AN ITERATIVE CAPACITY DIMENSIONING SCHEME FOR AN LTE ADVANCED NETWORK UNDER RESOURCE CONSTRAINTS

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Degree of Master of Science

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Declaration

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The above candidate has carried out research for the master’s dissertation under my supervision.

Signature of the supervisor: Date:

Name of the supervisor: Dr. Chandika Wavegedara

Signature of the supervisor: Date:

Name of the supervisor: Dr. Tharaka Samarasinghe

Abstract

Since the need for high-speed broadband services is growing exponentially, legacy voice oriented networks are now becoming obsolete. Due to the unceasing demand for data, investors of mobile service providing companies are also keener on investing new technologies other than GSM, which ultimately improves spectrum efficiency and speeds up the access. Long Term Evolution (LTE) is the fastest and latest broadband technology with widespread global development of commercial networks. Until now, scientists are working to improve the communication capabilities while evolving from basic voice services to high definition video streaming and real time video game playing. However, every operator has a limited investment capacity and are highly concerned about the maximum utilization of resources with a higher ROI. As a result, it is imperative to have a properly dimensioned and well-optimized network.

However, LTE network dimensioning is not as easy as legacy pure voice-only networks (circuit switched), which can be easily modeled by Erlang formulae. LTE networks are evolving from circuit switching to packet switching; therefore, both voice and data will be transferred as packets. There can be combinations of different data service requirements such as streaming, browsing, interactive video, gaming etc. with voice. In fact, different types of traffic, which require different QoS are inherent. With the new releases of LTE standards, researchers all over the world are interested in finding most optimum ways of dimensioning LTE networks. Several perspectives have looked at calculating the required number of 4G sites in the initial network-planning phase. Even though there are quality-based models, coverage based models, capacity based models and hybrid models already, due to the complexity of both UL and DL throughput calculations, each model has its own advantages and disadvantages. None of the approaches are discussing about an iterative capacity dimensioning solution to fine tune the required site count. Therefore, in this research thesis author proposes an iterative method under constraints to find the minimum site count while achieving given UL/DL speed requirements for LTE network rollouts. This method will be based on iterations, and varying parameters will be heavily significant in the context of DL and UL throughput.

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Table of Contents

List of Figures

List of Tables

List of Abbreviations

Abbreviation	Description
2G	2nd Generations
3G	3rd Generations
3GPP	3rd Generation Partnership Project
4G	4th Generations
5G	5th Generations
BCCH	Broadcast Control Channel
BW	Bandwidth
CAPEX	Capital expenses
CCPCH	Common Control Physical Channel
CCSA	China Communications Standards Association
CDF	Cumulative Distribution Function
CDMA	Code Division Multiple Access
CN	Core Network
CP	Cyclic Prefix
CQI	Channel Quality Indicator
DL	Downlink
DSCH	Downlink Shared Channel
eNB	enhanced NodeB
EPC	Evolved Packet Core
E-UTRAN	Enhanced – UMTS Terrestrial Radio Access Network
FDD	Frequency Division Duplex
FDMA	Frequency Division Multiple Access
GBR	Guaranteed Bit Rate
GGSN	Gateway GPRS Support Node
GPRS	General Packet Radio System
GSM	Global System for Mobile
HSDPA	High Speed Downlink Packet Access
HS-DSCH	High Speed Downlink Shared Channel
HSPA	High Speed Packet Access
HS-PDSCH	High Speed Physical Downlink Shared Channel
HS-SCCH	High Speed Shared Control Channel

HSUPA	High Speed Uplink Packet Access
IETF	Internet Engineering Task Force
IP	Internet Protocol
L1	Layer 1
L2	Layer 2
LBA	Link Budget Analysis
LTE	Long Term Evolution
MAC	Medium Access Control
MAPL	Maximum Allowed Path Loss
MBMS	Multimedia Broadcast Multicast Service
Mbps	Megabits per second
MBR	Maximum Bit Rate
MCS	Modulation Coding Scheme
MME	Mobility Management Entity
MSC	Mobile Switching Centre
NFFT	Number of Samples of FFT
OBF	Overbooking Factor
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
OPEX	Operating Expenses
PBCH	Physical Broadcast Channel
PCRF	Policy and Charging Rules Function
PDCCH	Physical Downlink Control Channel
PDCP	Packet Data Convergence Protocol
PDF	Probability Distribution Function
PDSCCH	Physical Downlink Shared Control Channel
PDSCH	Physical Downlink Shared Channel
PGW	Packet Gateway
PHY	Physical Layer
PS	Packet Switched
PSS	Primary Synchronization Symbol
PUCCH	Physical Uplink Control Channel
PUSCH	Physical Uplink Shared Channel

QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
QPSK	Quadrature Phase Shift keying
RAN	Radio Access Network
RB	Resource Block
RLB	Radio Link Budget
RLC	Radio Link Control
RNC	Radio Network Controller
ROI	Retrun of Investment
RRC	Radio Resource Control
SAE	System Architecture Evolution
SAE	System Architecture Evolution
SB	Short Block
SC-FDMA	Single Carrier-Frequency Division Multiple Access
SCTP	Stream Control Transmission Protocol
SFN	System Frame Number
SGSN	Serving GPRS Support Node
SGW	Serving Gateway
SINR	Signal to Interference and Noise Ratio
SISO	Single Input Single Output
SNR	Signal to Noise Ratio
SSS	Secondary Synchronization Symbol
TDD	Time Division Duplex
TTI	Transmission Time Interval
UE	User Equipment
UL	Uplink
UMTS	Universal Mobile Telecommunication System
UPE	User Plane Entity
U-plane	User Plane
UTRAN	UMTS Terrestrial Radio Access Network
WCDMA	Wideband Code Division Multiple Access