Exploiting Infrastructure Capabilities to Dynamically Orchestrate NFV Services across Multiple Domains

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Abstract

Several orchestrators, both commercial and open source, are available today. However, some open question still remain, in particular with respect to the requirements arising from the distributed infrastructure of a telco provider, such as (*i*) the seamless service deployment in heterogeneous infrastructure, (*ii*) the optimization of the service deployment to keep functions as close as possible to the customers, (*iii*) the seamless addition/removal of heterogeneous domains/platforms under the considered orchestration umbrella.

The FROG is a software that is able to orchestrate NFV/cloud services across multiple heterogeneous domains. The FROG is based on multiple domain orchestrators, each one responsible of a single infrastructure domain, that cooperate by timely exporting the capabilities and the available resources in each domains to an overarching orchestrator, which has to coordinate the deployment of the service across the entire infrastructure. Supported domains include not only traditional infrastructures with network (e.g., OpenFlow only) or compute (e.g., OpenStack) capabilities, but also resource-limited SOHO home gateways, properly extended to make it compatible with the FROG orchestrator. The set of capabilities and resources exported by each single domain, coupled with the constraints specified by the service itself (e.g., the IPsec client endpoint must stay on the tenant home gateway and not on the data centre) determines how the orchestrator splits the service graph, originating the proper set of sub-graphs that are deployed on the selected infrastructure domains.

This demo shows the FROG overarching orchestrator that will receive a service request, will query the different infrastructure domains for their capabilities/resources and it will dynamically partition the requested service graph across the selected available infrastructure domains, determining also the network parameters that have to be used in the interconnections between domains. For instance, the orchestrator will be able to set up either the proper GRE tunnels, or VLAN-based connections, or OpenFlow paths, based on the resource exported by the involved domains, the cost of the solutions, and the constraints given by the service.

This demo shows also the possibility to integrate resource-constrained devices, such as existing home gateways, in the controlled infrastructure. For instance, we will show how an home gateway, extended with NFV support, can dynamically recognize a new user connecting to it and consequently create a GRE tunnel to deliver that traffic to the proper set of VNFs that are instantiated in the operator data centre. Furthermore, some more powerful

home gateways are shown as well that can execute a limited number of VNFs that are implemented as a “native software”, i.e., applications running on the bare hardware, in addition to the traditional VM-based or Docker-based VNF support.

Finally, the FROG architecture relies on an intermediate message bus instead of using the traditional REST API to interconnect the different components. This solution provides a clear advantage when the recipient of the information published is not known such as in the bootstrapping process, or when different components (e.g., service layer and orchestrator) need to know the same information coming from the infrastructure domains to perform their job.

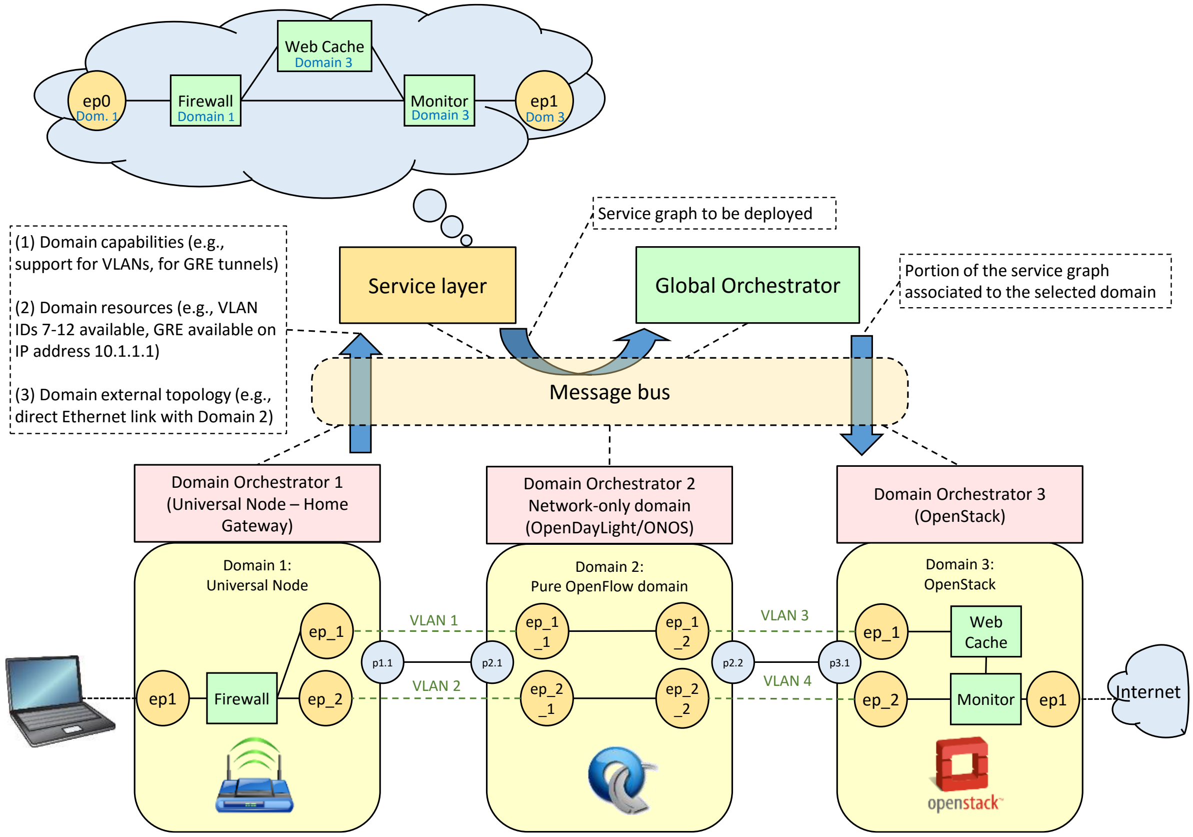
Web Cache
Domain 3
ep0
Dom. 1
Firewall
Domain 1
Monitor
Domain 3
ep1
Dom 3
Service graph to be deployed
(1) Domain capabilities (e.g., support for VLANs, for GRE tunnels)
(2) Domain resources (e.g., VLAN IDs 7-12 available, GRE available on IP address 10.1.1.1)
(3) Domain external topology (e.g., direct Ethernet link with Domain 2)
Service layer
Global Orchestrator
Portion of the service graph associated to the selected domain
Message bus
Domain Orchestrator 1 (Universal Node – Home Gateway)
Domain Orchestrator 2 Network-only domain (OpenDayLight/ONOS)
Domain Orchestrator 3 (OpenStack)
Domain 1: Universal Node
Domain 2: Pure OpenFlow domain
Domain 3: OpenStack
ep1
Firewall
ep_1
ep_2
VLAN 1
VLAN 2
p1.1
p2.1
ep_1_1
ep_1_2
ep_2_1
ep_2_2
p2.2
p3.1
VLAN 3
VLAN 4
ep_1
ep_2
Web Cache
Monitor
ep1
Internet
openstack

FIGURE 1. EXAMPLE OF POSSIBLE ORCHESTRATION OF A USER-DEFINED SERVICE SPANNING ACROSS MULTIPLE DOMAIN

In summary, the FROG distributed orchestration software will show the following concepts:

- The capability to deploy service graphs across different heterogeneous domains;
- The possibility to create an orchestration logic that is split across multiple domain orchestrators, coordinated by a single overarching component, which enables future services based on the concept of *federated* (and not only *hierarchical*) domains;
- The support of NFV on (existing) resource-constrained devices, enabling the overarching orchestrator to dynamically adapt to their capabilities and deploy the service based on the available resources;
- The use of a message bus to interconnect the different components together.

The demo will show how users can define their own service based on a set of building blocks (e.g., VNFs), how the service is dynamically deployed on the network, and how the network will recognize the traffic of *each* user and deliver it to the proper set of network functions; in other words, each user, attached dynamically to the same home gateway, will experience a different service.

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References

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- The Universal Node – An NFV node orchestrator with support to resource-constrained hardware: http://github.com/netgroup-polito/un-orchestrator
- The EU-FP7 UNIFY project http://www.fp7-unify.eu/
- The EIT Digital CC4BA project: http://www.eitdigital.eu/innovation-entrepreneurship/future-networking-solutions/cc4ba/