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Efficient Transfer of Applications Across Dual Core Networks: An Accessible Approach

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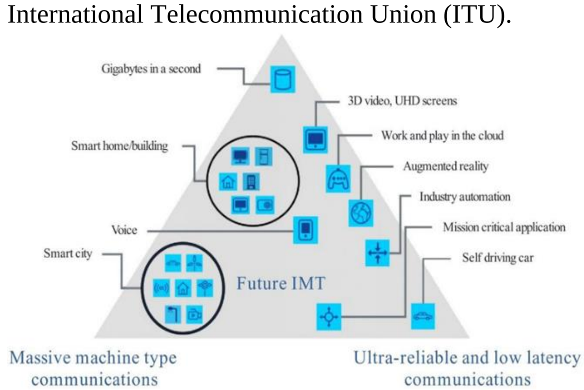
Abstract-The first part of this thesis work looks into MCN solution deployment on its own. It includes a performance analysis of an existing network using a range of KPIs that are measured in an actual network environment. This is carried out in order to confirm the MCN solution's viability and comprehend how it functions. In the second section of the thesis, MCN is installed using the standard installation procedures in a local breakout scenario. After that, it is connected to the 5G test network to create a multi-core network environment. After that, measurement data is used to assess the established network's KPIs in order to confirm that a multi-core network environment is feasible. This thesis' primary contribution is the creation of a multi-core network that can be installed in conjunction with multiple access points.

INTRODUCTION

Fifth-generation (5G) cellular networks are anticipated to be a technology that not only makes broadband connectivity possible but also helps to speed up and ease society's digitization [1]. Information and communication technology (ICT) is driving a transformation in a number of industries as society becomes more digital and globally interconnected. Future cellular network requirements for latency, resilience, coverage, and bandwidth will increase as a result of various vertical industries, including manufacturing, health, and automotive [2]. These commercial use cases, like autonomous driving, augmented reality (AR) support, remote robotic surgery, and so forth, will take off and pick up steam thanks to 5G capabilities [3].

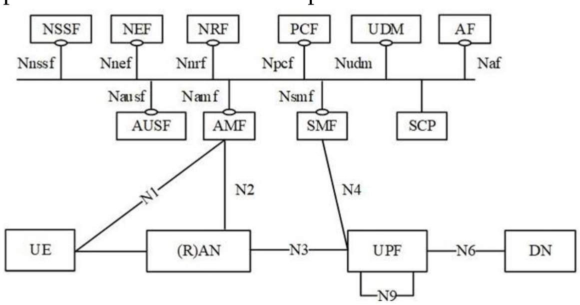
Low latency communication and increased cellular capacity are two benefits of the current communication network's ability to locally offload data traffic to the network's edge based on access point network (APN) selection. MNOs can serve a variety of vertical industries with a range of use cases by utilizing this deployment model. The primary goal of this thesis is to create a multi-core network using the current 4G, or long-term evolution (LTE), network in order to maximize latency optimization and edge computing capabilities. This thesis takes into account a multi-core network environment and makes sure that all of them are interconnected so that any user can easily access the application that is routed from the multi-core network. This dissertation uses the Nokia micro core network

Next-generation cellular standards, or 5G, are defined by the Third Generation Partnership Project (3GPP) in Release 15 [6]. LTE is the previous cellular standard that was succeeded by 5G. The traditional method of wireless global connectivity is being redefined by 5G technology. High throughput, a large number of connected devices, low latency, and reliable communication are requirements that are not met by the current cellular standard and should be supported by a new generation of cellular technology [7]. Previously, MNO was the only entity tasked with offering services to users under the current standard. On the other hand, 5G technology gives different vertical industries the resources and infrastructure they need to offer new services to customers [2]. Three different classes have been recommended by the International Telecommunication Union (ITU).



5G Architecture and Deployment Options

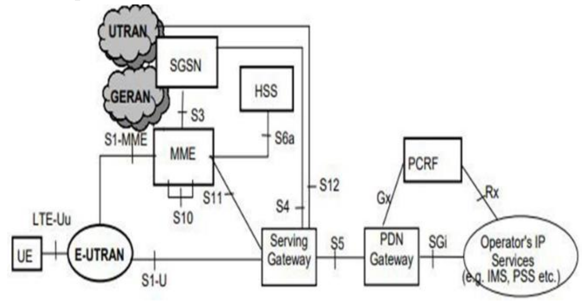
The coexistence of applications focused on people and those focused on machines will present a variety of challenges that the 5G network must take into account. Network slicing, software defined networking (SDN), edge computing, and other technologies will be integrated into the 5G network in order to efficiently support a variety of services and use cases [11]. In contrast to earlier generations of cellular standards, this forces cellular network architecture to be reorganized and modularized. The 3GPP has suggested a service-based network architecture for the 5G system (5GS), and the following describes the two ways in which the interaction between the control plane network elements is represented:



5G network architecture in service-based representation

Evolved Packet Core

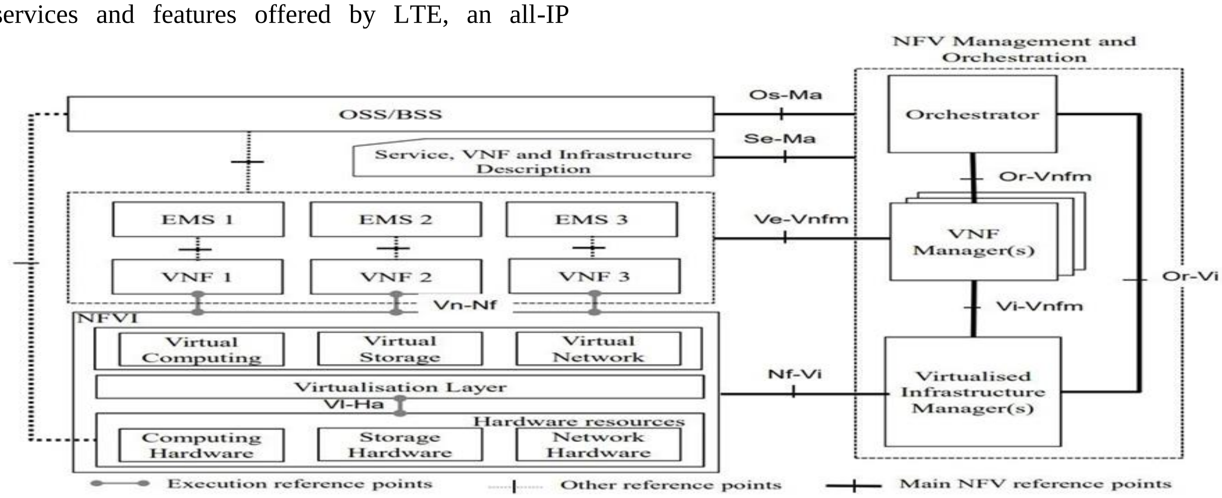
The EPC of the LTE network is discussed in this section. This thesis work has taken into consideration EPC, which manages all essential network-related functions. Introduced in Release 8, LTE is the fourth generation of mobile wireless standard developed by 3GPP [18]. High-speed internet connectivity, multimedia apps, low latency, and other features are just a few of the many comprehensive and secure services and features offered by LTE, an all-IP network with a flat architecture. Figure 6 displays a network using the 3GPP LTE architecture along with the required interfaces [19].



LTE Architecture

Virtual Evolved Packet Core

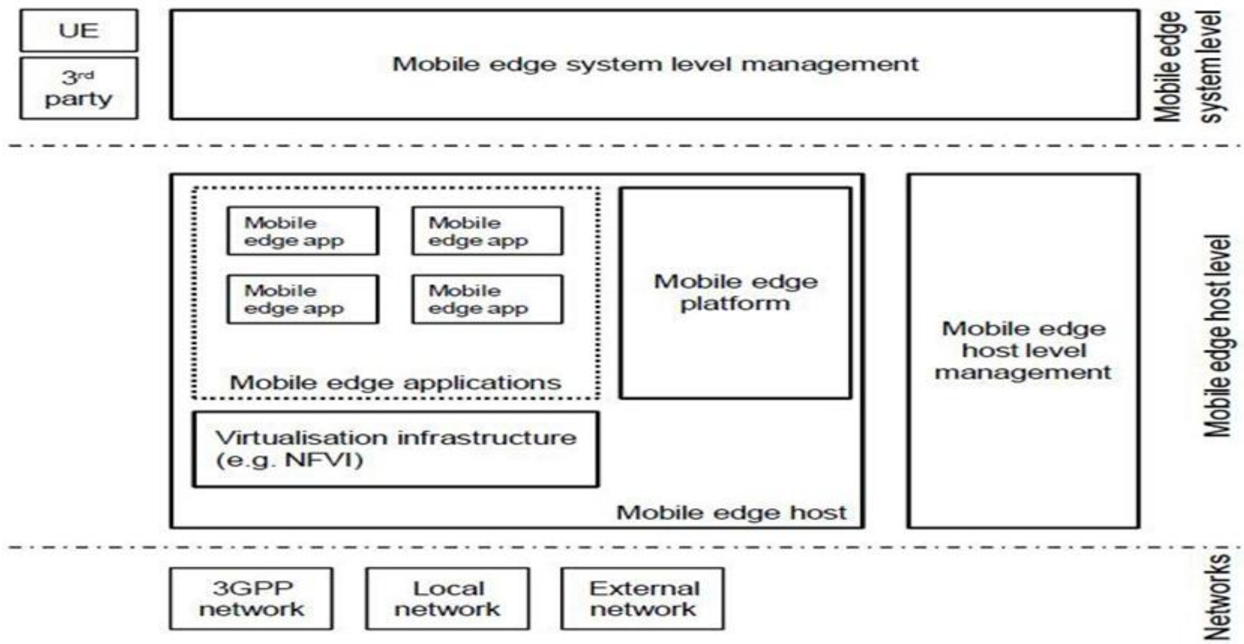
Vendor-specific proprietary dedicated hardware was utilized in traditional telecommunication networks to achieve network functionalities. The implementation of new services by operators, like IMS, which necessitates extra network components, would result in significant power consumption, space requirements, and complicated management. NFV technology, which changes the network architecture by implementing network functions as a software-only entity that runs on top of physical infrastructure, was suggested by the European Telecommunication Standards Institute (ETSI) as a way to combat the operator's increased capital expenditure (CAPEX) and operational expenditure (OPEX) [23]. Reduced network capital and operating costs, easier service development, and more flexible service delivery are some benefits of network function virtualization (NFV) [24]. The architectural framework of NFV, comprising different functional blocks and their inter-block interfaces, is illustrated in Figure 7 [23].



NFV architecture

MEC Deployment in vEPC Network

A crucial enabling technology that will move application-oriented services to the network's edge and allow users to explore a variety of services that demand low latency is multi-access edge computing. Though it can also be implemented in 4G networks, MEC technology is anticipated to be a crucial component of 5G [5]. On top of the virtualization infrastructure, any software-only application with locality requirements or low latency can be operated. Figure 9 [29, 30] illustrates the MEC framework that ETSI has proposed. It is divided into three categories: network level, mobile edge host level, and mobile edge system level.



MEC Architectural framework

RESULTS AND DISCUSSION

Following network topology setup and configuration, network performance is assessed using the same methodology as the standalone deployment case. On April 15, 2020, the measurement data were collected. While key network parameters and findings are covered in this section, the appendix contains the entire raw data set. APN at test phone is configured to "5gtnoulumec" as Figure 31 illustrates, and Figure 32 shows that TAC=151 acknowledges proper signal reception. A few key 3GPP-specified KPIs are then used to assess the deployed network's performance [36].

CONCLUSION AND FUTURE WORK

This amounted to the small-scale deployment of the EPC core network. The network entities MME, S-GW, P-GW, and HSS were realized for standalone deployment. Testing was then carried out using a test UE to confirm the functionality of the set-up framework in order to assess network performance. A number of parameters were measured, and the KPI was examined. The network is operating with a 100% success rate for a number of KPI parameters, according to the analysis of measurement data. Moreover, the network's observed latency was within a satisfactory bound.

Additionally, the Nokia micro core network solution was implemented in local breakout mode, supporting the S-GW and P-GW network entities covered in chapter 4. Following that, it was integrated into the 5GTN EPC network, creating a multi-core network environment. This setup aims to create a network for use cases like unmanned aerial vehicles (UAVs) that are sensitive to delays. Thus, data plane processing would be brought to the network's edge by installing a micro core network at the MEC host, which would lower latency. Testing and verification were completed following the desired network's setup. An analysis of the measurement data revealed that the network in this instance has a 100% success rate for a number of KPI parameters. APN was chosen in accordance with the MEC application. After all of the control plane processing was completed,

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