5GTANGO: 5G Platform for Industry-specific Network Services and Applications

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Abstract. 5G will not simply be an evolution of mobile broadband networks as its predecessors, but will open the door to unique service capabilities, calling for new business models. In this context, Software Defined Networks (SDN) and Network Function Virtualization (NFV) are technologies that will shape the evolution of the telecom sector with new network capabilities and business opportunities. The ultimate goal is to increase the level of programmability, control and flexibility of networks, while reducing network operation costs and provide platforms for the validation and verification of network services. Towards addressing these challenges, this paper provides insights of the 5GTANGO Management and Orchestration (MANO) framework, along with insight from its building blocks and project achievements.

Keywords: Virtualized Network Functions · Network Services · 5G programmability.

1 Introduction

5G networks will not only improve the radio access but also drastically improve the flexibility of the network by using Software Defined Networks (SDN) and Network Function Virtualisation (NFV) concepts. In NFV, network services consist of multiple interconnected Virtual Network Functions (VNFs), that are implemented in software and can be instantiated on virtual machines or containers. This virtualization allows dynamic scaling, i.e., flexibly determining a suitable number of VNFs and allocated resources according to the current load. In doing so, no resources are wasted and operational expenditures (OPEX) are reduced while always ensuring good quality of service. Furthermore, VNFs can easily and quickly be migrated and placed at different nodes in the network, minimizing the resulting delay and required bandwidth. As VNFs are software (as opposed to old hardware network functions (NFs)s), the development and deployment effort can also be significantly reduced, leading to shorter time-to-market and lower capital expenditures (CAPEX). There are various ongoing projects aiming

to achieve flexible NFV Management and Orchestration (MANO) of such Network Services (NS) and VNFs. However, current approaches are still not mature enough and support only limited functionality [ref]. The 5GTANGO project is developing an NFV framework that provides a programming model, development and testing toolchain for virtualized services, which is fully integrated with a DevOps-enabled service platform and orchestration system. In particular, the objective of 5GTANGO platform is threefold: First, to support and simplify the creation of network service packages and descriptors, even for complex configurations by providing an extensive Software Development Kit (SDK) that supports creation of network service descriptors and packages. Second, a main novelty of 5GTANGO is the development of the Validation and Verification (VnV), which is a stand-alone platform that allows developers, operators, or 3rd parties to test their VNFs and network services in an automated fashion. Third, the Service Platform (SP) manages and orchestrates submitted network services while abstracting the infrastructure details and providing management of different users and isolation of resources (network slicing). Overall, 5GTANGO greatly alleviates the burdens of development, deployment, management, and orchestration throughout the lifecycle of network services by introducing a complete DevOps Approach. 5GTANGO can be downloaded, install and run by using the referred quickguide. The next sections provide an overview of the 5GTANGO architecture along with a brief explanation of the main building blocks, as well as project achievements and future work.

2 Project Architecture

The goal of this section is to describe the high-level architecture and concepts envisioned for 5GTANGO, providing a brief overview of the three main building blocks, namely the SDK, the VnV, and the SP, as depicted in Figure 1. An adequate synergy between these three components aims for enabling rapid design, implementation, testing and deployment of novel networked services following a DevOps workflow.

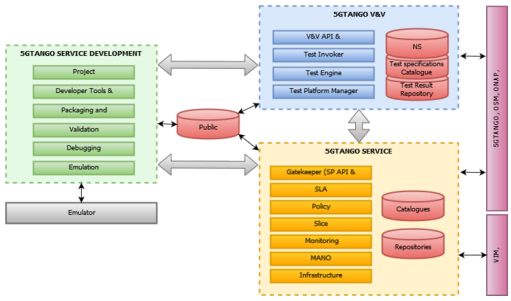

Fig. 1. 5GTANGO architecture.

2.1 SDK toolset

The philosophy of 5GTANGO SDK is to provide a useful blend of loosely-coupled, light-weight tools which could be used independently on their own, as well as in synergy with each other, assisting the global goal of VNF and service development for the 5GTANGO Service Platform. The functionality of the SDK can be roughly bundled in the following major components. Project environment tools are responsible for setting up the local developer workspace environment on the developer's computer, for example preparing the file system and folder structure to store environment information, authorization tokens, etc. Developer schemas are used to formalise the structural requirements of involved 5GTANGO artifacts. In many cases, descriptors are required. These schemas will detail the data model and required format to specify them. The development tools assist the programmer in creating images, descriptors for services or VNFs and specific managers for controlling services. These tools usually result into additional files within the prepared project folder structure. Packaging and access tools enable to combine all single, standard-aligned, project artifacts into a single package or archive which can be uploaded to execution environments such as the emulator, the VnV or the Service Platform. Validation tools are used to execute a number of formal checks on produced packages without actually deploying them, such as syntactical checking of the descriptor files. Emulation tools enable to deploy service packages on a locally emulated environment. Finally, debugging tools assist the developer to inspect state, conditions or bugs in deployed services, presumably the emulator.

2.2 VnV platform

The VnV platform has been designed and developed to work seamlessly with the rest of the 5GTANGO components and other MANO platforms. The major components which comprise the VnV are described below. The API gateway provides a common entry point for all VnV API calls, while the GUI provides a user friendly way to exercise the VnV APIs. The test results repository stores the results of each test (either pass or fail), making them available to interested entities. The Test invoker checks for events which can trigger automated test execution. These are triggered by changes to test environment configuration, test metadata, test, network service, or network service metadata. The test invoker receives notifications of changes and then generates the list of tests which need to be executed and passes that on to the test engine. The test engine is a network service capable of testing specific workflow engine. The test engine is responsible for executing tests and controlling the scheduling of tests to be executed. The test platform manager provides the test engine with an interface for network service deployment. This component contains a lot of the logic required to actually deploy, run, and tear down network services. It also provides a high level interface to allow the collection of advanced metrics. The test platform manager supports multiple orchestration platforms.

2.3 Service Platform

The 5GTANGO Service Platform consists of several components running as microservices and interacting with each other in order to manage the lifecycle of VNFs and NS. The Gatekeeper is the front-end component, responsible to secure and forward the incoming requests to the platform (OSS/BSS). The MANO Framework is the core of the Service Platform and implements the ETSI NFV Orchestrator (NFVO) and VNF Manager (VNFM) functions, responsible to onboard and manage the lifecycle of VNFs and NSs. The Slice Manager is responsible for the Network Slice layer, on-boarding Network Slice Templates (NSTs) and managing the lifecycle of Network Slices Instances (NSIs). The Infrastructure Adapter implements the interaction with several infrastructures, providing an abstraction to support multiple the Virtualized Infrastructure Managers (VIMs) and WAN Infrastructure Managers (VIMs). The Catalogue and Repository are databases that store descriptors and records, respectively, as well as other service-related information. The Policy Manager centralizes the policies of the whole system XIL18, while the SLA Manager defines and manages SLAs, checking whether violations occur. Finally, the Monitoring Manager is responsible to collect and deliver monitoring data related to VNFs, NSs, and Network Slices.

3 Project Achievements

This section provides the main project achievements with respect to the three major components discussed above.

3.1 SDK

It provides a set of more than ten loosely coupled, but tightly integrated, tools to develop, manage, validate, test, and package single VNFs, complex network services and NFV test scenarios for the most prominent service platforms, i.e., SONATA, OSM, and ONAP. It also provides a lightweight prototyping platform allowing to emulate complex multi-PoP scenarios on a local environment, shortening the development cycle and lowering the barrier to create new VNFs and services. Moreover, it also introduces benchmarking tools to evaluate locally VNF performance.

3.2 VnV

This component has been designed to be generic in order to be easily adaptable to all NFV-compliant infrastructures, so that it can be easily replicated in any operators NFV infrastructure or even multi-tenant infrastructures, providing a simple interface to interact with. Moreover, one of the main achievements is that the VnV is compatible with OSM, ONAP and SONATA platforms, which allows the VnV user to instantiate, validate and verify network services in the

most advanced and completed NFV orchestration platforms. Finally, the developed probes can perform functional tests, benchmarking tests, connectivity tests, among others on top of multiple NFV-O.

3.3 SP

The main outcome of the 5GTANGO SP component is the support to the design and deployment of VNFs and NS on top of Kubernetes (k8s) infrastructures (VIM), enabling the use of this lightweight technology in low-resource and agile environments such as edge PoPs, that no other MANO framework supports until now. Moreover, the SP supports the design and deployment of network slices (following relevant 3GPP and ETSI standards), which are virtual end-to-end networks, isolated from each other, built on top of a common physical infrastructure. SP component supports the design of VNFs and NS with multiple flavours, which define different deployment topologies and resources in order to cope with different requirements from customers in terms of QoS and performance characteristics. Finally, SP also includes an innovative monitoring framework able to guarantee the required Network Service SLA and a policy engine, that introduces autonomicity to the SP.

4 Future Work and Conclusions

Despite the wide range of functionality already provided, the final software release (5.0) does not necessarily stop development and maintenance once the 5GTANGO project ends (January 2020). In addition to potential bug fixes, and based on the architecture principles mentioned above, the 5GTANGO enables further extensions, taking into consideration emerging technologies and market trends. Below some potential future directions are sketched out. These might be targeted through individual developers, novel research and innovation projects or other instances. As a conclusion, 5GTANGO managed to develop an innovative MANO platform for developing, testing and deploying VNFs and NS in a multi-platform and multi-vendor manner. Finally, all project results are open source and publicly available in a GitHub repository under Apache v2.0 license, a permissive license that guarantees full rights for adoption, modification and distribution.

5 Acknowledgement

This work has been performed in the framework of the 5GTANGO project, funded by the European Commission through the Horizon 2020 and 5G-PPP programmes (H2020-ICT-2016-2 761493).