5G for Telehealth: Utility of Local Mobile Network Operator Architecture and Network Slicing

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Abstract

This thesis studies two novel technologies enabled by network softwarization, namely Local 5G Operator (L5GO) networks and network slicing for 5-th Generation (5G) and beyond 5G networks. This study proposes a L5GO network architecture for delay critical future telehealth services, considering two use cases on Augmented Reality Assisted Surgery (ARAS) and Robotic Aided Surgery (RAS). Study compares the latency performance of the proposed Local 5G Operator (L5GO) architecture with a traditional legacy network and a network equipped with Mobile Edge Computing (MEC). The results highlight the unique advantages of utilizing an L5GO to cater the communication needs of delay critical telehealth, compared to a traditional network. To the end of network slicing, which enables the creation of multiple logical independent networks on physical networking infrastructure can be classified as vertical and horizontal slicing. It is a key methodology to deliver guaranteed Quality of Service (QoS) to a multitude of use cases with varying resource requirements, and hence considered vital for 5G and beyond 5G mobile networks. This thesis focuses on the optimal resource allocation in a 5G network that utilizes network slicing, and caters to the communication requirements of a smart hospital. The study compares the performance of the slicing methods through solving two convex optimization problems, considering several smart hospital scenarios that differ from each other based on their medical speciality. The results are used to draw insights on the most appropriate slicing approach for each setup.

Keywords:
3GPP, 5G, local 5G operator, network slicing, smart hospital, telehealth, URLLC.

Declaration

I declare that this is my own work and this thesis 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.

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Signature of the supervisor	Date

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Contents

Abstract i

Declaration ii

Acknowledgement iii

Table of Contents v

List of Figures vi

List of Tables vii

Abbreviations viii

1 Introduction 1

1.1 Background and Selected Scope 1

1.2 Contribution of the Thesis 3

1.3 Organization of the Thesis 3

2 Literature Survey 6

2.1 5G Mobile Networks 6

2.1.1 5G Network Architecture 6

2.1.2 Key enablers of 5G Networks 9

2.2 Network Slicing 13

2.2.1 Network Slicing architecture 15

2.2.2 Different network slicing methods 18

2.3 Local 5G Operator Networks 20

2.3.1 What are local 5G operator networks? 20

2.3.2 Research work carried out on local 5G operator networks 21

2.3.3 Business opportunities and applications of L5GOs 23

2.4 Communication Services of Critical Medical applications in Smart Hospitals 24

2.4.1 Augmented reality assisted surgery . . . 25
2.4.2 Robotic aided surgery . . . 26
2.4.3 Internet of Medical Things . . . 27

3 Local 5G Operator Architecture for Delay Critical Telehealth Applications 29
3.1 The L5GO Network Architecture . . . 29
3.1.1 The L5GO Network Registration . . . 29
3.1.2 The Protocol Data Unit Session Establishment . . . 31
3.1.3 The Proposed Architecture . . . 32
3.2 The Network Deployment Models . . . 33
3.3 Results analysis . . . 36
3.3.1 The Impact of the Distance to the Core Network . . . 36
3.3.2 Impact of the Network Function Processing Delay . . . 38

4 Deployment Options of 5G Network Slicing for Smart Healthcare 41
4.1 System Model and Problem Formulation . . . 41
4.2 Resources, Applications and Services in a Smart Hospital Environment . . . 45
4.2.1 Resources . . . 45
4.2.2 Applications . . . 45
4.2.3 Services . . . 46
4.3 Result Analysis . . . 46

5 Discussion and Future Work 52
5.1 L5GO for Smart Hospitals . . . 52
5.2 Vertical and Horizontal Network Slicing . . . 52
5.3 Future Work . . . 53

6 Conclusion 54

References 59

List of Figures

2.1 ETSI 5G Architecture [1]. 8
2.2 3GPP non-Roaming 5G System Architecture in reference point representation [2]. 9
2.3 NFV reference architecture framework [3]. 11
2.4 A high-level overview of SDN architecture [4]. 12
2.5 ETSI MEC architecture [5]. 14
2.6 Concept of network slicing. 15
2.7 NGMN network slicing conceptual outline [6]. 16
2.8 5G Infrastructure Public Private Partnership (5GPP) network slice orchestration architecture [6]. 18
2.9 Collaborative service delivery by both L5GO and MNO. 20
2.10 Use cases of 5G wireless networks. 24
2.11 Augmented Reality Assisted Surgery (ARAS) system model 26

3.1 The message flow diagram for device registration. 30
3.2 The message flow diagram for the PDU session establishment. 31
3.3 The proposed network architecture. 32
3.4 Deployment model for a L5GO serving a hospital premises. 34
3.5 Deployment model for a MNO serving a hospital premises. 34
3.6 Deployment model for a MEC enabled network serving a hospital premises. 35
3.7 (a) Latency breakdown for ARAS use case (b) Latency breakdown for RAS use case. 35
3.8 E2E latency of use case 2.4.1 with respect to distance to core network. . . . 37
3.9 E2E latency of use case 2.4.2 with respect to distance to core network. . . . 37

4.1 Vertical Slicing Architecture. 42
4.2 Horizontal Slicing Architecture. 43
4.3 Number of users served for different weight types. 48
4.4 5G network resource allocation percentages for different weight types. 49

List of Tables

2.1 Design principles of Next Generation Mobile Network (NGMN) 5G network vision. 7
2.2 Description of 5G Network Functions. 10
2.3 Summary of important research works on L5GO. 22
2.4 Network level requirements of use cases. 28

3.1 General calculation parameters. 36
3.2 Increased resource levels at the MNO and the MEC networks compared to the L5GO. 38
3.3 Distance to the core network for ARAS and RAS use cases when L5GO T_{NF} = 0.01 ms. 39
3.4 Distance to the core network for ARAS and RAS use cases when L5GO T_{NF} = 0.05 ms. 40

4.1 Weight assignments and the respective values of the objective function. . . . 47
4.2 Calculation parameters. 47

Abbreviations

μO Micro Operator.

3D Three Dimension.

3GPP 3-rd Generation Partnership Project.

4G 4-th Generation.

5G 5-th Generation.

5GPP 5G Infrastructure Public Private Partnership.

AMF Access and Mobility Management Function.

API Application Programable Interface.

AR Augmented Reality.

ARAS Augmented Reality Assisted Surgery.

AUSF Authentication Server Function.

BSS Business Support Systems.

CNF Cloud-native Network Function.

CoMP Coordinated Multi-Point Transmission and Reception.

CP Control Plane.

CT Computer Tomography.

DS-TT Device-side TSN translator.

E2E End-to-End.

EIR Equipment Identity Register.

eMBB enhanced Mobile Broadband.

ETSI European Telecommunications Standards Institute.

FDD Frequency Division Duplexing.

GMC Grand Master Clock.

gNB next generation NodeB.

HDR High Dynamic Range.

IoMT Internet of Medical Things.

IoT Internet of Things.

L5GO Local 5G Operator.

M2M Machine to Machine.

MANO Management and Network Orchestration.

MEC Mobile Edge Computing.

MIMO Multiple input multiple output.

mMTC massive Machine Type Communication.

MNO Mobile Network Operator.

MR Magnetic Resonance.

NF Network Function.

NFV Network Function Virtualization.

NFVO Network Function Virtualization Orchestrator.

NG-RAN Next Generation-Radio Access Network.

NGMN Next Generation Mobile Network.

NSaaS Network Slice as a Service.

NW-TT Network-side TSN translator.

OSS Operating Support Systems.

PCF Policy Control Function.

PDU Protocol Data Unit.

PNF Physical Network Function.

PPMU Portable Patient Monitoring Unit.

QoS Quality of Service.

RAKT Robotic Aided Kidney Transplant.

RAN Radio Access Network.

RAS Robotic Aided Surgery.

RAT Radio Access Technology.

SDN Software Defined Networks.

SLA Service Level Agreement.

SMF Session Management Function.

TSN Time Sensitive Network.

TSN AF Time Sensitive Network Application Function.

UDM Unified Data Management.

UDN Ultra-Dense Network.

UP User Plane.

URLLC Ultra-reliable Low Latency Communication.

VAS Value Added Services.

VIM Virtualized Infrastructure Manager.

VNF Virtual Network Function.

VNFM Virtual Network Function Manager.

VR Virtual reality.