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Deploying a containerized ns-3/LENA-based LTE mobile Network Service through the 5G-TRANSFORMER platform

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***Abstract*—This demo presents an ongoing prototype implementation of the Service Orchestrator (SO) building block of the 5G-TRANSFORMER (5GT) architecture. Within the 5GT-SO, we define the Service Manager (SM), which hosts the intelligence of the 5GT-SO and interacts with the other architectural blocks of the 5GT architecture through the defined APIs. The aim of defining the SM is to decouple the 5GT-SO implementation from the associated MANO platform, allowing the interoperability with other MANO platforms, hence increasing the scope of the 5GT solution. In this demo, we will show how the current ongoing implementation of the 5GT-SO, using the SM, is able to automate the orchestration of both computing and networking resources to deploy a virtualized mobile network service based on ns-3/LENA network simulator/emulator in minutes over an emulated environment consisting of a multi-point of presence infrastructure connected by a custom transport network.**

***Index Terms*—5G, end-to-end service orchestration, NFV, SDN, mobile transport**

I. Introduction

5G networks will suppose a revolution in the telecom network ecosystem, since its expected capabilities will allow the support of new innovative services requested by vertical industries, such as eHealth, automotive, media, or cloud robotics. To enable such vision, the 5G-TRANSFORMER (5GT) project proposes a flexible and adaptable SDN/NFV-based design of the next generation Mobile Transport Networks. This design [1], based on the ETSI Management and Orchestration (MANO) architecture, defines three novel building blocks, namely, the 5GT-Vertical Slicer (5GT-VS), the 5GT-Service Orchestrator (5GT-SO), and the 5GT-Mobile Transport and Computing Platform (5G-MTP).

This demo focuses on an ongoing prototype implementation of the 5GT-SO building block, which is responsible for the end-to-end orchestration of services and resources based on the vision provided by the 5G-MTP platform and to expose these services to the 5GT-VS in an unified way to satisfy the requirements of vertical industries. This prototype of the 5GT-SO will be used to deploy a containerized ns-3/LENA [2] LTE mobile network service over a multi-point of presence (PoP) NFV infrastructure connected by a custom transport network.

II. System Architecture

Figure 1 presents the demo system under demonstration. The value proposition of this demo is the architecture and implementation of the 5GT-SO block. As we can see in Figure 1, the ongoing prototype implementation of the 5GT-SO counts with two main subblocks, the Service Manager (SM) and an associated open source MANO platform. The SM prototype is a Python application, exposing its functionalities through a RESTful HTTP API at its northbound interface. Currently, the SM performs network service (NS) lifecycle management (LCM) tasks interacting with the counterpart MANO platform but hosts the intelligence of the 5GT-SO, handling computing and network resource databases based on the information provided by the 5G-MTP to perform placement operations of the Virtual Network Functions (VNFs) upon the requirements of the incoming NS requests from the 5GT-VS. If an error occurs in the process of instantiating a NS request, such as a problem to launch the VNFs, lack of available computing or network resources connecting VNFs, SM undoes all the performed actions, leaving the system clean and informing the *user* of the error cause.

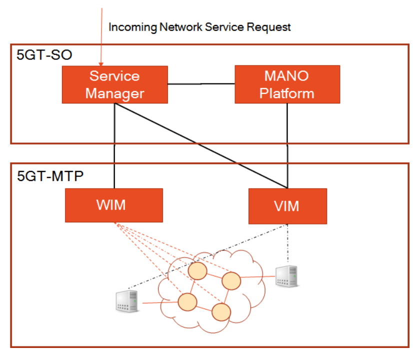

Fig. 1. System architecture under demonstration

The aim of the proposed architecture in the 5GT-SO is to decouple it from the associated open source MANO platform, which in this demo is OSM Release 3 [1]. Such decoupling will allow the interoperability with different open source MANO projects, hence increasing the scope of the 5GT solution. A mediator layer, currently under development, adapts the outputs of algorithms running inside SM depending on the associated MANO platform. Currently, the 5GT project considers Cloudify [2] and the already mentioned OSM as the possible open source MANO platforms.

[1]https://osm.etsi.org/
[2]https://cloudify.co/

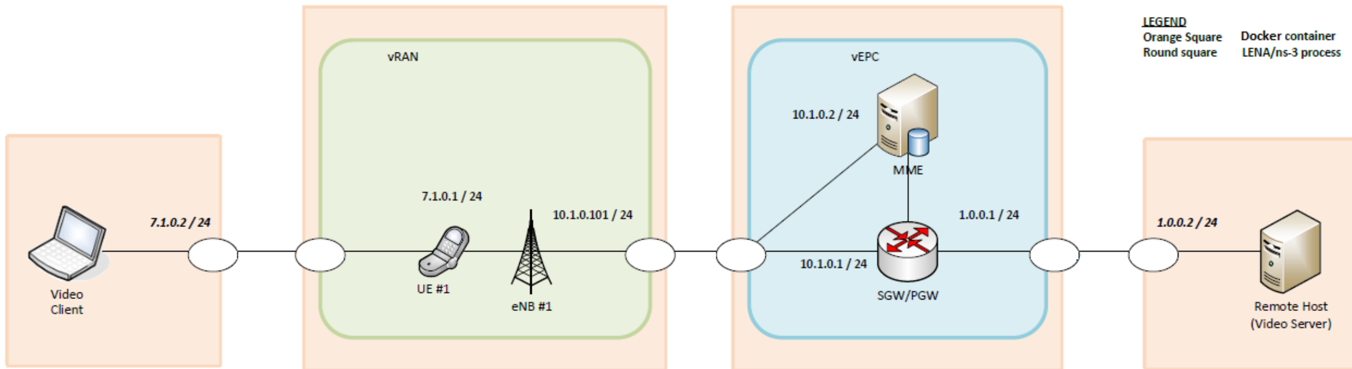

Fig. 2. Deployed mobile network service using ns-3/LENA network simulator/emulator

The role of the 5GT-MTP in this system setup is reduced to the Virtualized Infrastructure Manager (VIM), the Wide Area Network (WAN) Infrastructure Manager (WIM) and an emulation of the computing and networking transport infrastructure. This infrastructure and the VIM component are provided by the *vim-emu* platform [3]. It is an open-source emulation framework allowing the execution of real network functions packaged as Docker containers deployed in emulated PoPs running locally on the developer's machine. Each emulated PoP offers an OpenStack-like API so it can interact with different MANO solutions. The PoPs are connected over locally emulated network topologies using Containernet (a fork of Mininet). The WIM component is provided by the WiseHAUL SDN controller [4], a custom SDN controller developed for wireless transport networks based on Ryu framework.

III. Demonstration

We will demonstrate the automated end-to-end orchestration of computing and networking resources for the deployment of a LTE mobile NS using the ns-3/LENA network simulator/emulator [2] over the emulated environment consisting of two PoPs infrastructure connected by the custom transport network depicted in Figure 1. This emulated NS, depicted in Figure 2, consists of four Docker containers, which were specifically generated for this demonstration. These containers are a video client user, an emulated Virtual Radio Access Network (vRAN) entity communicating with a Virtualized Evolved Packet Core (vEPC), and a video server application. The VNF descriptors and the NS descriptors have been generated and onboarded previously in the employed OSM MANO platform. The main steps of the demo are:

1) A NS request arrives to the 5GT-SO block asking for the deployment of the virtualized LTE mobile network service.

2) The SM validates the NS request, determines the placement of the four entities mentioned previously based on the requirements included in the NS petition, and communicates its decision to the MANO platform, which will interact with the VIM to manage the instantiation of the different Docker containers running the VNFs in the different emulated PoPs.

3) Once the SM verifies that the MANO platform has correctly launched the requested NS, it computes the required paths to connect the containers as requested by the NS and generates the corresponding network provisioning calls to the WIM.

4) The SM acknowledges the correct installation of the network provisioning calls at the WIM and stores the appropriate information at its service instance database to make an appropriate resource management in subsequent NS requests. Among the stored information of a NS instance, for each VNF in the NS, the service instance database stores its IP address, its MAC address, the associated PoP and the associated network provisioning calls.

5) Once containers are running and the requested network connectivity exists between them, the enodeB registers at the Mobility Management Entity (MME) and the LTE default bearer is activated between the LTE UE#1 and the Serving PDN Gateway (SGW/PGW). At this point we can start a video transmission between remote host and video client containers.

Several graphical user interfaces (GUI) show information about the different components depicted in Figure 1. The GUI of the VIM shows the different containers running over the emulated transport infrastructure, the GUI of the MANO platform shows the different running service instances and the GUI of the WIM shows the transport topology and a dynamic representation of the relative load of the emulated transport nodes and its associated links.

Acknowledgments

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