Multi–domain Service Orchestration with X-MANO

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***Abstract*—In this demo we introduce X–MANO, a cross–domain network service orchestration framework consisting in an inter–domain confidentially–presenting federation interface and in an information model for multi–domain network service life–cycle programmability. X–MANO is effectively deployment–agnostic and can be used in hierarchical, peer–to–peer and cascading (or recursive) configuration. During this demo we will illustrate how to deploy a video transcoding application. The network service is composed by one streaming VNF and one transcoding VNF deployed over two different domains. Finally, we release all the code under a permissive APACHE 2.0 license making it available to researchers and practitioners.**

***Index Terms*—Network Management, Network Function Virtualisation, Multi-domain orchestration, Proof–of–concept.**

I. Introduction

Multi–domain network service orchestration requires to compose resources (both physical and virtual) across different Infrastructure Providers (InPs). However, in order to preserve confidentiality, the different InPs must be allowed to orchestrate their part of the network service according to their own internal administrative policies without having to disclose confidential information, such as traffic matrices and internal topology, to the other InPs involved in the service [1], [2], [3]. As a result, existing NFV Management and Orchestration (MANO) frameworks [4], [5] that assume global network knowledge are not applicable to the multi–domain network service orchestration scenario.

In this demo we introduce X–MANO, the first open–source multi–domain NFV network service orchestrator. X–MANO allows to deploy network services across different administrative as well as technological domains. X–MANO consists of a confidentially–preserving interface for inter–domain federation and a set of primitives enabling cross–domain network service life–cycle programmability. Said primitives tackle all the aspects of *cross–domain* network service provisioning including on–boarding, scaling, and termination.

During this demo we will illustrate how X–MANO can be used to deploy a video transcoding service in a multi–domain environment. Finally, we release the X–MANO implementation under a permissive APACHE 2.0 license making it available to researchers and practitioners[1].

[1]On line resources available at: https://github.com/5g-empower/x-mano

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II. The X–MANO Platform

Fig. 1 sketches the demo architecture. First of all, it should be clear that there is a X–MANO *core* element and a set of NFV domains associated (federated) through it. The X–MANO core main components are the Federation Manager (FM) and one or more Federation Agents (FAs). Each FA is associated to a domain and inside it interacts with the so-called Domain Orchestrator/Manager (DOM), a set of applications and modules which are in charge of the control over the whole domain, in terms of VNFs' life–cycle management and monitoring. The main task for the X–MANO is to allow users to define and instantiate network services according to the federated domains resource availability and to drive and control the life–cycle of all the instantiated network services.

In addition to this, the FM is also in charge of exposing the resources and the network services available in the federated domains. Resource availability is advertised by each FA to the FM using a VNF Manifest, i.e. a file providing the description, the identifiers, the exposed "actions" (a set of scripts that can be invoked on the VNF by the X–MANO) and the monitoring capabilities of each VNF available in each federated domain. Users compose their multi–domain network services exploiting the resources advertised in the VNF Manifests. The FM is then in charge of splitting the multi–domain network service into many single–domain network services and to push them toward the DOMs trough the appropriate FA. Notice how, in this way, each domain is aware only of a portion of the entire network service. The FA is in charge of retrieving all the information related to VNFs and network services available within one domain and of exposing them to the FM. It is also responsible for translating the requests coming from a FM into DOM–compliant requests and returning to the FM the responses generated by the DOMs. The DOM is the entity in charge of all management activities in a given domain. Even if the X–MANO design has been inspired by the ETSI MANO architecture, no constraints are imposed on the DOM except that it must support basic VNF and network service life–cycle management operations (creation, chaining, and deletion). The DOM must also support monitoring capabilities over the instantiated VNFs.

III. Demo

The goal of this demo is to provide evidence on the operations of our X–MANO implementation. The aim is to show that the X–MANO is able to deploy network services

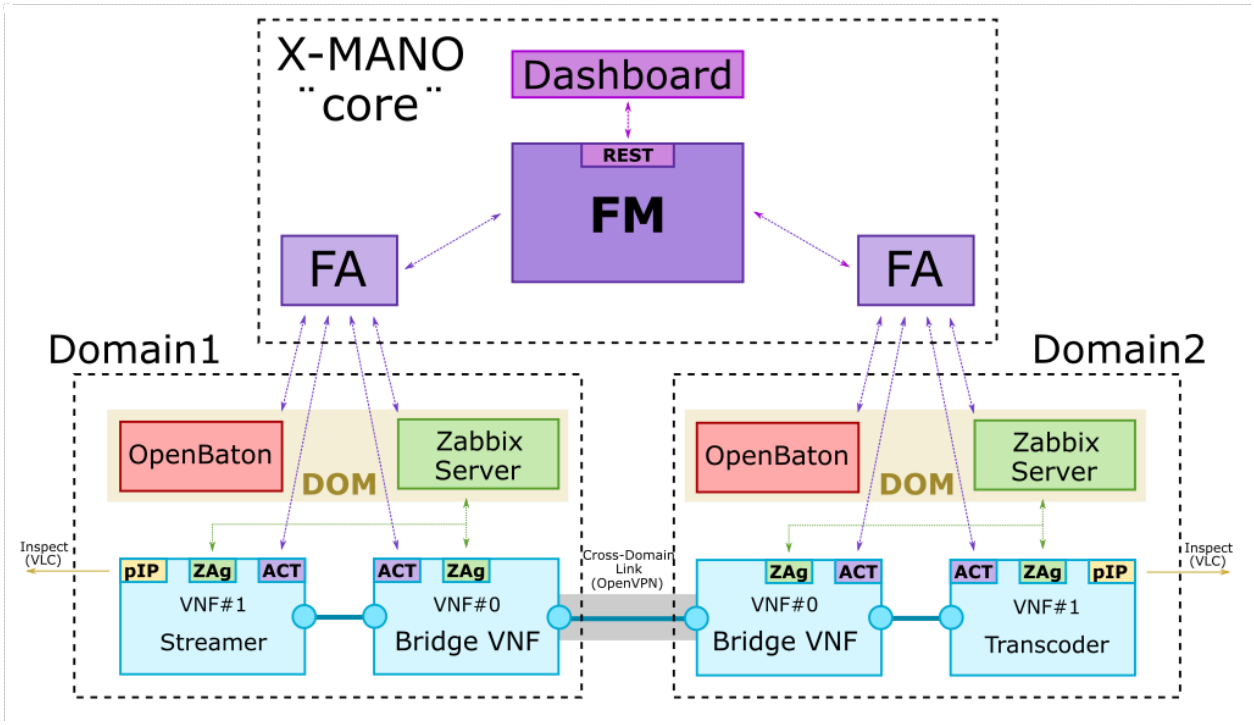

Fig. 1. The X–MANO architecture. A Federation Manager (FM) is interfaced with one or more Federation Agents (FA). The user interacts with the FM trough a web dashboard. Each domain is locally managed by its local Domain Orchestrator/Manager (DOM). A cross-domain link is created between the two domains using OpenVPN. Zabbix is used to monitor each domain. Each instantiated VNF can be accessed by the FA to trigger actions (i.e., local scripts).

with a negligible overhead and without imposing limitations on the underlying domains.

The network service used in this demo implements a video streaming/transcoding application and is composed by one streaming VNF and one or two transcoding VNFs running on different domains. Both the streaming and the transcoding VNFs have been implemented using the VideoLAN application [6]. The deployment consists of three stages. During the first stage the resources on the two domains are allocated. In the second stage the information related to the multi–domain VNFs chaining are collected by the FM. Finally, during the third stages the video streamer and video transcoder VNFs are started. The FM enters in the first stage automatically when the network service is launched, while before entering the other stages additional conditions must be verified.

The environment that has been setup for the demo is composed of two domains, namely each of them consisting in an OpenStack deployment. Each domain uses OpenBaton as DOM. The two domains are connected via an OpenVPN tunnel. A Bridge VNF is instantiated at both ends of the OepnVPN tunnel in order to enable cross–domain VNF chaining. As for any VNF in the system, each Bridge VNF exposes a set of actions that can be remotely invoked in order to have the VNF properly configured by the X–MANO. The Bridge VNF are manually instantiated by the domain local administrator and exposed to the FM by the FAs.

In terms of monitoring support, Zabbix is used for managing and collecting measurements the two domains. The Zabbix Server (which is part of the local DOM) is collecting the measurements and forwarding them to the FA, which can store and aggregate the information, sending updates to the FM according to the network service configuration. Measurements collected are finally shown in the GUI.

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