Femtocell and Fractional Frequency Reuse (FFR) for LTE Network Performance Enhancement

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TABLE OF CONTENTS

CHAPTER 5 RESULT ANALYSIS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

1G	First Generation System
2G	Second Generation System
3.9G	3.9 Generation System, beyond 3G but pre4G
3G	Third Generation System
3GPP	Third Generation Partnership Project
4G	Fourth Generation System
ADSL	Asynchronous Digital Subscriber Line
AFRF	Average Frequency Reuse Factor
ARQ	Automatic Repeat Request
AWGN	Additive White Gaussian Noise
BCCH	Broadcast Control Channel
BCH	Broadcast Channel
BP	Belief Propagation
BS	Base station
BW	Bandwidth
CCCH	Common Control Channel
CP	cyclic prefix
CQI	Channel quality indicator
CRC	Cyclic Redundancy Check
CRS	Collision of Reference Signal
CSG	Closed Subscription Group
DAS	Distributed Antenna System
DCCH	Dedicated Control Channel
DCI	Downlink control information

DCT	Dynamic Coordinated Transmission
DFP	Dynamic Frequency Planning
DFRA	Dynamic Femtocell Resource Allocation
DL	Downlink
DL-SCH	Downlink Shared Channel
DSL	Digital Subscriber Line
DTCH	Dedicated Traffic Channel
EBW	Effective bandwidth
EFRS	Enhanced frequency reuse scheme
eNB	Evolved Node B
EPC	Evolved Packet Core
EPS	Evolved Packet System
E-UTRA	Evolved UTRA
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network
f	Frequency
FDD	Frequency Division Duplexing
FFR	Fractional Frequency Reuse
FFT	Fast Fourier Transform
FRF	Frequency Reuse Factor
GSM	Global System for Mobile
HARQ	Hybrid-Automatic Repeat Request
HeNB	Home eNB
HeNB GW	Home eNB Gateway
HetNet	Heterogeneous Network
IC	Inter-cell Interference Cancelation
ICI	Inter-cell Interference
ICIC	Inter-cell Interference Coordination

IDMA	Interleave Division Multiple Access
IIM	Inter-cell Interference Management
IIWF	Improved Interactive Water-filling algorithm
IMT	International Mobile Telecommunications
IMT-A	International Mobile Telecommunications-Advanced
IP	Internet Protocol
ISI	Inter-symbol interference
ITU	International Telecommunications Union
Liw	Indoor Walls Loss
Low	Outdoor Walls Loss
LTE	Long Term Evolution
LTE-A	Long Term Evolution-Advanced
MAC	Medium Access Control
MBMS	Multimedia Broadcast/Multicast Service
MBSFN	Multicast Broadcast Single Frequency Network
MCCH	Multicast Control Channel
MCH	Multicast Channel
MCS	Modulation and coding rate
MIMO	Multiple Input Multiple Output
MME	Mobility Management Entity
MSINR	maximum SINR
MTCH	Multicast Traffic Channel
NB	Node B, Base station
NFFT	Fast Fourier Transform Size
OFDMA	Orthogonal Frequency-division Multiple Access
ORA	Orthogonal Resource Allocation
PAPR	Peak-to-average-power ratio

PBCH	Physical Broadcast Channel
PCCH	Paging Control Channel
PCFICH	Physical Control Format Indicator Channel
PCH	Paging Channel
PDCCH	Physical Downlink Control Channel
PDCP	Packet Data Convergence Protocol
PDSCH	Physical Downlink Shared Channel
PHICH	Physical Hybrid-ARQ indicator Channel
PHY	Physical layer
PLMN	Public Land Mobile Network
PMCH	Physical Multicast Channel
PMI	Pre-coding Matrix Indicator
PPC	Power based Femtocell Base Station Power Control
PRACH	Physical Random-Access Channel
PSTN	Public Switched Telephone Network
PUCCH	Physical Uplink Control Channel
PUSCH	Physical Uplink Shared Channel
QoS	Quality of Service
R	Macrocell radius
r	Macrocell inner radius
RACH	Random-Access Channel
RB	Resource block
RE	Resource Element
RI	Rank indicator
RLC	Radio Link Control
RNC	Radio Network Controller
RR	Round Robin

RRC	Radio Resource Control
RSRP	Reference signal received power
SAE	System Architecture Evolution
Sb	Subband
S-BS	Strong BS
SC-FDMA	Single-Carrier Frequency Division Multiple Access
SFR	Soft Frequency Reuse
SG1	Subframe Group 1
SG2	Subframe Group 2
S-GW	Serving Gateway
SINR	Signal to Interference Noise Ratio
SISO	Single Input Single Output
SMS	Short Message Service
SNPC	SINR based Femtocell Base Station Power Control-SINR based Neighbouring Femtocell Power Control
SNR	Signal to Noise Ratio
SPC	SINR based Femtocell Base Station Power Control
TDD	Time Division Multiplexing
UCI	Uplink control information
UE	User Equipment
UL	Uplink
UL-SCH	Uplink Shared Channel
UMTS	Universal Mobile Telephone System
UTRA	UMTS Terrestrial Radio Access
W-BS	Weak BS
WCDMA	Wideband Code Division Multiple Access
WF	Water-filling

WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network

Peningkatan Prestasi Sel Femto Dan Kaedah Penggunaan Semula Sebahagian Frekuensi (FFR) untuk Rangkaian Selular LTE

ABSTRAK

Dengan memperkenalkan Sel Femto yang berkuasa rendah dan kawasan rangkuman kecil di dalam rangkaian Sel Makro, liputan perkhidmatan dilanjutkan. Akan tetapi, ini telah menyebabkan gangguan Inter-sel (ICI) berlaku. ICI berlaku disebabkan perkongsian sumber antara sel-sel bersebelahan. Di antara kaedah yang boleh mengurangkan gangguan, kuasa manipulasi dan peruntukan frekuensi adalah fokus tesis ini. Kaedah Penggunaan Semula Sebahagian Frekuensi (FFR) adalah salah satu teknik penyelarasan antara sel untuk meningkatkan kualiti isyarat. Cabaran yang dihadapi apabila menggunakan FFR adalah rekacipta dengan peruntukan sumber dengan cekap. Dengan FFR, perkongsian spektrum antara Sel Makro dan Sel Femto ranakaian menyebabkan ketiadaan sumber berdedikasi dan dengan itu lebih teruk ICI berlaku. Tambahan pula, apabila semata-mata skim kawalan kuasa digunakan, kekerapan universal guna semula (FRF=1) menyebabkan masalah ICI lebih teruk dalam rangkaian sesak. Pemodelan pautan turun LTE-A rangkaian heterogen (HetNet) dilakukan dengan menggunakan MATLAB dalam kajian ini. Kajian semula Kaedah FFR dibuat dan menggunakan kaedah Peruntukan Ortogon Sumber (ORA) untuk memperolehi sumber mengikut wilayah dalam rangkaian heterogen. Selain itu, skim Peruntukan Dynamic Sel Femto Sumber (DFRA) dicadangkan untuk memastikan sumber-sumber yang diberikan kepada Sel Femto saling eksklusif dengan Macrousers atau sel Femto bersebelahan. Semasa menghadapi isu kepadatan Sel Femto dan penghabisan sumber ortogon, skim kawalan kuasa seperti skim Kawalan Kuasa berdasarkan Kuasa Sel Femto Stesen Pangkalan (PPC), skim Kawalan Kuasa berdasarkan isyarat nisbah gangguan dan hingar (SINR) (SPC) dan Kawalan Kuasa berdasarkan Jiran Sel Femto SINR (SNPC) telah disepadukan ke dalam sistem. Berbanding dengan penggunaan FFR klasik, penggunaan Skim Kajian Semula FFR dan rangkaian Hybrid (dengan Sel Femto yang kurang sesak) meningkatkan penggunaan sumber dan bilangan pengguna aktif dengan 8.7% dan 8.72% untuk skim kombinasi DFRA-PPC dan skim kombinasi DFRA-SPC masing-masing. Selain ini, kadar data ditingkatkan kepada 15.73% dan 15.51% dengan penggunaan skim DFRA-PPC dan DFRA-SPC. Dari perspektif kecekapan spektrum, dua teknik ini telah meningkatkan prestasi kepada 15.68% dan 15.48% masing-masing. Sebaliknya, dalam rangkaian sesak (150 sel Femto), penggunaan sumber dan bilangan pengguna aktif ditingkatkan kepada 11.43% untuk kombinasi skim Peruntukan Dynamic Sel Femto Sumber bersama Kawalan Kuasa berdasarkan Jiran Sel Femto SINR (DFRA-SNPC). Selain itu, dengan melaksanakan skim DFRA-SNPC ini, kadar data dan kecekapan spektrum dalam rangkaian sesak ini meningkat sebanyak 13.52% dan 13.53% masing-masing. Mekanisme yang dicadangkan, ORA, DFRA, SPC, PPC dan SNPC telah meningkatkan prestasi sistem dari segi penggunaan sumber, kadar data dan kecekapan spektrum.