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Demonstration of the 5GUK Exchange: A Lightweight Platform for Dynamic End-to-End Orchestration of Softwarized 5G Networks

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Abstract *We demonstrate the 5GUK Exchange, a lightweight platform which enables end-to-end network service orchestration allowing users to combine network services offered by multiple 5G network domains, while also abstracting the infrastructure specific information of each domain.*

Overview

Emerging network use cases and verticals in 5G rely on network and compute resources, posing diverse and stringent requirements which the legacy network architectures cannot meet. Consequently, there is an increased interest by service providers in introducing Software Defined Networking (SDN), Network Functions Virtualization (NFV) and Management and Orchestration (MANO) technologies to 5G networks. These technologies provide the necessary agility and programmability while also efficiently provisioning and utilizing the infrastructure resources[1,2].

5G networks aim to build a single end-to-end MANO platform over the heterogeneous network segments (core, metro and access) and domains (throughout different operators). A lot of effort has already been put towards the realization of such a platform, both by industry and academia, taking a theoretical as well as a practical approach. Standardization organizations such as ETSI and IETF have created standards and best practices for such NFV-MANO systems. Open Source MANO (OSM)[3], SONATA[4], Open-Baton[5] are a few examples of such NFV MANO systems based on the ETSI-NFV models. However, most efforts have focused on the orchestration of the local network domain, while the inter-domain case has not been fully explored.

5G use cases can span across different domains, such as remote surgery and content provider networks over multiple domains. The goal of 5G for end-to-end management and orchestration covers also the inter-domain case. As such, it becomes clear that the inter-domain orchestration is also critical.

The advancement of different 5G technologies may lead to various 5G infrastructure flavors.

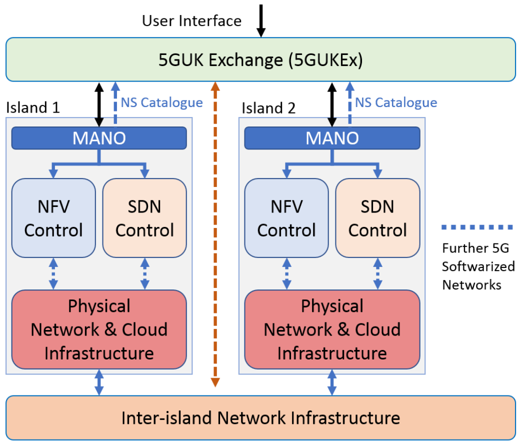

Fig. 1: 5GUK Exchange Architecture

Therefore, an inter-domain orchestrator would be able to bring together such 5G resources and create a diverse feature rich environment for innovative 5G applications. However, while building an inter-domain orchestrator, infrastructure confidentiality is a considerable aspect, since the operators and network providers sharing their individual 5G infrastructure would like to hide underlying infrastructure information critical to their business e.g., network configurations and specificities. Therefore, each domain shall be individually orchestrated. Furthermore, the inter-domain orchestration shall not be operationally heavy, allowing to federate numerous 5G networks.

In this demonstration, we showcase the 5GUK Exchange (5GUKEx) platform and its capabilities to enable lightweight, dynamic inter-domain network service orchestration, allowing to combine different 5G flavors across multiple network domains while also hiding any business-related information.

Innovation

We have developed a MANO hierarchy consisting of a thin inter-domain orchestration layer, which we call 5GUK Exchange, on top of the underlying local ETSI NFV-MANO system which orchestrate the resources of their individual local domains, as shown in Fig. 1. The 5GUKEx performs dynamic service orchestration (service brokering) by delegating the resource orchestration to the local domains, aiming to implement the minimum functionalities needed for the end-to-end orchestration. The platform serves as a thin central management entry point that coordinates the orchestration of the individual domains, i.e., reserves the necessary local resources across the domains and keeps track of the service provisioning and termination. It also performs on-demand service interconnection to provide the cross-domain end-to-end service.

The 5GUKEx leverages standardized models[6] to build a common cross-domain API that facilitates seamless introduction of any ETSI MANO standard compliant platforms to the 5GUKEx. The cross-domain API of the 5GUKEx is non intrusive for the local domains, abstracting any confidential domain information needed to enable the end-to-end orchestration. The local orchestrators that register to the 5GUKEx expose their network service catalogues, hiding any critical information of their infrastructures. This way, infrastructure providers can easily collaborate towards creating cross-domain feature-rich services.

Fig. 1 illustrates the high-level architecture for the 5GUKEx. We refer to the local autonomously-orchestrated domains as islands. The 5GUKex stores the network service catalogues that are exposed by the islands and offers them for selection through a portal to the users accessing the 5GUKEx. A user can either select an available NS Descriptors (NSDs) on a single island or combine NSDs from different islands to create an inter-island Network Service (iNS) template. The user then requests the instantiation of either the NS or the iNS and in turn the 5GUKEx will coordinate with the local island orchestrators to serve the user request and dynamically interconnects the service traffic when needed using an SDN controller integrated within the 5GUKEx. We consider that there is an inter-island network infrastructure that the 5GUKEx controls to dynamically provision the inter-island network connectivity.

Demonstration

The demonstration focuses on creating, deploying and terminating an iNS. A user composes multiple network services, offered by island or-

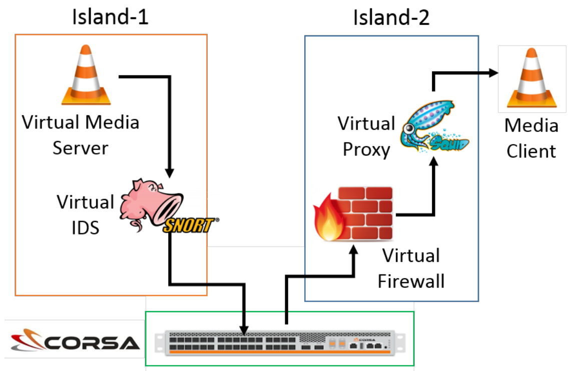

Fig. 2: 5GUKex: Use Case Scenario

chestrators and then the 5GUKEx coordinates with the local orchestrators for the life-cycle management of the iNS.

We consider a 4K media streaming use-case for our demonstration as shown in Fig. 2. For this use-case, we are chaining 4 VNFs running across two separate domains. In the given use-case, Island 1 provides a virtualized NS consisting of a 4K media server and a virtualized Intrusion Detection System (vIDS) using Snort[7]. Similarly, Island 2 provides another NS consisting of a Virtual Firewall and a Virtual Proxy using Squid[8]. The users on the 5GUKEx can select the two separate network services published on the 5GUKEx by Islands 1 and 2 and match them together to create an inter-island network service template and then request its deployment. The 5GUKEx identifies the islands of the relevant NSDs which are part of the iNS. Subsequently, it checks if there are enough resources available for deploying the NSDs with the corresponding island orchestrators. If each island has resources available to deploy the relevant NSD, it notifies the 5GUKEx and proceeds with the service deployment. Once the services have been deployed on the local islands, the island orchestrators send to the 5GUKEx information about the network endpoints of each island infrastructure that will be used by the service traffic, and also the network information which identifies the service traffic. Then the 5GUKEx uses this information to provision the end-to-end inter-island service connectivity via the integrated SDN controller which configures the underlying inter-island network infrastructure. As a result, the 5GUKEx enables end-to-end service provisioning across the two domains. Our setup considers two domains but our solution is generic enough to enable using multiple ones.

Our demonstration setup is shown in Fig. 3. Two islands (Island 1 and Island 2) are registered

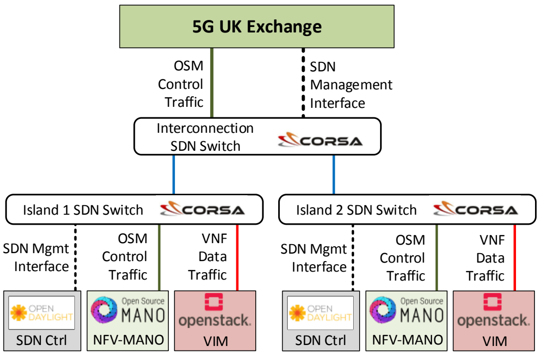

Fig. 3: 5GUKex: Demo Setup

with the 5GUKEx. Each island runs OSM as the local NFV MANO system with OpenStack as the underlying Virtual Infrastructure Manager (VIM) and OpenDayLight as the SDN Controller controlling the network within each island. For the data plane of the islands, we are using two virtual SDN switches on top of a single physical SDN Corsa switch. The inter-island data plane, that the OpenDaylight controller of the 5GUKEx controls, is comprised of a Corsa SDN switch. The physical rack hosting the 5GUKEx, the individual island servers and the SDN switches are shown in Fig. 4.

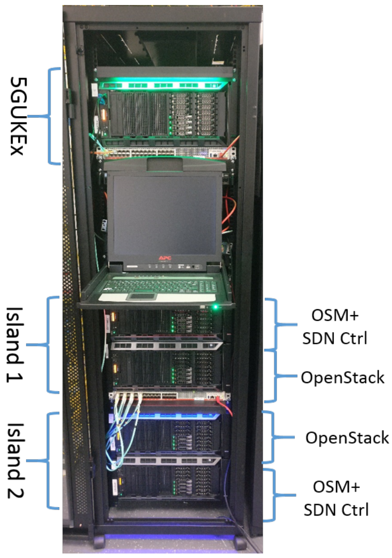

Fig. 4: 5GUKEx Demo Rack

ECOC Relevance

This demonstration addresses topics within the SC7 and SC8 committees. The demo audience will be able to gain knowledge on the functionalities of NFV orchestration systems in both the local and inter domains. They can gain insights on how such a platform can bring together varied 5G softwarized networks and how it can open up new opportunities through collaboration among infrastructure and service providers and other relevant stakeholders. The demo leverages and extends state-of-the-art open source NFV MANO platforms and is aligned with ETSI NFV standardization activities aiming to attract broader audiences.

Demo Requirements

Our demo will require a 24-inch screen (or preferably a larger one) with HDMI interfaces so we can plug our laptop and present the components of our setup. Furthermore, an Internet connection (preferably wired) would be required to connect to our demo setup in the University of Bristol lab.

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