Baranda, J., Mangues-Bafalluy, J., Vettori, L. y Martínez, R. (2020). Demo: Scaling Composite NFV-Network Services. In *Mobihoc '20: Proceedings of the Twenty-First International Symposium on Theory, Algorithmic Foundations, and Protocol Design for Mobile Networks and Mobile Computing,* p. 307-308.

DOI: https://doi.org/10.1145/3397166.3415277

Demo: Scaling Composite NFV-Network Services

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ABSTRACT

The composition of NFV-network services (NSs) helps 5G networks to provide the required flexibility and dynamicity to satisfy the needs of vertical industries. The mentioned capabilities are required not only at instantiation time but also during operation time to maintain the corresponding service level agreements in the presence of changing network conditions. In this demonstration, we present the capabilities of the 5Growth platform to handle the scaling of composite NSs under different situations. In particular, we show the scaling of a composite NS implying the update of the required deployed nested NS components and its interconnections but also how the scaling of a shared single NS entails updates on its associated composite NSs.

CCS CONCEPTS

• **Networks → Network experimentation**; **Programmable networks**; **Network management**;

KEYWORDS

Composite Service scaling, Network Service sharing, End-to-End service orchestration, NFV, SDN, 5G networks

ACM Reference Format:

Jorge Baranda, Josep Mangues-Bafalluy, Luca Vettori, Ricardo Martínez. 2020. Demo: Scaling Composite NFV-Network Services. In *ACM MobiHoc '20, October 11–14, 2020, Online.* ACM, New York, NY, USA, 2 pages. https://doi.org/XX.xxxx/YYYYYY.yyyyyyy

1 INTRODUCTION

The composition of NFV-Network services (NSs) allows creating them as a joint set of smaller but specialized units, the so-called nested NSs. Besides combining them, nested NSs can also be shared, which is a key aspect to make feasible the concept of network slicing. This allows 5G networks to provide a higher degree of flexibility and dynamicity to better adapt to the requirements of vertical industries. However, dynamicity and flexibility are not only important during NS instantiation time but also during operation time. Indeed, the maintenance of the corresponding service level agreements (SLAs) in spite of the traffic dynamics associated to an NS is one of the most critical tasks for a service provider. Actually, this is one of the main objectives defined in the EU H2020 5Growth project [1]. In this demonstration, we show the capabilities of the 5Growth platform, and specially of its 5Gr-Service Orchestrator (5Gr-SO) to manage the end-to-end scaling of composite NSs deployed in a complex infrastructure featuring multiple transport technologies (wireless, optical) and several NFVI-Points of Presence (PoPs). To the best of our knowledge, this is the first operational demonstration of NS scaling implying network composition and sharing of a previously deployed single NS, i.e. non-composite NS. This work advances related work performed by ETSI NFV working groups [2], restricted to high-level specifications. In particular, this demonstration considers an emulated Industry 4.0 scenario where a Non-Public Network (NPN) [3] single NS is shared among composite NSs acting as *industrial virtual services*. Then, we show how the 5Gr-SO is able to satisfy successive scaling requests aiming to shape the deployed NSs to maintain the required SLAs during NS operation time.

MobiHoc'20, October 11–14, 2020, Online

ACM ISBN 978-1-4503-XXXX-X/20/06…$15.00
https://doi.org/XX.xxxx/YYYYYY.yyyyyyy

2 SYSTEM ARCHITECTURE

Figure 1 presents the system under demonstration. The aim of this demonstration is to show the enhanced capabilities of the 5Gr-SO to orchestrate the scaling of composite NSs under different situations. Actually, the kind of required operations depends on how the composite NS has been deployed (whether referencing an already deployed single NS) and which is the destination of the scaling request (either the whole composite NS or a single NS which is shared by other composite NSs). To handle that, the 5Gr-SO relies on its hierachical (parent-child) service orchestrator engine (SOE) [5] and the composite Resource Orchestrator Engine (CROOE). In the hierarchical SOE, the parent SOE orchestrates all the operations in case of a composite NS, relying on the child SOE to perform the instantiation/scaling of the differents nested NSs in a composite NS as if they were a single NS [6]. The CROOE, triggered by the SOEp, is in charge of determining the inter-nested NS connections and the successive required updates (creation/deletion) upon successive scaling operations (out/in). The 5Gr-Resource Layer (RL) module coordinates the underlying infrastructure providing storage, computing and networking resources upon the requests from the 5Gr-SO. In this demonstration setup, storage and computing resources are provided by two PoPs managed by different instances of Openstack software. The networking resources of the depicted transport network are coordinated by a hierarchy of SDN controllers [4]. This transport network counts with two domains. The edge domain is a ring of four forwarding elements using WiFi (IEEE 802.11ac) and the core domain is a multi-layer packet/optical transport network.

3 DEMONSTRATION

In this demonstration, we show the composite NS scaling capabilities of the 5Growth platform, which increase the NS deployment dynamicity to provide better adaption to the vertical industries' needs. To illustrate this feature, we consider an Industry 4.0-like scenario, where a company uses the 5Growth platform to deploy a standalone NPN network [3]. Such NPN can be dynamically adapted to accomodate new necessities or address different conditions within the

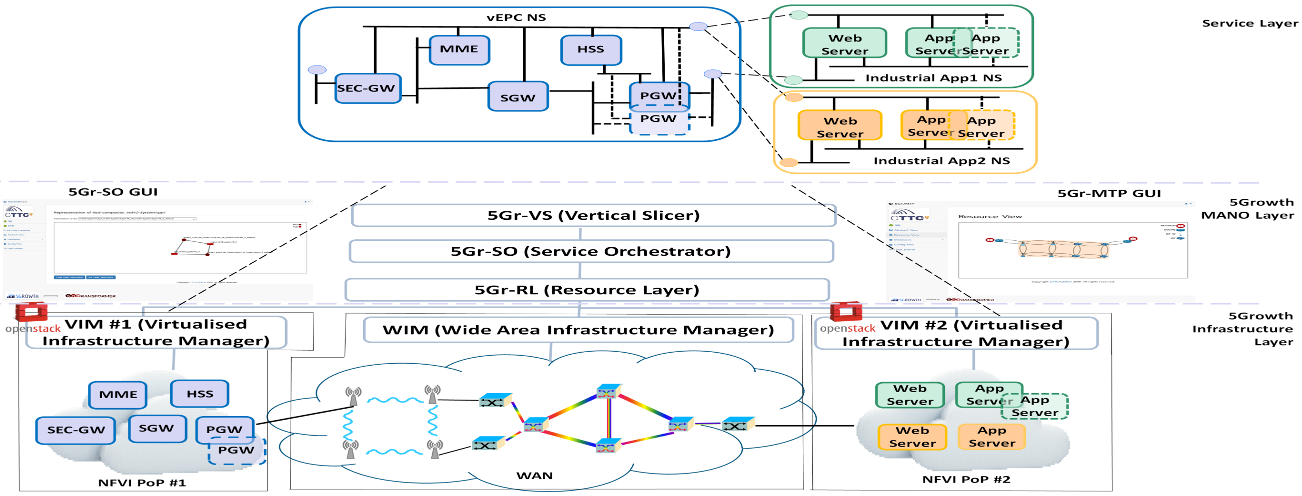

Figure 1: Scaling of composite NSs over the 5Growth platform

factory. Thanks to the use of the concept of NS composition, we define the *"Industrial System"* composite NS, where a new nested NS, which herein we refer to as *"Industrial App"*, interacts with the previously instantiated NS implementing the mobile infrastructure (NPN). Thus, the envisaged *"Industrial System"* composite NS used in this demonstration consists of two nested NSs. First, we have the NS emulating a Virtualized Evolved Packet Core (vEPC). This vEPC NS is made up of five VNFs, namely SEC-GW, MME, HSS, SGW and PGW. The second nested NS represents the so-called *"Industrial App"*. This NS is initially formed by two VNFs: the webserver (WS), which includes load balancing capabilities, and an application server. The main steps of the demonstration are:

1) The 5Gr-SO receives a request to deploy the emulated vEPC NS implementing the standalone NPN. The SOEp processes the request and delegates it to the SOEc to instantiate the single vEPC NS (blue boxes in Figure 1), as explained in [6].

2) Then, we proceed with the deployment of two different *"Industrial Systems"*. These systems are deployed as composite NSs, and both share the previously deployed vEPC NS. When the 5Gr-SO receives the request, the SOEp considers the provided reference to orchestrate the required instantiation operations for the remaining nested NS of each composite NS [5]. These remaining nested NSs are represented by the "Industrial App" NSs in Figure 1 (green and orange boxes). At this point, there are three different deployed NSs: one single NS and two composite NSs sharing this single NS.

3) After the creation of the previous composite NSs, the expected increase of processed traffic may cause problems in the vEPC NS. To solve this issue, the 5Gr-SO receives a scaling request to change the instantiation level (IL) of the vEPC NS. Initially, the SOEp processes this request, which refers to a single NS, and relies on the SOEc to orchestrate this scaling operation. This IL implies the deployment of a new PGW VNF instance, to attain traffic load balancing among the upcoming new sessions. The new PGW VNF instance is represented in Figure 1 with the light blue box. After that, since there are two composite NSs sharing the vEPC NS, the SOEp proceeds with the update of the associated composite NS deployments. This consists of establishing the new inter-nested NS connections from the composite NSs to the new PGW VNF instance in the vEPC NS.

4) Next, upon an increase in the factory production, the *Industrial App1* overloads due to a surge in the number of operations. Thus, this requires a change to scale the associated resources. Then, the 5Gr-SO receives a scaling request to change the IL of the *Industrial System* composite NS used by the *Industrial App1*. The SOEp analyses the request, concluding that this new IL for the composite NS implies the instantiation of a new application server VNF in the nested *Industrial App1* NS. After instantiating the new VNF (light green VNF box in Figure 1), the SOEp proceeds with the update of the inter-nested NS connections towards the associated vEPC NS.

During this demonstration, the graphical user interfaces (GUIs) of the 5Growth platform show the result of the successive demonstration steps. The 5Gr-SO GUI shows the structure of the different deployed NSs and the new VNFs resulting from the successive scaling operations. The 5Gr-RL GUI shows the underyling networking and compute infrastructure. Specifically, we will focus on the update of the inter-nested NS connections among the deployed NSs. A demonstration video is available online[1].

ACKNOWLEDGMENTS

This work has been partially funded by the EC H2020 5G-Growth Project (grant no. 856709), by MINECO grant TEC2017-88373-R (5G-REFINE) and Generalitat de Catalunya grant 2017 SGR 1195.

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