The 5GinFIRE platform

A testbed for end-to-end 5G experimentation

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***Abstract* — 5G is the next generation networking infrastructure with a strong focus on requirements of various vertical domains. 5G brings improvements on networking performance but also introduces new services for deploying software involving networking aspects in an end-to-end manner from the edge to the cloud. 5GinFIRE is an EU H2020 project that builds and operates an Open 5G NFV based reference ecosystem of experimental facilities. It enables 5G NFV-based architectures for vertical industries' applications and facilitates experimentation.**

Keywords—5G; experimentation; NFV; MANO;

I. Introduction

The 5G system has the ambition of responding to the widest range of services and applications in the history of mobile and wireless communications [1]. Addressing the question of how a platform can host and integrate verticals and concurrently deal with reconciling their competing and opposing requirements, requires operational 5G infrastructures that can host various vertical industries' applications. A key issue is the lifecycle management of the verticals' services by means of Virtualized Network Functions (VNF) deployment and programmability techniques. The technical objective of 5GINFIRE is to build and operate an Open, and Extensible 5G NFV-based reference ecosystem of experimental facilities that lays down the foundations of a standards-based network substrate for instantiating fully softwarised architectures for vertical industries purposes.

II. Architecture and Implementation

A. Use cases and requirements

5GINFIRE (https://5ginfire.eu/) derives its requirements from a set of simple use cases that are positioned in the areas of the automotive vertical sector and smart cities. The use cases are used as source of requirements for building the infrastructure and to showcase its capabilities. In the automotive case the requirements are extracted from scenarios such as sensing-based and video-camera-based assisted driving, which use a multitude of information sources (intra-vehicle, as well as inter-vehicle and vehicle-to-infrastructure) to enable assisted driving. In the smart cities case the requirements are derived from the scenarios to facilitate the use and exploitation of available open data provided by existing sensor deployments in cities, as well as interfacing with the capabilities of the existing deployments of sensor functionality in the testbeds of the project partners in Bristol (U.K.), Aveiro (Portugal) in Europe and São Paulo and Uberlândia in Brazil.

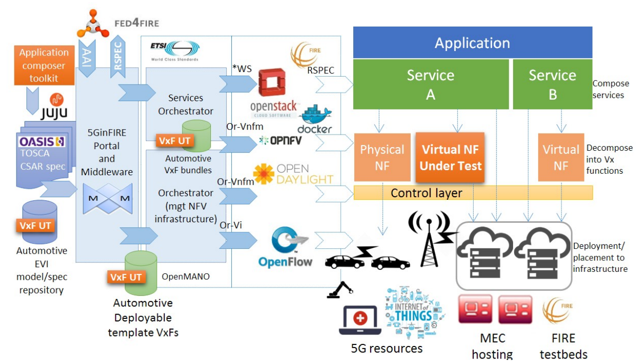

Fig. 1. 5GINFIRE Conceptual Architecture for Experimentation (Workflow, Technologies and Infrastructures)

B. Arhitecture

Fig. 1 illustrates the 5GINFIRE conceptual architecture derived from the ETSI NFV reference architecture [2] and upstream open source projects. It depicts the major architectural areas and shows in a workflow manner the various interactions. Although not exhaustive, the conceptual architecture highlights the functionality that is required to integrate existing open source components and physical infrastructures or being developed by the project. It provides an indication on how the required architectural and technological convergence with mainstream industrial and open source activities could be achieved. In Fig. 1 an application is composed of services that are configured to offer this application. These services are further decomposed into virtual networking and vertical functions (VxFs) that are deployed at the corresponding points of presence in the infrastructure. A use case from the automotive vertical is used to validate the platform. Following similar practices more types of virtual experimentation environments may be instantiated. The 5GINFIRE middleware communicates with the endpoints of the orchestration services that are responsible for orchestrating the managers for instantiating the experimentation scenarios. At this layer we use the Open Source MANO [3] implementation that is based on the corresponding ETSI specification. At the next stage we adhere to other ETSI NFV specifications and adopt state-of-the-art mature and open source tools such as Openstack, Docker, OpenDaylight OPNFV, etc.) Finally, through the implementation of the 5GINFIRE architecture, the project provides a platform that allows experimenters to easily deploy their VxFs under test. To achieve this, the user needs to submit to the repository the VxF specification, its metadata and deployment template so that the platform can deploy it on top of the infrastructure and configure it to be used by existing services.

The following is a list of innovative actions that 5GINFIRE brings to the experimentation world combined with 5G infrastructures, SDN, NFV and Cloud technologies:

- 5G experimentation management platform on top of 5G experimentation infrastructure, validated through an automotive vertical case study
- Standards-based 5G experiment provisioning, scheduling, experimenter management etc.
- Open repository for sharing VxF artefacts while facilitating developers of VxFs to easily maintain them
- Standards-based experimentation description (CSAR)
- Tools that transform the CSAR specification to Service Composition and Orchestration services
- AAI integration with Keystone authentication
- Define the experimentation VxF under test in terms of the vertical model and the VxF Deployment Bundle
- Align 5G resources, MECs and testbed gateways with Openstack or Docker APIs for deployment of VxFs; Opendaylight and Openflow APIs for network service topology, control and configuration

C. *Workflow and implementation*

Fig. 2 provides an overview of the process workflow. The workflow has been described from the three main stakeholder roles: the experimenter, the 5GINFIRE operations and the 5GINFIRE testbed providers that interact during an experimentation life-cycle. At the simplest case, users signed-up to the platform via the portal (see Fig.3) are approved by

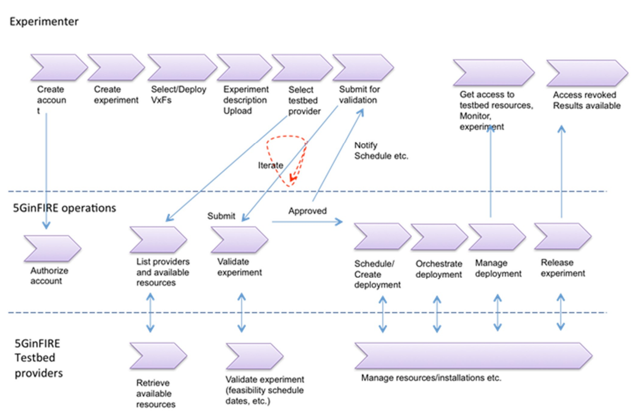

Fig. 2. 5GINFIRE experimentation workflow overview

5GINFIRE operations. To perform an experiment the user needs to create an experiment description by providing experiment metadata, scheduling, purpose etc. and selecting available VNFs or deploying new ones. Then, the user needs to compose the experimentation solution in terms of an OSM Network Service Descriptor. In the first version of the implementation, the user will provide an OSM-supported YAML description of the network service, potentially aided by a graphical composer. As soon as everything is in place for an experiment description, the experimenter selects the testbed facility based on resource availability after the experiment is submitted for validation.

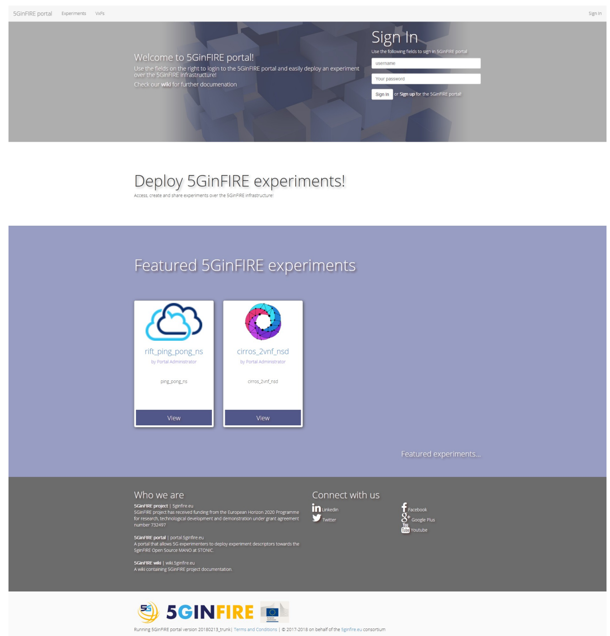

Fig. 3 5GINFIRE portal at https://portal.5ginfire.eu

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Available source code for our works can be found at project open source repository at github [4]. The 5GinFIRE project is funded by the European Horizon 2020 Programme for research, technological development and demonstration, grant agreement number 732497

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