O2CMF: Experiment-as-a-Service for Agile Fed4Fire Deployment of Programmable NFV

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Abstract: An open platform over OpenStack for control and management of experiments (O2CMF) for merging and adapting wireless and optical federated testbeds with proper cloud infrastructure is presented. TOSCA-enabled orchestration provides programmability for NFV experiments.

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1. Overview

Network functions virtualization (NFV) [1] is a key enabler for 5G networks and new cloud-based software stacks are needed to support agile development and experimentation of NFV services. Usually, federated testbeds are used to perform proof-of-principle network experiments. They offer heterogeneous resources that can be shared among users (from academia or industry) owning a federated identity [2]. However, there are important issues yet to be addressed in federation of testbeds for NFV experimentation. On one hand, cloud platforms were not designed to support repeatable and reproducible experimentation of heterogeneous computing and (wireless and optical) networking resources. On the other hand, federated testbeds with such facilities, e.g., Fed4FIRE (https://www.fed4fire.eu) and GENI (http://www.geni.net), are not fully prepared to support NFV experiments. They do not offer adequate virtualization mechanisms to guarantee networking slicing and automated experiment control. Therefore, efforts toward adapting and merging wireless and optical federated testbeds with proper cloud infrastructure are needed to unleash NFV innovation.

2. Innovation

Here we introduce an open testbed control and management framework for OpenStack (O2CMF) to support experimentation capabilities in Fed4Fire federation for agile deployment of NFV. This initiative leverages the concept of Experiment-as-a-Service for NFV testbeds. On testbed owner or cloud operator side, it is important to provide: (i) user authentication and credentials, (ii) experiment life cycle management, (iii) integration of computing resources with wireless and optical networks, (iv) networking slicing and isolation, and (v) service level policies for resource quotas. The first three requirements were achieved by developing federation interfaces compliant with Fed4Fire and by integrating these interfaces with the provisioning capabilities of OpenStack basic modules. The fourth requirement was achieved with the use of tunnels and private networks in OpenStack. Finally, the fifth requirement was achieved by configuring flavors in OpenStack, which define resource usage limits of a virtual machine, such as CPU, memory, and network bandwidth. From the experimenter's point of view is important to offer: (i) repeatability, (ii) reproducibility, (iii) automation, and (iv) programmability. To provide these functionalities, we developed an orchestrator module that receives user experiment scripts and interacts with the following OpenStack modules to deploy the experiment: Ceilometer, for measuring and monitoring; Heat, for orchestration automation; and Tacker, for NFV management and orchestration (MANO).

Figure 1 shows that physical resources are controlled by OpenStack (Ocata version). An aggregate manager (AM) and an orchestrator are O2CMF key elements. The former is in charge of exposing testbed resources to the federation, and the latter is used by experimenter to specify service orchestration using a script in TOSCA[1] language. The AM

[1] http://docs.oasis-open.org/tosca/TOSCA/v1.0/TOSCA-v1.0.html

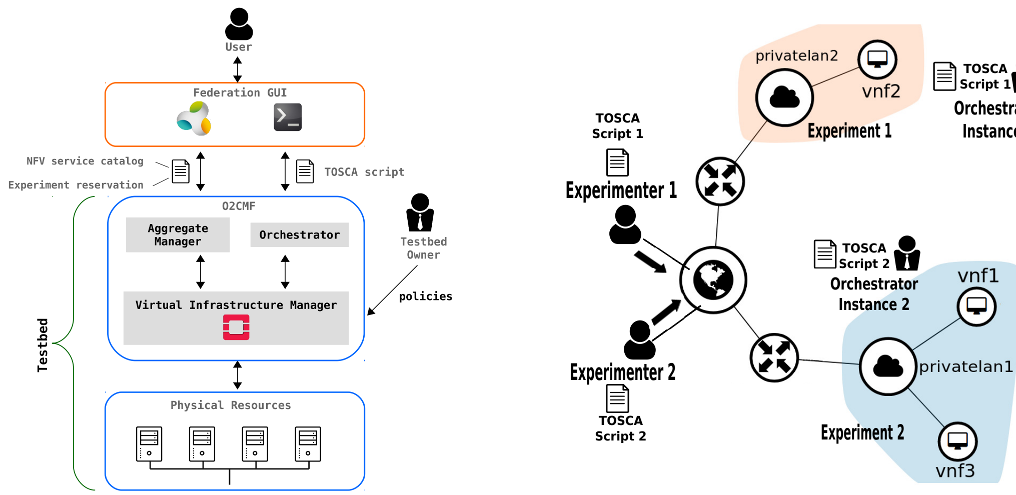

Fig. 1: O2CMF software stack and demonstration scenario for orchestrating NFV solutions.

acts as a mediator between requests from the federation to OpenStack. User can interact with AM through a federated protocol based on XML message exchange. In testbeds managed by O2CMF, such messages can be used for resource discovery regarding a *catalog of available Virtual Network Function (VNF)* and also to automate pre-experiment configurations. It allows users to setup a complete network, with the desired VNFs, requiring minimal manual intervention. This approach also brings interoperability, since, beside cloud resources, it enables the inclusion of heterogeneous resources from Fed4FIRE federation. The orchestrator plays an important role in O2CMF: It decouples the federation mechanisms from the resource management technologies while delivering a proper virtual infrastructure [3]. After resource provisioning, during the experiment execution, O2CMF orchestrator allows experimenters to specify both service policies and service functionalities.

3. Demonstration

Figure 1 gives an overview of our O2CMF demonstration. In the first experiment, the testbed owner will setup a policy to limit CPU and bandwidth usage for VNFs that compose the VNF Catalog. Then, two different users will instantiate experiments with VNFs from the Catalog using federation mechanisms. Firstly, we will show that both users are isolated and there is no connectivity between the different private networks. Then, the first experimenter will try to increase resource utilization of his VNF until the specified limits are reached, so we prove that one experiment cannot cause performance degradation in the other. In the second experiment, we show how a user can interact with the O2CMF orchestrator, using a TOSCA script to define orchestration policies to scale the instantiated VNFs according to resource utilization. In this way, we show how O2CMF makes the testbed management more dynamic while providing a flexible environment for the development and test of NFV services.

4. OFC Relevance

Fiber and wireless integration converged with mobile edge computing (MEC) are key enablers for supporting the new services in 5G networks. Our software stack[2] enables fast validation and agile deployment of NFV solutions in federated testbeds.

References

1. R. Mijumbi *et al.*, "Management and orchestration challenges in network functions virtualization," IEEE Communications Magazine **54**, 98–105 (2016).
2. M. Berman *et al.*, "Future internets escape the simulator," Communications of the ACM **58**, 78–89 (2015).
3. A. Mayoral *et al.*, "Cascading of tenant sdn and cloud controllers for 5g network slicing using transport api and openstack api," in "2017 Optical Fiber Communications Conference and Exhibition (OFC)," (2017), pp. 1–3.

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