SERVICE-BASED 5G NETWORK DIMENSIONING FRAMEWORK

Keeragala Arachchilage Vindya Charuni Kumari Keeragala

199409R

Degree of Master of Science

Department of Electronic and Telecommunication Engineering

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DECLARATION

I declare that this is my own work and this Dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

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The above candidate has carried out research for the Degree of Master of Science Dissertation under our supervision. We confirm that the declaration made above by the student is true and correct.

Name of Supervisor: Dr. Abhaya Sumanasena

Signature of the Supervisor: Date: 17-03-2025

Name of Supervisor: Dr. Kasun Hemachandra

Signature of the Supervisor: Date: 17-03-2025

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to Dr. Abhaya Sumanasena, Visiting Lecturer, Department of Electronic and Telecommunication Engineering, University of Moratuwa, for the guidance, supervision and advice given to complete this research. Then, I would like to extend my gratitude to Dr. Kasun Hemachandra who provided guidance and support to complete the M.Sc. in Telecommunications and the research amidst many challenges.

Next, I would like to express my gratitude to Mr. Kalum De Alwis, Assistant Vice President, Network Strategy and Transformation, Dialog Axiata PLC, who encouraged me every step of the way, with indispensable logistical support.

I would also like to thank all the authors and owners of the materials that have been referred in this thesis and finally, I would like to thank my family members and friends who helped me a lot in completing the research.

ABSTRACT

The fifth generation (5G) mobile networks are designed to deliver multiple services with varying requirements and are mostly delivered through a single New Radio (NR) carrier in an early 5G network. However, designing a network to serve multiple services will not be simple and will drastically vary depending on the user demand and the business requirements of the operator. This thesis introduces a service-based 5G network dimensioning framework designed to address the multifaceted requirements of such 5G networks that deliver multiple services through the same NR carrier. Unlike previous studies that rely solely on theoretical models and are based on population census data which do not provide an accurate distribution of users, this research uses real user traffic data and Minimization of Drive Test (MDT) based serving locations to create an accurate and very granular traffic map with user geolocation to service areas of dimension 100m x 100m, offering a practical approach to accurate network dimensioning. The thesis clearly differentiates between the Mobile and Fixed service throughput requirements and how network operators should consider both services in dimensioning a network considering the each service users separately, while previous studies mainly focused on coverage and capacity dimensioning for a common cell edge throughput. The thesis elaborates how the increase in user density due to demographic variation or capture rate impacts the utilization of 5G NR resources and impacts dimensioning parameters contributing to the increase of required Next Generation Node B (gNodeB) to cover certain areas such as hot-spots. Further, the thesis briefly goes through pre-dimensioning process before dimensioning of gNodeB cells, where crucial decision for spectrum selection is done giving a holistic view of the dimensioning process, which are not commonly addressed in existing literature. This work is particularly beneficial for operators in emerging markets, providing a practical guide to address challenges in early stage 5G deployments with mixed services on the same carrier.

Keywords: Service, 5G Network Dimensioning, Capacity, Coverage

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LIST OF ABBREVIATIONS

Abbreviation	**Description**
3GPP	3rd Generation Partnership Project
5G	fifth generation
5QI	5G Quality of Service Identifier
AAU	Active Antenna Unit
AR	Augmented Reality
BS	Base Station
BWP	Bandwidth Part
CA	Carrier Aggregation
CAPEX	Capital Expenditure
CPE	Customer Premises Equipment
CQI	Channel Quality Indicator
eMBB	Enhanced Mobile Broadband
EN-DC	EUTRAN NR Dual Connectivity
FDD	Frequency Division Duplex
FWA	Fixed Wireless Access
gNodeB	Next Generation Node B
IMT2020	International Mobile Telecommunications 2020
ITU	International Telecommunication Union
KPI	Key Performance Indicator
LTE	Long Term Evolution
MAPL	Maximum Allowed Path Loss
MBB	Mobile Broadband
MCS	Modulation and Coding Scheme
MDT	Minimization of Drive Test
MIMO	Multiple Input Multiple Output
mMTC	Massive Machine Type Communication
MNO	Mobile Network Operator
MU-MIMO	Multi User Multiple Input Multiple Output
NLOS	Non-Line-of-Sight
NR	New Radio
NSA	Non-Standalone Architecture
OPEX	Operating Expenditure
PRB	Physical Resource Block
PUCCH	Physical Uplink Control Channel

Abbreviation	**Description**
PUSCH	Physical Uplink Shared Channel
QAM	Quadrature Amplitude Modulation
QoE	Quality of Experience
QPSK	Quadrature Phase Shift Keying
RAN	Radio Access Network
RB	Resource Block
RI	Rank Indicator
RND	Radio Network Dimensioning
RRC	Radio Resource Control
RTT	Round Trip Time
SA	Standalone Architecture
SD	Standard Definition
SINR	Signal-to-Interference-plus-Noise Ratio
SNR	Signal to Noise Ratio
SS-RSRP	Synchronization Signal Reference Signal Received Power
SS-RSRQ	Synchronization Signal Reference Signal Received Quality
SU-MIMO	Single User Multiple Input Multiple Output
SUL	Supplementary Uplink
TDD	Time Division Duplex
Tx	Transmit
UE	User Equipment
UHD	Ultra High Definition
UMa	Urban Macrocell
URLLC	Ultra Reliable Low Latency Communication
VR	Virtual Reality