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Packet Scheduling for LTE-Advanced

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Certificate of Originality

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Abstract

LTE-Advanced has been approved by the International Telecommunication Union (ITU) as a 4G mobile communication system. It is also called IMT-Advanced or true 4G technology. LTE-Advanced is an evolution of LTE (Release-8) and backward compatible with LTE because they both use the same air-interface technologies such as OFDMA, MIMO, and the same core network.

Since radio spectrum is the most valuable resource in mobile technology, radio resource management (RRM) mechanisms are critical for the operation of a cellular network. One of the key RRM mechanisms is packet scheduling and it allocates suitable radio resources to each user for transmission of the downlink from the base station through the air interface to each mobile station.

The overall objectives of this project are to study packet scheduling mechanism for LTE-Advanced and find an optimized packet scheduling algorithm(s) to fully utilize new features and challenges of LTE-Advanced. This project is an extension of previous work done in packet scheduling in LTE at Centre for Real-time Information Networks (CRIN), UTS.

This thesis begins by explaining the design considerations used to create a computer simulation tool to model packet scheduling as well as other RRM mechanisms for LTE-Advanced. Thereafter, it will model, simulate, validate, and evaluate the performance of current well-known and new packet scheduling algorithms for LTE-Advanced. In this thesis, two new algorithms called optimized cross-CC proportional fair (OCPF) and optimized cross-CC M-LWDF (OCM) are proposed. (CC: component carrier)

The OCPF algorithm can overcome the weaknesses of current algorithms and improve system throughput. The OCM can provide a more effective solution for realistic traffic with strict requirement on the quality of services (QoS).

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List of Acronyms

3G	3rd Generation Wireless Network
3GPP	3rd Generation Partnership Project
3GPP2	3rd Generation Partnership Project 2
4G	4th Generation Wireless Network
ACK	Acknowledgement
BLER	Block Error Rate
BS	Base Station
BSC	Base Stations Controller
CA	Carriers Aggregation
CC	Component Carrier
CDMA	Code Division Multiple Access
CoMP	Coordinated MultiPoint transmission and reception
CP	Cyclic Prefix
CQI	Channel Quality Indicator
CRIN	Centre of Real-Time Information Networks
Cross-CC	Cross-Component Carriers
CS/CB	Coordinated Scheduling/Beam-forming.
CSI	Channel State Information
EDGE	Enhanced Data rates for GSM Evolution
eNodeB	evolved NodeB
EPC	Evolved Packet Core
E-UTRAN	Evolved UTRAN
EXP/PF	Exponential/Proportional Fair
EVRC	Enhanced Variable Rate Coder
FDD	Frequency Division Duplex
FDMA	Frequency Division Multiple Access
FIFO	First-in-First-out
GSM	Global System for Mobile communications
HARQ	Hybrid-Automatic Repeat Request
HOL	Head of Line
HOM	Higher Order Modulations
HSDPA	High-Speed Downlink Packet Access
IEEE	Institute of Electrical and Electronics Engineers
IMT-2000	International Mobile Telecommunications-2000
In-CC	Independent-Component Carriers
IP	Internet Protocol
ITU	International Telecommunication Union
JP	Joint Processing
LTE	Long Term Evolution

LTE-A	Long Term Evolution Advanced
Max-Rate	Maximum-Rate
MCS	Modulation and Coding Scheme
MIMO	Multiple Input Multiple Output
M-LWDF	Modified-Largest Weighted Delay First
MME	Mobile Management Entity
NACK	Negative Acknowledgement
NRT	Non-Real Time
OCM	Optimized Cross-Component Carrier M-LWDF
OCPF	Optimized Cross-Component Carrier Proportional Fair
OFDM	Orthogonal Frequency Division Multiplex
OFDMA	Orthogonal Frequency Division Multiple Access
PCU	Packet Control Unit
PDF	Probability Density Function
PDN	Packet Data Network
PF	Proportional Fair
P-GW	PDN Gateway
PLR	Packet Loss Ratio
PS	Packet Scheduling
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
QSI	Queue State Information
RAN	Radio Access Network
RB	Resource Block
RMS	Root Mean Square
RN	Relay Node
RNC	Radio Network Controller
RNP	Radio Network Planning
RR	Round Robin
RRM	Radio Resource Management
RT	Real Time
RTT	Round-Trip Time
SA	Spectrum Aggregation
SC-FDMA	Single Carrier Frequency Division Multiple Access
SDF	Sub-band Discrimination Factor
S-GW	Serving Gateway
SINR	Signal to Interference-plus-Noise Ratio
SISO	Single-Input-Single-Output
SNR	Signal-to-Noise-Ratio
TB	Transport Block
TDD	Time Division Duplex
TDMA	Time Division Multiple Access

TFT	Time For Transmission
TTI	Transmit Time Interval
UDF	User Discrimination Factor
UE	User Equipment
UMB	Ultra Mobile Broadband
UMTS	Universal Mobile Telecommunications System
UTRAN	UMTS Terrestrial Radio Access Network
VoIP	Voice over IP
WCDMA	Wideband Code Division Multiple Access
WiMAX	Worldwide Interoperability for Microwave Access