FENDE: Marketplace and Federated Ecosystem for the Distribution and Execution of VNFs

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ABSTRACT

In this demo, we present FENDE: Marketplace and Federated Ecosystem for the Distribution and Execution of Virtualized Network Functions (VNFs) and for the creation of Service Function Chains (SFCs). The FENDE ecosystem enables the distribution of both network functions and services in a manner that is akin to marketplaces found in mobile platforms (*e.g.,* Google Play and Apple Store), leveraging a federated infrastructure and testbed that spans three research institutions that are part of the Brazilian Research Backbone.

1 INTRODUCTION

Network Functions Virtualization (NFV) promotes the design, deployment, management, and integration of Virtualized Network Functions (VNF)s through an architectural framework proposed by the European Telecommunications Standards Institute (ETSI) [1]. Given its capability of VNF lifecycle management and integration, the NFV paradigm has started to be adopted by both industry and academia, becoming an enabler for flexible network service provisioning. In addition, NFV eases the provision of services through the composition of functions into Service Function Chains (SFC)s [5]. Given the indisputable advantages of NFV, solutions for different elements of its architecture have emerged, specially to design and deploy innovative VNFs [2, 3].

As the number of VNFs designed started to grow, solutions have been proposed to offer these functions to customers through NFV marketplaces [4, 7]. However, such solutions provide VNFs' source code for download but do not offer management tools or the NFV Infrastructure (NFVI) to execute VNFs. When VNF management tools are provided, providers tend to require users to pay for them or register their infrastructures to be able to use their VNFs. Shieldbox [6] provides a framework for middlebox instantiation focused in security deployment over untrusted commodity servers, using Docker Hub[1] as a catalog of code repositories to build images and stores manually pushed images for local deployment. Despite the VNF management tools provided by Shieldbox, it does not support the required mechanisms to enable offering and execution of VNFs in both public and private infrastructures. Moreover, there is no well-defined roles to define a marketplace, such as developers offering network functions and customers interested in acquiring such functions.

In this paper, FENDE is presented: a Marketplace and Federated Ecosystem for the Distribution and Execution of VNFs. The FENDE ecosystem allows the distribution of both network functions and services, also encompassing a platform for executing VNFs in federated infrastructures. FENDE provides a platform for developers, network operators, and network researchers to create, offer, and distribute VNFs by using an ecosystem similar to mobile distribution applications platforms. Moreover, FENDE allows not only the management of the virtualized environment (including VNF and SFC lifecycle management), but also assists the creation of network functions and the composition of services to supply specific demands.

2 SYSTEM DESIGN

The prototype was designed to reflect a real VNF marketplace scenario. FENDE architecture is based on basic elements of the NFV architectural framework defined by ETSI. The prototype's architecture is illustrated in Figure 1, divided
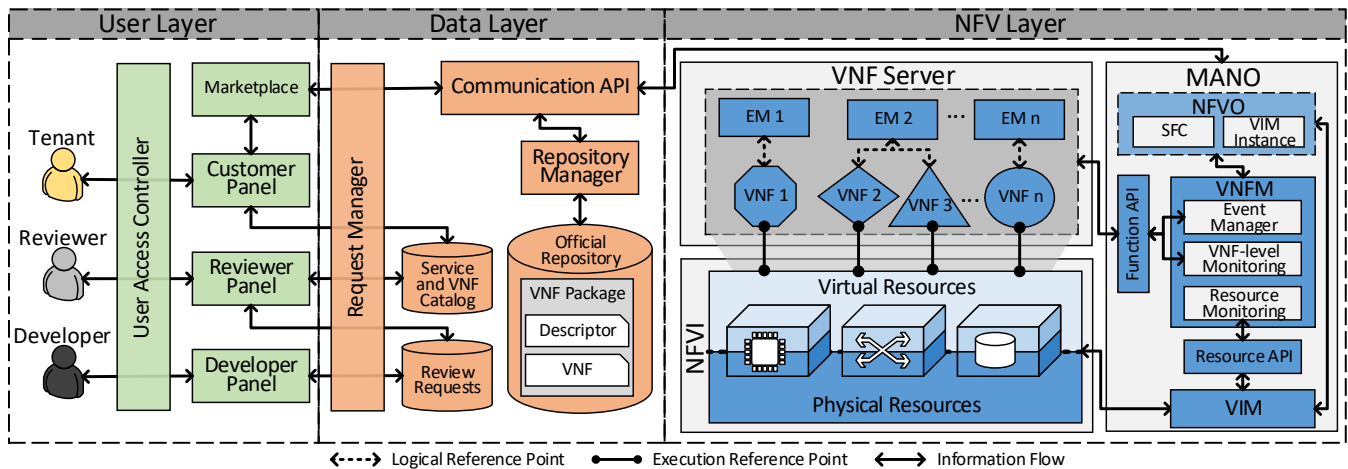
[1]https://hub.docker.com/

Figure 1: FENDE architecture

into three different layers, each layer with specific modules for different operational levels, as described in the following.

2.1 User Layer

Contains elements responsible for the interaction between different actors with the platform. Three different actors were considered: *(i)* Developers, who may request the insertion of their VNFs in the marketplace; *(ii)* Reviewers, responsible for accepting or rejecting developers' requests; and *(iii)* Customers, who may acquire and deploy VNFs available in the marketplace. For management and interaction with different users, a Web interface was designed.

2.2 Data Layer

Once VNFs are reviewed, a series of events must occur in the platform so that other modules can use the information synchronously. To do so, three modules were designed in the Data layer to integrate the User layer with NFV layer:

- **Request Manager**: Controls the repository of submissions in the Review Requests database and performs the migration to the catalog when the repository is accepted. Developers must submit a Git repository with the VNF source code to be evaluated by reviewers;
- **Communication API**: Provides communication between User and NFV layers. Its main functions are: *(i)* to request the creation or update of VNFs' repositories and *(ii)* to request VNFs' descriptors for instantiation. All modules should forward requests to the Repository Manager through the Communication API;
- **Repository Manager**: Creates and manages VNFs' descriptors available in the Catalog. For example, when a repository is accepted, the Repository Manager clones and maintains a local version of that Git repository.

2.3 NFV Layer

This layer brings together the main NFV elements proposed by ETSI, divided into three sublayers: *(i)* NFV Management and Orchestration (MANO), with components responsible for VNF and service management; *(ii)* VNF Instances, responsible for VNF execution; and *(iii)* NFVI, which provides the resources to execute VNFs. The modules developed for each sublayer are described below.

- **VNF Manager (VNFM)**: Performs VNF and SFC lifecycle management operations at two levels: at the hardware level, virtual machine characteristics are adjusted (*e.g.*, memory and CPU). At the software level, the function can be configured, initialized, updated, and terminated;
- **Virtualized Infrastructure Manager (VIM)**: Controls all resources available in the NFV infrastructure. FENDE currently uses OpenStack as VIM, due to its extensive documentation, performance, and especially its wide adoption by the community;
- **NFV Infrastructure (NFVI)**: Disposes physical and virtual resources available for VNF deployment, as well as virtualization and networking tools.

The FENDE front-end is accessed to perform operations of each different actor, such as developers requesting the insertion of their VNFs in the marketplace, the VNF review process, and all operations regarding VNF lifecycle management by customers, including interactive statistical information about VNFs operation. FENDE offers a marketplace for VNF distribution between developers and customers, together with the execution, management, and monitoring environment for VNFs and SFCs through an intuitive front-end. FENDE is available in the following link: https://gt-fende.inf.ufrgs.br/marketplace/.

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