEERING DEPARTMENT
Faculty of Engineering, Cairo University

Dr. Ahmed S. Ibrahim
……………………………….
Assistant Professor,
ELECTRONICS AND COMMUNICATIONS ENGINEERING DEPARTMENT
Faculty of Engineering, Cairo University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2015

THE IMPACT OF EXTENDED SYNCHRONIZATION SIGNALS ON LTE ACCESS PROCEDURE IN DENSE FEMTOCELL DEPLOYMENT

By

Ahmed Mohammed Abdel-Fattah Abdel-Rahman

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
ELECTRONICS AND COMMUNICATIONS ENGINEERING

Approved by the
Examining Committee

____
Prof. Mohammed F. Abu-Elyazeed, Thesis Main Advisor

____
Prof. Mohamed M. Khairy, Internal Examiner

____
Prof. El Sayed Mostafa Saad, External Examiner
(Professor at the Faculty of Engineering, Helwan University)

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2015

Engineer’s Name: Ahmed Mohammed Abdel-Fattah Abdel-Rahman
Date of Birth: 16/12 /1979
Nationality: Egyptian
E-mail: aelfattah@mcit.gov.eg, Eng.ahmad.1777@gmail.com
Phone: 01003028431
Address: 20 Berket El-Feel Street, El- Sayada Zaynab, Cairo

Registration Date: 1/10/2007
Awarding Date: / /
Degree: Master of Science
Department: Electronics and Communications Engineering
Supervisors:
Prof. Mohammed F. Abu-Elyazeed
Dr. Ahmed H. Zahran
Dr. Ahmed S. Ibrahim
Examiners:

Prof. El Sayed Mostafa Saad,	(External examiner)
Dr. Mohamed M. Khairy,	(Internal examiner)
Prof. Mohammed F. Abu-Elyazeed	(Thesis main advisor)

Title of Thesis:
The Impact of Extended Synchronization Signals on LTE Access Procedure in Dense Femtocell Deployment

Key Words:
Cell Search; Femtocell; Mobility Management (MM); Extended Synchronization Signals (ESS); Primary Synchronization Signal (PSS); Secondary Synchronization Signal (SSS); Physical Cell Identity (PCI); Bit Error Rate (BER); Probability of Miss Detection (PMD)

Summary:
This thesis presents a Proof of Concept of the Extended Synchronization Signals (ESS) through studying its impact on the physical layer performance of LTE cell search procedure. The ESS concept is based on replacing the padding bits in each of the Primary Synchronization Signal (PSS) and the secondary synchronization signal (SSS) by additional information bits.

The simulation results show that these additional information bits are detectable and have no effect on the synchronization process after testing in two channel models and also with different values of the frequency offsets.

By applying the ESS concept, these mentioned bits can be used for different purposes; such as enhancing the performance of LTE access procedure and solving some open issues of mobility management especially in dense femtocell deployment scenario.

Acknowledgments

All praises and thanks to Allah the most beneficent and the most merciful, who gave us guidance, strength and abilities to complete this research work in a successful manner. I am also indebted to many people who have directly and indirectly inspired me through this thesis.

First of all, I would like to express my deepest gratitude and appreciation to my supervisors, Prof. Mohammed F. Abu-Elyazeed, Dr. Ahmed H. Zahran and Dr. Ahmed S. Ibrahim, for their advice, guidance, continuous support, and their patient supervision during my research work. Discussions with them have always been instructive and insightful and helped us to identify our ideas.

In addition I would like also like to say thank you to my colleagues for their great effort and continuous support
Last but by no means least; I can never express enough gratitude to my dear mother, my dear father for their persistent supports, encouragement and love to me

Dedication

To my parent and my sisters. Without your unconditional support, encouragement, and your sound advice, this work wouldn’t have been successfully achieved.

Table of contents

List of Tables

List of Figures

List of Abbreviations

3GPP	3rd Generation Partnership Project
4G	4th Generation
AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
BPSK	Binary Phase Shift Keying
BSS	Basic Synchronization Signals
CA	Carrier Aggregation
CAPEX	Capital Expenditure
CN	Core Network
CoMP	Coordinated Multi-Point
CP	Cyclic Prefix
CSG	Closed Subscriber Group
DL	Downlink
EPC	Evolved Packet Core
EPS	Evolved Packet System
ESS	Extended Synchronization Signals
E-UTRAN	Enhanced Universal Terrestrial Radio Access Network
FAP	Femto Access Point
FBS	Femto Base Station
FDD	Frequency Division Duplexing
FFT	Fast Fourier Transform
FO	Frequency Offset
HeNB	Home eNodeB
HetNet	Heterogeneous Network
HSS	Home Subscriber Service
ICI	Inter-Carrier Interference
IFFT	Inverse Fast Fourier Transform
IMT	International Mobile Telecommunication
IMT-A	International Mobile Telecommunication Advanced
IP	Internet Protocol
ITU	International Telecommunication Union
LPN	Low Power Nodes
LTE	Long Term Evolution
LTE-A	Long Term Evolution Advanced
MAC	Medium Access Controller
MIB	Master Information Block
MIMO	Multiple-Input Multiple-Output

MM	Mobility Management
MME	Mobility Management Entity
MU-MIMO	Multiple User Multiple-Input Multiple Output
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
OPEX	Operational Expenditure
PAPR	Peak-to-Average-Power Ratio
PBCH	Physical broadcast channel
PCI	Physical Cell Identity
PDSCH	Physical Downlink Shared Channel
PMD	Probability of Miss Detection
P-GW	Packet Data Network Gateway
PHY	Physical Layer
PLMN	Public Land Mobile Network
PSS	primary Synchronization Signals
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
RAN	Radio Access Network
RRC	Radio Resource Control
RRH	Remote Radio Head
SC-FDMA	Single Carrier Frequency Division Multiple Access
S-GW	Serving Gateway
SIB	System Information Block
SINR	Signal-to-Interference-and-Noise Ratio
SNR	Signal-to-Noise Ratio
SON	Self Organizing Networks
SSS	Secondary Synchronization Signals
SU-MIMO	Single User Multiple-Input Multiple Output
TDD	Time Division Duplexing
UE	User Equipment
UMTS	Universal Mobile Telecommunication System
UTRAN	Universal Terrestrial Radio Access Network
ZC	Zadoff-Chu

Abstract

Long Term Evolution (LTE) is standardized by the 3rd Generation Partnership Project (3GPP) and considered the latest development in the field of mobile communication system. The aim of LTE is to achieve high data rates, minimum latency with higher performance and low cost. The increasing demand of good quality voice traffic and high speed data streaming in mobile networks propels the deployment of femtocells to enhance indoor coverage and improve network capacity. Although, the several advantages of the femtocell technology, there are several open issues for its dense deployment. These issues include Physical Cell Identity (PCI) confusion/collision, handover between cells and femtocells access control.

In this thesis, we present a Proof of Concept of the Extended Synchronization Signals (ESS), more specifically; we investigate the impact of ESS concept on the LTE cell search procedure. Briefly, the ESS concept is based on replacing the padding bits in primary and secondary synchronization signals, which are used in the cell search procedure, by additional information bits.

Based on the simulation results, we concluded that these additional information bits are detectable and have no effect on the cell access procedure in LTE. So the ESS concept can be implemented in the practical synchronization techniques to enhance the performance of LTE access procedure and to solve the open issues of mobility management especially in dense femtocell deployment scenario. Also in our research work, we focus on the PCI collision/confusion problem which is considered one of the most critical challenges of mobility management in femtocell networks and state of the art techniques to solve this problem.