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A simulative model of a 5G Telco Operator Network

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Abstract

In the near future, an important milestone for the evolution of wireless technologies will be the deployment of 5G network, having the target of supporting very huge data rate generated by a very high number of devices. One of the main technological enablers in this evolution is the joint SDN/NFV paradigm, defined in the last years to support the softwarization process of the Telco Operator networks. Given the very hard quality of experience (QoE) and quality of service (QoS) requirements in some application scenarios, mainly in terms of end-to-end delay, a challenging activity is to realize tools that can support network architects in performance evaluation and network design.

With this in mind, this paper proposes a simulative tool for 5G networks, which is able to capture delay statistics due to both CPU load and transmission link congestions in NFVI-PoP nodes. The model is then applied to a case study to demonstrate how it can be applied for performance evaluation.

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Keywords: 5G, SDN, NFV, End-to-end delay, Network Model.

1. Introduction

In the last years, wireless technology has emerged as one of the most significant trends in networking. According to recent statistics, mobile wireless broadband penetration will exceed that of fixed wireline broadband networks, and by 2018, the global mobile traffic is expected to increase from 2.6 to 15.8 Exabyte[1].

To meet the request of this massive device connectivity, the fifth generation (5G) will be developed with efficiency, scalability, and versatility as main design objectives, with the final target of supporting 1000 times the

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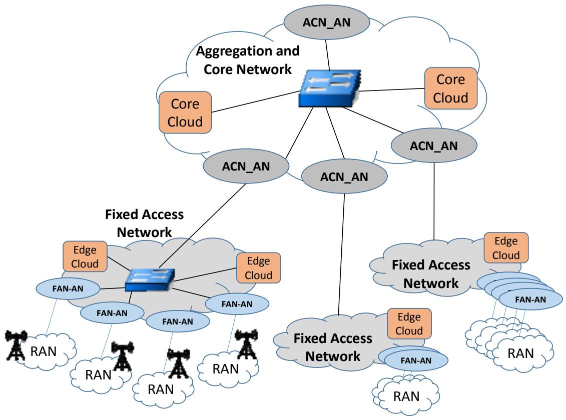

Figure 1: Reference 5G Network Architecture

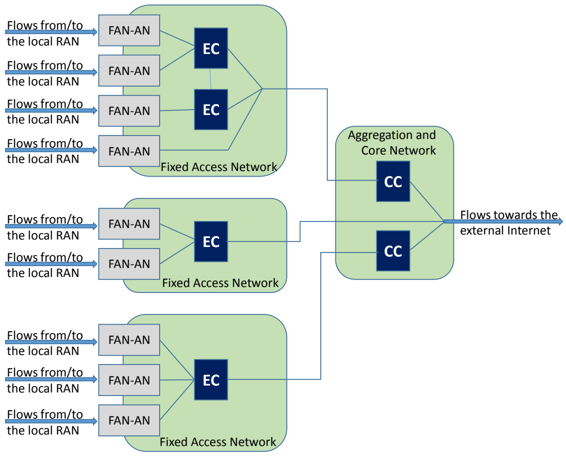

Figure 2: Reference 5G Network Architecture

current aggregate data rate and 100 times the user data rate, while enabling a 100 times increase in the number of currently connected devices, 5 times decrease of end-to-end latency, and 10 times increase of battery lifetime[2].

In this context, the joint SDN/NFV paradigm is an enabling technology to meet efficiency, scalability, and versatility objectives of 5G networks, while smoothing its coexistence with previous technologies[3].

Software Defined Networks (SDN)[4,5] aims at separating the control plane from the data plane, so providing the possibility of dynamically steering traffic flows according to some policy centrally implemented by the SDN Controller. Network Function Virtualization (NFV)[6,7], on the other side, inherits resource virtualization technologies from data center and cloud environments to implement network functions in software components called virtual network functions (VNFs), which are deployed on high-volume servers or cloud infrastructure instead of specialized hardware middle boxes[8,9,10]. Joining the above technologies allows the realization of a big data center distributed over the node of the Telco Operator network.

Given the very hard quality of experience (QoE) and quality of service (QoS) requirements in some application scenarios, like for example video surveillance[11,12], telelearning[13,14] and real-time multimedia content delivery[15,18], mainly in terms of end-to-end delay, a challenging activity in this future Internet scenario is to realize tools that can support network architects in performance evaluation and network design.

The target of this paper is to propose a simulative tool of a 5G network that is able to capture delays due to both CPU load and transmission link congestions in NFV Infrastructure Point-of-Presence (NFVI-PoP) nodes. At the best of our knowledge, this is the first model in the literature that is specific for a 5G network, and that considers the application of the SDN and NFV network paradigms.

The paper is structured as follows. Section 2 details the reference system, while the system model is described in Section 3. Section 4 introduces a case study to show how the proposed model can be applied. Finally, Section 5 draws some conclusions and describe some future work.

2. Reference System

The system we refer to in this paper is the 5G network architecture, as described in[19] and sketched in Fig. 1. It presents a hierarchical structure constituted by three different layers: the Radio Access Network (RAN), the Fixed Access Network (FAN), and the Aggregation and Core Network (ACN). Each RAN provides connectivity to mobile users, and is connected to a FAN through a FAN Access Node (FAN-AN). Moreover, each FAN is connected to the ACN through an ACN Access Node (ACN-AN).

According to the SDN/NFV paradigm, network functions run as virtual functions on NFVI Points of Presence (NFVI-PoPs), which are network nodes compliant with the NFV specifications[20,21].

Referring to Fig. 1, nodes working as NFVI-PoPs are the Edge Clouds located in the FANs, and the Core Clouds located in the ACN. In addition, according to the edge-computing approach[22,23], any access of the FAN network can be equipped to be NFVI-compliant, so working as NFVI-PoP.