SOFTFIRE

Software Defined Networks and Network Function Virtualization Testbed within FIRE+

Grant Agreement Nº 687860

D3.2.

Handbook: Guidelines and Rules for On-Demand Access to the SoftFIRE Testbed

Version:	3.1
Due Date:	April 30th 2016
Delivery Date:	June 16th 2017 (Revised after Review)
Type:	Report (R)
Dissemination Level:	PU – Public
Lead partner:	Deutsche Telekom
Authors:	All Partners (See List of Contributors below)
Internal reviewers:	PMC

Disclaimer

SoftFIRE has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 687860.

Version Control:

Version	Date	Author	Author's Organization	Changes
1.0	15/06/2016	Peter Feil	Deutsche Telekom	
2.0	27/06/2016	Roberto Minerva	Telecom Italia	Comments from Project meeting.
2.1	04/07/2016	Roberto Minerva	Telecom Italia	Consolidation of on-demand part
2.1	08/07/2016	Susanne Kuehrer	EIT Digital	Approval at PMC, final editing and Submission to the Commission
3.0	30/05/2017	Roberto Minerva	EIT Digital	Extension to chapter related to the offering of functions and support to "on-demand" experimenters according to review's requests
3.0	14/06/2017	Serdar Vural	UoS	Checks and improvements
3.01	15/06/2017	Roberto Minerva	EIT Digital	Duplications elimination on the first document chapter. Introduction hints on how "on-demand" experimenters can exploit the platform functions.
3.02	15/06/2017	Peter Feil	Deutsche Telekom	Additional review and editorial changes, corrections in spelling and formatting.
3.03	15/06/2017	Roberto Minerva	EIT Digital	Further reduction of the text eliminating duplications with other deliverables, focus on the basic information.
3.1	16/06/2017	Peter Feil	Deutsche Telekom	Final Editing, approval in PMC, submission to EC

Contributors:

Contributor	Partner
Massimiliano Calavaro	Ericsson
Giuseppe Carella	TUB
Daniele Carmignani	Reply
Marius Corici	FOKUS
Peter Feil	Deutsche Telekom
Gerry Foster	University of Surrey
Antonio Fusco	Ericsson
Susanne Kuehrer	EIT Digital
Roberto Minerva	Telecom Italia
Simone Monticelli	Reply
Sergio Nuccio	Telecom Italia
Daniel Nehls	TUB
Marco Persichini	Ericsson
Björn Riemer	FOKUS
Umberto Stravato	Ericsson
Lorenzo Tomasini	TUB
Mario Ullio	Telecom Italia
Serdar Vural	University of Surrey

Keywords: NFV, SDN, 5G

Executive Summary:

SoftFIRE is an experimental federated testbed aiming at nurturing an ecosystem of organizations willing to extend, consolidate and possibly industrialize solutions in the realm of NFV/SDN solutions with a specific reference to their adoption in 5G architectures.

In order to take advantage of SoftFIRE, two kinds of organizations could use the platform:

- Those selected by means of the Open Calls mechanisms
- Those interested in using the SoftFIRE infrastructure independently from the Open Calls and on the basis of precise purposes of the organization.

From a programming perspective, the two kinds of requests will not differ too much and they will go through substantially the same guidelines and mechanisms. What will be different are the timeframe of the experimentation and a different level of project support.

While Open Calls are devoted to many different organizations accessing to the platform in a specific timeframe, “on-demand” access to the platform resources will allow requesting organization to access the platform in different timeframes and also to request a different involvement of the SoftFIRE partners according to negotiation and availability of committed resources. This will have also a business facet that will be governed and determined by a commercial agreement and contract.

This document presents a short description of the SoftFIRE testbed platform and the lifecycle for experimenters and it provides hints on the level of support that SoftFIRE will generally allocate to organizations participating to the open calls. It also describes limitations and constraints for the general use of the platform.

Similar arrangements can be made as the basis for on-demand experimentation. If the requesting organization has more stringent requirements, a negotiation with the SoftFIRE project and its partners is needed in order to determine if the project and/or individual partners can support the request. A simple process for this is described in the final chapter of this document. Such possibilities are described along the document, differentiating the normal use of the platform from the “on-demand” one.

Table of Contents

List of Figures

List of Tables

1 Introduction

SoftFIRE is building a federated experimental platform aimed at the construction and experimentation of services and functionalities built on top of NFV and SDN technologies. The platform is a loose federation of already existing testbeds owned and operated by distinct organizations for purposes of research and development.

SoftFIRE intends to offer the opportunity to use the federated environment in order to allow the vaster ecosystem to create services as well as to make functional extensions of the platform.

SoftFIRE has three main claims, to support: interoperability, programming, and security of the federated testbed. Supporting the programmability of the platform is the major goal.

The objective of this document is to facilitate the usage of the testbed to third parties and to monitor and govern the access of resources to them during the programming phase and the execution phase. This document strongly relays on D3.3 (guidelines, rules and mechanisms governing the usage of the SoftFIRE testbed). This means that the architecture, the intended usage of the Federated testbed is left to that document. However, in order to create a self-contained document, D3.2 (this document) replicates some parts of the that document (or a summary of them).

Hence, in this document, some rules and mechanisms that ease the access to functionalities of the federated testbed are presented and exposed to programmers in order to ease the access, the programming and the usage of SoftFIRE.

The approach used by the project is to work with different testbeds in order to figure out a set of common available functionalities to describe and offer externally. They allow a uniform access and governance of the federated testbed. The project also targets at implementing a first minimal set of FIRE requirements to be fulfilled in order to allow the access to the platform. The tools that allow this are FITEagle (FITEagle) and Open Baton (OpenBaton). The programmers and experimenters should devote some time to familiarize with them.

Different component testbeds offer distinctive capabilities. Along the project development period they will progressively be made available to programmers, in such a way that the platform will be enriched and made more suitable for complex developments related to NFV/SDN technologies and with a perspective to 5G.

This document also describes the individual testbeds, with the purpose of introducing the underlying infrastructure to the experimenters. In perspective, this could also be used in order to plan the interworking with other platforms.

In section 2.3, the document describes the approach used in order to be compliant with the FIRE framework and provides a description and hints on the life cycle of the experimentations on the federated testbed. This is clearly the most useful part of the document for programmers and coders. Then, in sections 2.4 and 3, the support provided by SoftFIRE to the experimenters and the use of the platform offered by SoftFIRE, along with its limitations and constraints are explained.

This document is intended to be a living document and it will be extended and improved along the course of the project, while the project improves the federated testbed and acquires more knowledge on the experimenters' and programmers' needs.

2 SoftFIRE Federated Testbed

In this chapter, a short presentation about the composed testbeds, the access to the platform and the support to the lifecycle of the experiments is provided. More information will be presented in D3.3.

2.1 The Federation of Testbeds

SoftFIRE comprises of five European testbeds owned by the partners of the project. These testbeds are:

- *RMED Cloud Lab* from Ericsson, located in Rome;
- *FUSECO Playground* from FOKUS Fraunhofer/TUB, located in Berlin;
- *JoLNet* from TIM, spread over several Italian cities;
- *5GIC* from University of Surrey, located in Guildford, Surrey;
- Deutsche Telekom testbed located in Berlin.

Four of these testbeds are already federated and can be used for the first wave of experimentations. The Deutsche Telekom testbed will be integrated in a second stage because it needs special attention in terms of processes and relationships with the owners. Secured links (IPsec) over the Internet interconnect the testbeds' data and control planes.

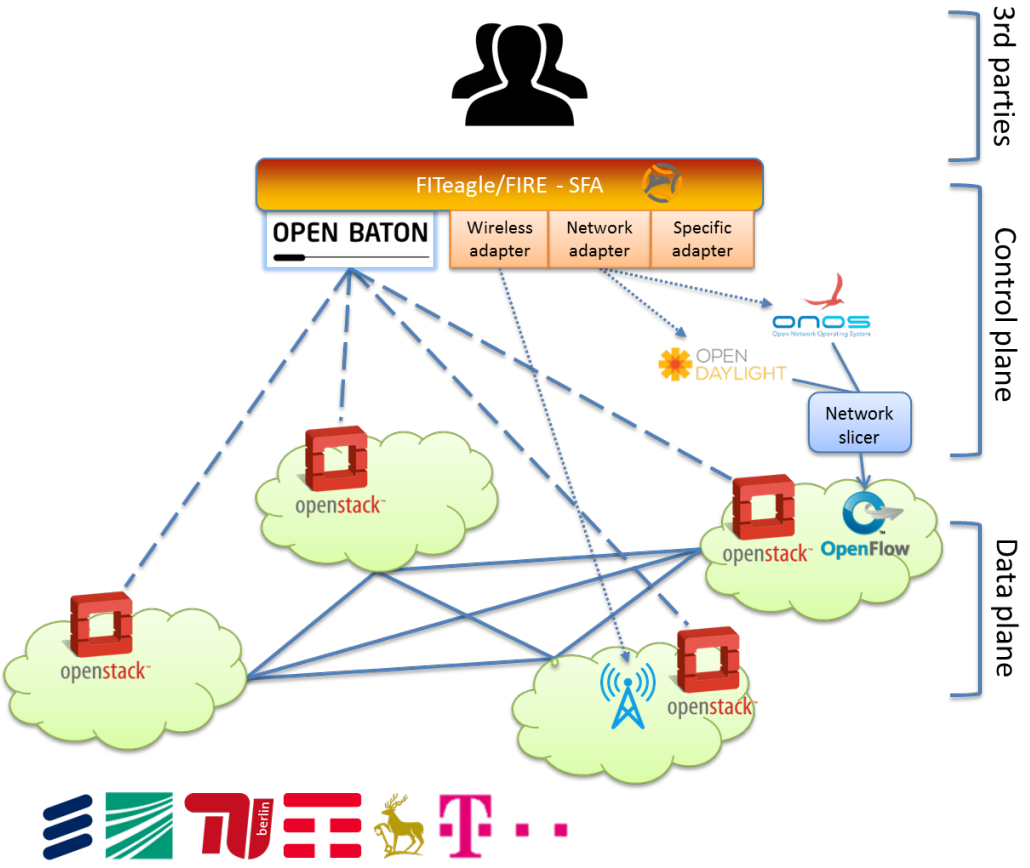

Figure 1: The SoftFIRE structure for programmers

Experimenters access the available resources through a single access-point based on FIRE tools, i.e., the *FITeagle* framework, as shown in **Fehler! Verweisquelle konnte nicht gefunden werden.Fehler! Verweisquelle konnte nicht gefunden werden.**. FITeagle provides functions and interfaces to authenticate users and to discover, reserve, acquire, monitor, and finally to deliver a set of allocated resources of the infrastructure. Once users have been authorized to access the system, they can execute experiments on top of the architecture for a certain amount of time. FITeagle ensures interoperability with other technologies by implementing the standard FIRE Slice Federation Architecture, SFA interface. This configuration of tools has been chosen for two main reasons: to be compatible with the FIRE framework, and to use an existing set of functionalities that allow the project to rapidly focus on the interworking of the platforms. Other framework services could be used but they would request a large development from the project perspective. In order to quickly realise the interworking of the platform, the adoption of this solution has been pursued.

FITeagle is integrated with an orchestrator that manages computing and networking resources offered by the different testbeds. The chosen orchestrator is *OpenBaton* running on the FUSECO testbed. OpenBaton is a Network Function Virtualization Orchestrator (NFVO) that follows the ETSI NFV Management and Orchestration (MANO) specification and allows users to define and launch virtualized instances and to connect them through a set of virtualized networks. In addition, it provides auto scaling and fault management capabilities, based on monitored information collected from the monitoring system available at the NFVI level. The choice of OpenBaton is due to: (i) its alignment with the ETSI NFV MANO standard, (ii) it is an open source solution, and (iii) the developers of OpenBaton are partners of the SoftFIRE project, providing quick support. In a perspective of “on-demand” usage of the federated testbed, the availability of open source software is an enabler for the possibility to functionally extend the orchestrator capabilities and it offers to “on demand” experimenters the possibility to customize it or to tailor its functions to specific needs.

Each testbed uses *OpenStack* (OpenStack) cloud controller that controls the physical Compute, Storage, and Networking resources dedicated to the project. Even if the versions of OpenStack are different, this choice of virtual infrastructure manager offers the possibility to have a sufficiently homogeneous infrastructure, while also making it possible to exert and check the interworking capabilities between the different testbeds. Furthermore, when an experimenter wishes to integrate their system with the federated testbed, the co-existence of different versions of OpenStack could be considered as an advantage; due to the interworking experience gained by the SoftFIRE project during the setup phase of the platform, the time required for integration could be considerably reduced.

The OpenStack controller is visible and controllable by the centralized OpenBaton orchestrator, which coordinates and governs the instantiation of virtual machines (VMs) and containers over the testbeds. By exploiting the *Regions* and *Availability Zones* defined in OpenStack, experimenters can choose either the testbed or specific locations within the testbeds in which they want to instantiate VMs. This is a particularly important function in case of further integration of the federated testbed with the framework of an “on-demand” experimenter. In fact, the experimenters can decide to execute particularly important Network Functions in their domain (e.g. security and/or confidentiality reasons) and can distribute other more local processing network functions across the other testbeds.

The SoftFIRE architecture can support different scenarios including the interaction of different domains inside one operator’s network or among different operators. In order to make some resources, which are normally not accessible, available to experimenters by means of the ETSI

NFV framework (e.g., OpenFlow physical switches, wireless access points), FITeagle has been extended with specific *adapters* that integrate those resources, which are then exported towards the experimenters.

These mechanisms could be further extended and used by "on-demand" experimenters in the case of a need for particular resources. This offers the possibility to have loosely coupled solutions that enable the orchestration as well as the identification and allocation of heterogeneous resources, and offers them to experimenters.

2.2 The Component Testbeds

For a full description of the currently used testbeds we point the reader to the project deliverable D3.3 (Consortium, D3.3 Guidelines, rules and mechanisms governing the usage of the SoftFIRE Testbed, 2016) and the project website (www.softfire.eu), where updates on changes and new functions are available. In the following section, brief descriptions of the component testbeds are provided in order to present the context of the SoftFIRE Federated Platform. These testbeds are available either on their own, or as a federated framework for external experimentation carried out by "on-demand" customers. If an individual usage is foreseen, the reader can directly address the owner of the requested component testbed.

2.2.1. Ericsson Lab

Ericsson SoftFIRE testbed is part of the Ericsson RMED CloudLab. Located in Rome, the Lab scope is to provide hands on and competence build-up, to show specific and concrete "proof" points related to the cloud benefits, to present customer demos on specific products, and to demonstrate how issues and concerns can be managed, mitigating the risks.

Ericsson testbed in SoftFIRE project provides an OpenStack Liberty-based virtualized framework in order to deliver an Infrastructure as a service (IaaS) solution for creating and managing large groups of virtual private servers in a data center.

2.2.2. The TUB/FOKUS Testbed

The SoftFIRE Testbed node located at Fraunhofer FOKUS in Berlin is realized as a slice of a bigger testbed that is used to benchmark virtual 5G core network functions. This includes a dedicated part (tenant) of an OpenStack cluster to provide computing and storage resources. The connectivity to the distributed parts of the SoftFIRE Testbeds is realized by IPsec secured VPN links. The Fraunhofer FOKUS node is currently the center of the VPN network. It is realized as a pure virtual network that is fed as VLAN into the two Virtualization environments at FOKUS. The VPN encryption is handled by a virtual instance of an OpenBSD based Firewall running on a different VMware based virtualization cluster.

The TUB/FOKUS Testbed is providing a number of services and functionalities used by the entire project in order to support the envisaged framework functions. From an "on-demand" experimenters it may be important to gain familiarity with the provided functions and with the usage of the networking capabilities (such as OpenVPN).

2.2.3. TIMlab

JoLNet (TIM Lab) is a geographical-distributed experimental network based on SDN/NFV paradigms. It exploits OpenFlow capable switches and Common Off-The-Shelf (COTS) servers in order to offer flexibility and programmability, allowing experimenters to test novel network architectures along with the issues deriving from "real" operators' networks. JoLNet consists of seven points of presence (PoPs) located in Universities and Research Centers spread over the Italian country, which are logically connected as a full mesh. Each PoP includes two switches, namely CPE and node; the node connects to all the other nodes of the other PoPs. JoLNet exports an OpenFlow API and an OpenStack API that experimenters can use to program the behaviour of the network and to instantiate virtual machines acting as network services and users for testing purposes. Leveraging a slicing mechanism, JoLNet hosts multiple isolated experiments at a time on top of the same infrastructure.

Due to security concerns and company's policies, researchers and "on-demand" experimenters who would like to use the platform have to contact JoLNet technical support at supporto.jolnet@telecomitalia.it, submitting a request that includes the purposes of the research and technical details of the settlement. Experimenters must connect to Telecom Italia network from one of its venues, or by means of a VPN connection. Each experiment will be given a network slice that consists of one or more VLAN tags and a tenant account of OpenStack with a certain amount of virtual resources (vCPU, RAM, disk space). Experimenters can choose to use their OpenFlow network controller or to ask for one that will be provided by JoLNet itself and will be put on top of the given slice.

2.2.4. University of Surrey (UoS)

The UoS SoftFIRE testbed segment is part of the overall UoS 5GIC testbed. Located in the UK, the scope of the lab is to provide hands-on access to a 3GPP based campus RAN with indoor and outdoor coverage that is able to be inter-connected with a variety of virtualized core slices, in order to develop core network 5G evolutions and demonstrate 5G use cases running over the resultant LTE cellular network. In this manner, the testbed can be used to build industry core competence in 5G.

The network has evolved to provide a set of virtualized network capabilities that can be configured to connect with IP stubs towards the RAN to enable various network slices to be connected in circuit under the control of the federated SoftFIRE core.

It is envisaged that experimenters using the facilities of the UoS SoftFIRE testbed will be able to show specific and concrete "proof" points related to the 5G RAN and core evolutions and demonstrate applications running over this infrastructure. These use case proof points can be used to support many types of use cases to highlight their benefits, explain to customers and industry partners how they work and demonstrate how 5G targets may be met, and what the pros and cons are for each demonstration.

The UoS testbed is a flexible environment where it is possible to combine different RAN hardware configurations and RAN and Core software configurations to support different delivery designs and policies. There is also scope to evolve the testbed in cooperation with a given experimenter and/or customer.

The UoS testbed could be considered, for the time being, choice for carrying out experimentation that need to have access to mobile resources. The "on-demand"

experimenters may leverage these capabilities in order to run specific experiments that are demanding in terms of mobile infrastructure.

2.2.5. Deutsche Telekom

The testbed of the Telekom Innovation Laboratories is called Multi Radio Access Technology (MultiRAT)-testbed. It is planned to be a key testbed for innovation and to be an integral part for selected topics within Deutsche Telekom and its subsidiaries. It is currently declared as an optional testbed part of the overall SoftFIRE project.

The DT node is located at T-Labs in Berlin and offers a network infrastructure basis for several internal and external projects. The current MultiRAT-testbed allows access via 2G, 4G, Wi-Fi, and WiMAX. However, the main scope lies on network connectivity based on Wi-Fi.

Next to the physical opportunities, the MultiRAT-Testbed is currently starting to be interconnected with an OpenStack environment (access level: tenant), offering cloud-based computing and storage.

More information about the Testbed and its access will be timely provided in future Deliverables and on the project Website.

2.2.6. Other Testbeds

The SoftFIRE project is also involved in international activities. There are joint activities with other possible partner to create a wider federation of testbeds. A first step towards this is the integration of the EIT Digital Silicon Valley testbed. It could be the first of a series of similar further collaborations with organizations in the USA, one example could be ON.Lab (ON.Lab).

2.2.7. The individual Offerings of Testbed (services and virtual network functions)

Currently the project and its partner are experimenting some functionalities and related virtual machines. If they will achieve an acceptable level of stability and robustness, the federated testbed will be complemented with a set of well-formed and ready to use network functions. The programmers will be capable of using them in order to create services and applications taking advantage of more programmable building blocks.

The topics addressed are existing network architectures (like IMS and its evolution) and a special attention is given to initial building blocks for 5G. This will allow the programmers to exploit these functionalities and start design applications for the 5G environment.

"On-demand" experimenters could negotiate with the SoftFIRE project to speed up the delivery of scheduled functionalities or the possibility to introduce or integrate their own special functions on the whole infrastructure. This can allow for experimenting specific functions that could be offered as "services" on a virtualized and federated platform or for testing purposes of internal solutions that have to be tested on a larger infrastructure. This opening could also be interesting for SMEs that are interested in proving the feasibility of their solutions on a largely distributed platform.

2.3 The SoftFIRE Usage

In this section, we briefly describe the guidelines for accessing, using and programming the SoftFIRE infrastructure. For a richer description, the reader can refer to (Consortium, D3.3 Guidelines, rules and mechanisms governing the usage of the SoftFIRE Testbed, 2016) and to the SoftFIRE web site for the latest developments.

2.3.1. FIRE Approach to Accessing and Using the Testbeds

The SoftFIRE project is adopting and proposing, for the time being, the usage of existing and widespread FIRE related tools in order to support access and control functionalities of the experimenters and the allocation of the basic resources.

This has essentially the scope of identifying the users accessing the system and segmenting the usage of the platform in order to avoid any interference between different on-going activities.

For an “on-demand” experimenter, identification/authorization and segmentation capabilities should be of the highest interest, because the envisaged usage of SoftFIRE platform in this case is for internal developments of competitive solutions. Any security breach is to be avoided.

The SoftFIRE project is using these tools to guarantee a fair access and usage of the platform to its users. Additional management tools are integrated in the platform (e.g., Zabbix) in order to further support the experimenters.

For a description of the FIRE tools used by the project, the reader is referenced to other documents (e.g., the forthcoming (Consortium, D3.3 Guidelines, rules and mechanisms governing the usage of the SoftFIRE Testbed, 2016)).

2.3.2. The Experimenter’s Life Cycle

The SoftFIRE’s experiment lifecycle is represented in Figure 2: Experiment lifecycle below. The experimenter should register to the platform and “discover” its possible capabilities. In a second step, the platform will map experimenter requirements to the functionalities available to the experimenter. This followed by a resource reservation phase, which is performed in order to optimize the allocation of resources and to schedule their use. This may be important for scarce resources that are used by many experiments. For an “on-demand” experiment, the reservation and allocation of resources could be potentially negotiated; either by permanently allocating resources or by means of a prioritisation mechanism. In the next phase, the system is checked in order to provision the expected resources according to parameters and choices made by the user. In this case, a different range of parameters or choices could also be provided to the “on-demand” experimenters in order to make their experience on the platform richer. Then, the monitoring phase will organize the platform in such a way to be able to monitor the allocated resources. In this phase, monitoring mechanisms are triggered and allocated to the usage context of the experiment. For instance, some of the KPIs defined in (Consortium, D3.1 KPIs for evaluating and assessing the features of the Testbed, 2016) could be instantiated in this phase for runtime usage. Then, the usage phase can start. During this phase, the users can use the allocated resources in order to run their experiments on the SoftFIRE infrastructure. Eventually, the termination phase is executed when the experimenter wants to finish the activities because the experiment has reached its end.

All of these experiment life cycle steps are supported by mechanisms for identity management, authorization, and authentication.

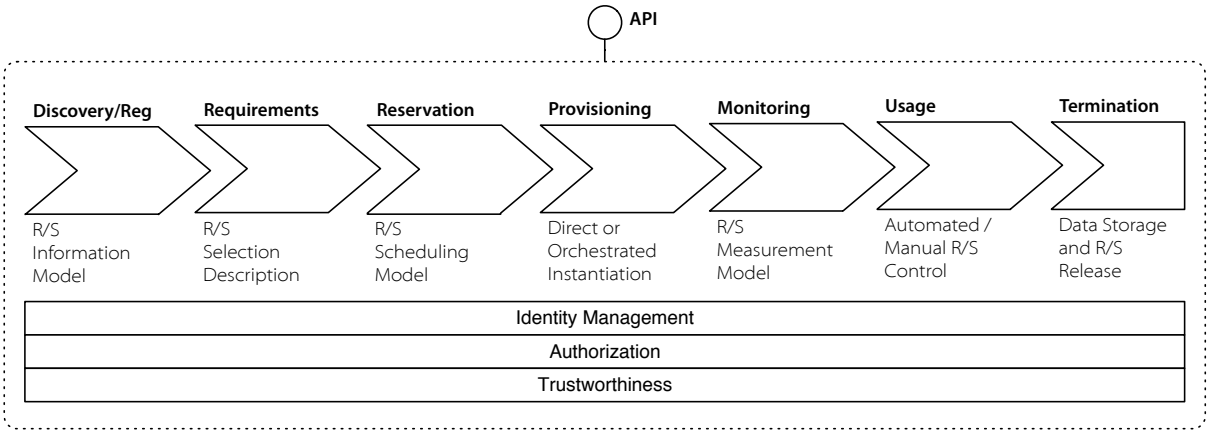

Figure 2: Experiment lifecycle

The design and programming of the platform are described in the project document (Consortium, D3.3 Guidelines, rules and mechanisms governing the usage of the SoftFIRE Testbed, 2016).

2.4 SoftFIRE Support to Experimenters

In this section, a summary of the support offered to the experimenters is provided. It should be noted that support is a feature that should carefully be considered and negotiated between the "on-demand" experimenter and the SoftFIRE project. Special care could be requested and possibly offered for specific activities. However, the SoftFIRE project has obligation towards Open Call experiments and hence mediation between different requirements has to be achieved.

The experimenter can request support about the usage of the federated testbeds by means of a first level support systems (e.g. trouble ticket system), implemented with the REDMINE Tool accessible at the following address https://redmine.softfire.eu/

Before opening a new ticket, it is recommended to verify in REDMINE if similar cases have been recently issued (https://redmine.softfire.eu/projects/softfire/issues). The project is willing to use the REDMINE as a sort of historical repository of issues encountered and solved. It is to be considered as a sort of knowledge base made available to experimenters in order to speed up the process of spot issues and solve them.

2.4.1. Subscription

In order to account the users, the selected experimenter is configured in Redmine tool portal with proper credentials in order to run case submissions. The Redmine portal will provide experimenter with credential via mail notification at the start of the Open Call. The subscription will last till 15 days after the closure of the Open Call. This ensures that the experiments can have a bit of extra time for consolidating its software development and to evaluate the platform.

2.4.2. Case Submission and Follow-up

Once entered in REDMINE, the experimenter can use the REDMINE functionalities in order to submit or check the status of a submitted issue.

In opening the issue, the experimenter is recommended to be the most exhaustive possible in describing the issue so that the support can be more specific. In addition, the experimenter is suggested to check the historical repository in order to see if the same issue, or a similar one, has been already addressed and solved. This will enable the support team to focus on the exact issue at hand.

For “on-demand” experimenters, the issue tracking could be part of a SLA agreed between the experimenter and the SoftFIRE team.

2.4.3. Workflow

The just opened issues will be notified to a reference person for each infrastructure island: They will analyse it and, based on its description, will assign it to the most suitable responsible for follow-up. Keep in mind that the SoftFIRE is not yet an industrial service. It is still an experimental platform and as such some issues could be longer or more difficult to spot and solve. In addition, the personnel allocated to the support is not operative staff. They are researchers, sharing the development within the entire project team. For “on-demand” experimenters, some specific contact could be established and possibly a timelier response could be negotiated.

2.4.4. Service Standards

The platform will be operational during these time frames:

Working hours: Monday to Friday, 10:00 a.m. to 5:00 p.m. CEST/CET

Outside this timeframe: issues/requests will be emailed and managed at best effort

Please check your local time correspondence (http://www.worldtimebuddy.com/)

3 SoftFIRE General Use

SoftFIRE can be used by experimenters that have applied to Open Calls as well as from organizations or entities that want to experiment on the platform outside of the Open Calls. For the use of the testbed, there are general rules that are described in the following sections and they generally apply. For more specific services, experimenters can refer to Section 3.2.

3.1 Constraints on the Experimenters' Use

The SoftFIRE infrastructure is composed of loosely integrated platforms under different administrative domains. In addition, the different platforms are run for experimental purposes, and they cannot be considered yet a mass production tool. This means that bugs and issues in the platform behaviour may occur. In fact, the scope of the experiments is also to help the SoftFIRE project to identify the platform flaws and to support the tune-up and the assessment of the platform as a whole. This is extremely important for the SoftFIRE team, because it will help to consolidate the solution, but it could also be relevant for the experimenters; in fact, certain inconsistencies could emerge because of the adoption of standards-aligned solutions. Identifying such inconsistencies could be a major help to the entire SDN/NFV community.

The platform is still under development and it has a basic set of functionalities that have to be tuned up, and it is missing a number of features that will be progressively added in the future. SoftFIRE is by no means to be considered as a product, and so the usual support for software development may not be available.

Even if SoftFIRE aims at programmers, not all the features to allow for a fast programming approach are provided. This is due to not only the differences in the component testbeds, but also the security controls imposed by different administrative domains. As a result, the programming phases could result in cumbersome and not particularly attractive procedures, however they may improve along the lifetime of the project.

Service level agreements (SLA) do not apply during the experimentation phases. Because this is a period to test and explore SoftFIRE, the experimenters should not run production applications on the infrastructure Platform during the trial.

The SoftFIRE project reserves the right to discontinue at any time any service, if the use is not consistent with the purpose of SDN/NFV and/or violate any aspects of infrastructure security or conflicts with any other ongoing experimentation.

During the running period of the experiments, the SoftFIRE project will put in place a team that will support the experiments in their work on the platform. As mentioned, this is not offered as a professional service and but on best-effort basis. The entire infrastructure should be considered more a sort of α-test platform. Possible down-times could occur without notice or due to any potential overload caused by parallel running experiments by multiple experimenters.

SoftFIRE will offer support by email (with possible follow-up by phone) which can be up to two hours per day during the experimentation phase in order to collect issues and provide responses. The team will try to respond to most queries within 24 hours (typically next morning or afternoon). Some issues could be not solved due to wither the short span of the experimentation period or due to the need to intervene the platform. The support team will work with experimenters to circumvent any potential problems.

The project will also issue limits and constraints on the allocation of available resources. This is due to the need to support and allow parallel experimentations. This limitation depends on the total capabilities of the federated platform as well as the number of experimenters and their requests in terms of resources. One such limitation could be related to the maximum number of VMs to be instantiated, the number of available physical resources, or the maximum memory usable per experimenter, along with any other virtual or physical resource. Other limitations could also apply, or be noticed during the course of the experimentation phase.

Paid support: If you have extensive support needs during the experimentation, you may purchase "paid support" for the SoftFIRE platform. This paid support package offers increasing levels of hands-on support and expedited response time to queries and has to be negotiated with SoftFIRE beforehand.

Some more assistance for the experimenters could be added in due time in the SoftFIRE portal at http://www.softfire.eu

- An "on line" tutorial on how to access and use the platform will be prepared before the experimentation phase
- A presentation with a use case
- Other educational material.

3.2 SoftFIRE on Demand

3.2.1. Introduction

SoftFIRE is to be considered as an experimental platform that cannot support industrial developments for the time being. However, it can have many merits and it could be appealing to organizations that are willing to achieve specific competences, skills or to start the development of specific solutions in an environment that is close to the future industrial platforms for NFV/SDN. For such organizations, it is possible to schedule an on-demand usage of the federated testbed. The partners of SoftFIRE could make their platforms available in order to accommodate some specific needs. The availability of the platform for the period of choice and a set of further requests (e.g., specific levels of support, specific functionalities offered by a single testbed, etc.) should be negotiated case by case with the project as a whole or with a smaller group of partners, if this is of interest to the requesting organizations. It will be necessary for the SoftFIRE team to guarantee that the usage of the testbed by on-demand experiments does not conflict with the scheduled activities of the Open Calls.

The SoftFIRE project reserves the right to discontinue at any time any service if the use is not consistent with the purpose of SDN/NFV and/or violates any aspects of infrastructure security or conflicts any ongoing experimentation.

For the time being, instead of having a standardized offering with detailed prices, the SoftFIRE project prefers to individually discuss the requests in order to understand if there is a possibility to accommodate the requests in such a way to minimize the costs for the requestors and to figure out if there is an experimental interest or advantage from the SoftFIRE point of view that can be exploited for a cost reduction in order to create a "win-win" situation for project partners and requestors.

The SoftFIRE and the project partners are also available to support some testing campaigns if there is an interest by a requesting organization to do so.

Each individual testbed has allocated for SoftFIRE a part of its available resources. As a rule of thumb, the experimenters could provide an initial idea of their required virtualized infrastructure in terms of processing, storage and networking requirements, so that the SoftFIRE project can determine if it can satisfy the experimentation requirements. For on-demand experiment of high technological or business value, it is possible to allocate further resources increasing the poll of those allocated to SoftFIRE. This could allow federating a larger testbed in order to accommodate specific experimenter requests.

In addition, during the SoftFIRE project lifetime, partners will make available not only resources, but also platform services, as well as possibly entire use cases that an experimenter could be willing to try (e.g., virtualized system such as EPC, IMS, and the like).

SoftFIRE is also available to support interworking with other existing similar platforms in order to prove the interoperability and the possibility to use resources and services of SoftFIRE in the context of an experimentation platform.

The on-demand request will be treated by SoftFIRE as a project that is cumulative over the already scheduled activities. So far, no resources or activities have been planned or allocated for “on-demand” requests, which have to be dealt with outside of the current DoA and be regulated as a cooperative project between the involved partners and be paid and agreed with the requestor. Under this perspective, it is possible to extend the support provided to experimenters and to exceed the availability times and normal procedures of the Open Call.

In case the timeframe for the on-demand experiments and the scheduled Open Calls do overlap, it will be the responsibility of SoftFIRE to avoid potential issues and to guarantee the execution of the Open Call experiments in parallel with the on-demand experiments. In case the project deems that this parallelism cannot be supported, priority will be given to the Open Call experiments, and a proposal for a different timeframe will be offered to the on-demand requestor.

The procedures to activate a SoftFIRE on-demand campaign are the following:

- To contact the project partner responsible for on-demand experimentation: Peter Feil peter.feil@telekom.de
- To jointly elaborate a requirements document stating the needs in terms of resources and time frame
- The SoftFIRE project will then elaborate a specific answer to the request proposing a possible configuration that could satisfy the requirements with a possible pricing for the activity or a brief description of why it is not possible to accommodate the request
- The requesting organization and the SoftFIRE partners will negotiate the needed functions, support and related fees as well as the timeframe accordingly to the schedule of the project and the involved parties.
- When an agreement is signed, a specific project supported by extra resources of the partners will be prepared, and then the experimentation can take place.

If the experimenter wishes to use only one specific testbed, it is advised to make the request directly to a representative of the specific testbed in such a way to initiate a confidential negotiation between companies. Here are the references:

TestBed	Contact Point	Email
Deutsche Telekom	Peter Feil	peter.feil@telekom.de
Ericsson	Marco Persichini	marco.persichini@ericsson.com
Fokus/TUB	Bjorn Riemer, Lorenzo Tomasini	bjoern.riemer@fokus.fraunhofer.de lorenzo.tomasini@tu-berlin.de
TIM Lab	Sergio Nuccio	sergio.nuccio@telecomitalia.it
UoS	Gerry Foster Serdar Vural	g.foster@surrey.ac.uk s.vural@surrey.ac.uk

Updated references will be posted in the contact section of the SoftFIRE web site, available at https://www.softfire.eu/contact-support/.

The experimentations will be confidential, so that the organizations using the "on-demand" feature are safeguarded of any leak of information. The SoftFIRE project reserves the right to take measures and evaluate the match between the allocated platform resources and functions to the experimenter desiderata, but by no means information on the experimenters will be made public. If of interest for the experimenter, a set of feedback and comments will be requested by the SoftFIRE project in order to evaluate the feasibility of the experiment and to evaluate the robustness and adequateness of the platform.

The feedback from on-demand experiments will be of great use, and help to assess the maturity of the solutions and their applicability and potential to support business related implementations.

3.2.2. What to use SoftFIRE for

The SoftFIRE federated testbed can be used for several goals, exploiting its resources in different ways. For the time being, there a few major exploitations that are envisaged:

- Usage of SoftFIRE federated virtualization capabilities (orchestration and distribution of functionalities)
- Usage of special resources (e.g., physical resources present in a specific associated Testbed) within the virtualization and orchestration platform
- Usage of a specific testbed

All these modes of usage are strongly dependant on the goal that the requestor wants to achieve. Under this perspective, there are possible goals:

- To develop solutions on top of the federated testbed and get acquainted (and possible conformant) with a distributed platform supporting NFV/SDN technologies,
- To develop solutions for testing the interoperability of resources or solutions within an NFV/SDN environment,
- To develop mechanisms that can enhance the security level of NFV/SDN solution,

- To integrate new resources (e.g. 5G) and to interoperate with the controlling infrastructure envisaged for 5G,
- To prototype possible extensions and solutions to be offered to the NFV/SDN community.

It is up to the requestor to have a clear vision of the intended final goal of the experimentation. In fact, this goal could also be kept confidential and not exposed to the SoftFIRE project.

With the evolution of the federated testbed, new general capabilities and new resources will be added (e.g., a larger availability of SDN capabilities). As a consequence, the possible usage of the SoftFIRE platform could be substantially extended.

In the future, the project expects to make a number of functionalities and services available, which would be conformant to relevant industry standards. This means that one intended usage could be the conformance testing of some new functionalities with existing specifications (and related implementations).

There are different possible allocation modes of the federated Testbed:

- *Resources Mode:* The requestor may want to get access to the infrastructure and hire its resources for a certain period of time. In this case, the requestor must have a specific usage reason of the platform and can request specific resources (e.g. virtual machines).
- *Project Mode:* In this case, the requestor may want to run a specific trial and, apart from the resources of the platform, may need to have support from the SoftFIRE team in order to design, implement, and execute an experiment.
- *Training Mode:* In this case, the requestor may want to run an experiment privately (e.g., in the resource mode), but at an initial stage, a period of training may be needed in order to kickstart the activities and get an adequate knowledge of the environment.
- *Cooperative Mode:* In this case, the requestor could propose an experiment of interest for the SoftFIRE project. There may be some interest on the project side to offer a major discount or to work cooperatively with the requestor in order to improve the SoftFIRE platform or extend it.

In the first case, the request to SoftFIRE could be very similar to what is currently requested to Cloud service providers. In the other two modes, an involvement of the SoftFIRE team is needed in order to provide some sort of consultancy to the requestor.

3.2.3. Making a Blueprint of the Experiment

In order to allocate the needed resources and to prepare the platform, it is recommended that the requestor prepares a high-level specification of the resources needed and the “mode” of interaction with the project.

A *Resource Mode* request will be treated as a commercial transaction between the SoftFIRE team and the requestor. The price of the experiment will vary depending on the duration of the experiment and the resources allocated. Considering that the SoftFIRE platform is still in an experimental phase, its usage will be offered on a best-effort basis, i.e., the resources will be made available to the requestor as they are currently available on the experimental platform.

If the requestor needs to have some guarantees for running an experiment, a basic Service Level Agreement could be defined between the parties, and the project will involve people and allocate the needed resources to satisfy these requirements.

A *Project Mode* request needs to be treated differently because the SoftFIRE project has to offer consultancy services related to training and development. The SoftFIRE team will work with the requestor team to verify how to make the project feasible and what platform and people resources (of the platform and of the SoftFIRE team) are needed for the experimentation.

In this case, the requestor may produce a high-level description of the application to be implemented on the SoftFIRE infrastructure and a general architecture of the software to be deployed. This is the basis for designing a viable solution (the SoftFIRE team will not design the application; it will help to design how it can be implemented and executed on the platform). In an initial phase, the requirements of the application on the platform will be determined and agreed upon, then the duration of the experiment and the needed training phase will be decided, and a possible SLA will be signed (if needed). The price of the experiment will be determined accordingly.

The *Training Mode* is an offer that can be realised in one of the two previous modes, according to the needs and the agreement reached with the Requestor. In the Resource Mode, it is up to the requestor to choose between the needed training in terms of people and the depth of the training. The SoftFIRE project should propose at least a couple of "courses" about the platform: a basic one and an advanced one. For the time being, the SoftFIRE project is planning to offer some training during events (e.g., Hackathons) or before the start of a wave of Open Calls. A training offering should be prepared.

The *Cooperative Mode* could be ignited by discussions within the SoftFIRE ecosystem or come from external companies (also not necessarily European ones interested in cooperating on the development and consolidation of tools and components for the effective enablement of NFV/SDN solutions). In this case, a "Proponent" could make a proposal for joint activities to the SoftFIRE consortium or vice versa, i.e. the SoftFIRE project could request to an organization to jointly work on some technical topics. The envisage mode of working in this case is essentially the Project Mode. However, depending on the interest of the SoftFIRE, the fee associated to the usage of the platform can be discounted or waved in favour of a more pair-based cooperation on development of new solutions. In this case joint commercial activities could be identified and they should be part of a more complex planning.

3.2.4. The needed Skills

The development on a (federated) distributed platform requires skills related to distributed programming and networking as well as specific knowledge of the platform. SoftFIRE is aware that some training is needed in order to provide a more detailed knowledge of the platform; however, the skills and capabilities to develop distributed solutions is out of scope of the project, and are prerequisites for the user of the platform. In addition, depending on the type of applications to be developed (prototyping or (pre-)industrial development, the needed notions span from networking and security mechanisms, and general management skills (the old style FCAPS). These are also out of scope for SoftFIRE and requestors should be aware of how to build their solutions. SoftFIRE can provide support about the networking, security, and monitoring mechanisms that will be progressively offered within the platform but it is up to

the requestor's team to properly use such mechanism, especially if the "Resource Mode" is the adopted model.

On the other hand, SoftFIRE should progressively offer larger documentation including user manuals and examples, and the team should prepare tutorials in order to widen the knowledge of the programmers developing on the platform. Hence, the responsibility domain of the SoftFIRE team is the offered platform, whereas that of a requestor is a specific vertical application domain. The eventual goal of training and support is to facilitate the developers to better use the functionalities offered by the platform.

3.2.5. Running an On-Demand Experiment

As previously discussed, the first turning point is the "mode of use" of the platform that the requestor wants to adopt. In the Resource Mode, the requestor should be very precise in identifying the resources and the functionalities of the platform to be used. It is to requestor's developers to allocate the right resources and to get acquainted with the functionalities and APIs offered by the platform.

The second step is to get access to the platform and prepare it (a description and reservation of all the needed platform resources).

A third step is the development and debugging of the applications. This phase could be cumbersome and complex and the developers could figure out progressively the functions and the way of working of the platform components in more detail. This could have an impact on the development process.

Running the experiment and the testing is the next step. In this phase, the developers will be using the platform and they will tune up the application in order to optimize its behaviour.

Next phase is the actual running of the application (possibly with internal or external users. In this case the requestors team should take responsibility of the interaction with the "users" of the platform. In case of platform malfunctioning, they may request first and second level assistance to the SoftFIRE project according to the SLA that has been agreed.

During all the period of usage of the platform, usage parameters and some major KPIs should be controlled by the development teams and be guaranteed by the SoftFIRE platform. These account usage parameters and KPIs could be part of the SLA.

The last phase is the closing of the experiment. The requestor's team will release the allocated resources and the SoftFIRE platform will provide access to historical data for further elaboration by the requestor. All the access grants will be progressively removed. It is up to the developers to take care of storing and transfer the developed software into external repositories of their choice.

SoftFIRE can make available different types of resources, and more of them will be added during the execution of the project. An example of resources available is depicted in the following table. These resources can be directly identified and asked for by the requestor or they could be proposed by the SoftFIRE team to requestors depending on the intended goal of the experiment.

Resources	**Required (Yes/No) Number of Resources requested**
Virtual CPUs	
RAM	
Block Storage Volume	
IP Addresses to be used	
Number of VLANs support	
EPC Slices	
Average and Max Bandwidth	
Needed RAN	
Type of End Points (fixed, wireless, cellular)	
Specify any other resources requested	

Table 1: Resource request for On-on-demand SoftFIRE

In the case of Project Mode, starting from the experiment design phase, a team of SoftFIRE experts will support the requestor in order to determine the best way to organize the packages of the experiment and how to deploy them properly on the SoftFIRE federated testbed. Indication and suggestion on how to use the monitoring and security features will be provided especially in case of applications offering services and features to external customers. The monitoring of the application behaviour on top of the SoftFIRE platform will be still on the requestor's development and management team. However, a greater level of support could be offered by the SoftFIRE team easing the burden of monitoring of the application.

It is suggested that for prototyping and applications that will not offered to end users, the SLAs and the support process (also to decrease the costs) should have a lower level SLA. While for production or customer related development the SLA should be a major point of discussion and agreement between the requestor and the SoftFIRE team. The stricter the requirement the higher the SoftFIRE team involvement in support of the platform.

All these features and agreement should be well represented in a contract between the requestor and the SoftFIRE consortium.

For experiments that need to use a (single) specific testbed (i.e., they do not need a federated functionalities), the requestors should directly negotiate and deal with the owner of the specific testbed.

3.2.6. Initial Considerations on Pricing

For the time being, the SoftFIRE project is at an early stage for presenting a listing of the functionalities offered and related prices. During the course of the project a clearer idea on the needed resources for supporting a specific experiment will be evident while supporting the Open Calls. At that point, a better idea of the internal effort to support a typical application development will be consolidated by practical experience.

The prices exposed to requestors will take into account the cost and investments on the infrastructure as well as the costs of personnel supporting the working of the federated testbed.

From the point of view of infrastructural costs, it should be noted that the SoftFIRE component testbeds have been put in place mainly as platform devoted to experimental development. As such, the investments may be different than those for a stable and industrial platform. The investment on the platforms has not typically considered any parameter of Return on Investment (ROI) or a clear business model and related business plans. This makes a more difficult to plan for future usage or for calculating the right pricing of the infrastructure.
In addition, the individual platforms have not been dimensioned with specific traffic or number of users in mind. It should also be considered that reliability and fault tolerance were not (for many of the testbed) a primary concern. This means that the platform could have malfunctioning or issues at run time. In addition, processing and power consumptions are not necessarily optimized for an industrial environment. Most likely also the requestors in an initial phase will be more interested in the offered functionalities than on the reliability of the entire platform. Another important consideration is that the communication between the different testbeds is on the big Internet and it is not optimized for providing controlled and dynamic bandwidth allocation. These factors (and others) makes the SoftFIRE platform peculiar with respect to industrial and commercial Cloud Computing platform and related commercial offering.

As a rule of thumb, SoftFIRE will considered the prices of the major commercial cloud computing offering as a desirable target price for the platform, but, as said, the Federated testbed has not been planned for commercial purposes. Hence this “target price” could be difficult to reach or to come close to. One possible way for calculating the infrastructural costs is to find out a trade-off between the investment costs of the individual platform and the possible price to expose to customers considering a period of three years (a technological cycle of the platform) and considering an average number of “requestors” over the same period. This price could then be compared with the existing pricing of commercially available cloud computing platform. Another consideration is that the SoftFIRE platform offers more capabilities (e.g., SDN) with respect to commercial ones.

From the point of personnel costs, the SoftFIRE testbeds are ran by specialized people usually pertaining to the research sector of organizations. Typical costs of people in this case could be

higher than those of people working on the operation side of the same company. All partners of the SoftFIRE project have declared to the EU Commission their average costs for people working on the project. The starting point for pricing the person related costs will be costs exposed at the definition and execution of the project. Another important point to evaluate is the costs supported bu the SoftFIRE project for maintaining and support the platform. Operation and customer support was another feature not programmed originally by yhe testbed owners. The Open Calls could provide hints on how much burden is typically put on the supporting teams in order to enable fruitful and efficient experimentations.

The revenue generation and the related percentage of gain over the costs of personnel and infrastructure is another issue that has not generally been considered when starting the work on the testbeds. Also, this parameter has to be calculated progressively by acquiring more information on the commercial offering and the real value exposed to potential customers over a time frame of three years.

If the SoftFIRE federated platform has to become a real commercial offering, it would be convenient to plan for the future. For instance, the homogeneity of machinery could offer better prices and could also limit the management effort by the SoftFIRE team. This could imply a restructuring of some testbeds with related costs.
The SoftFIRE project will collect as much as possible of information during the Open Calls and the general operation of the platform in order to understand the effort needed to operate and maintaining it. These elements could be used in order to determine an exploitation plan beyond the financed period of the project in order to evaluate the self-sustainability of the platform or the possibility for partners to move towards commercial offering.

4 Bibliography

Consortium, S. (2016). *D3.1 KPIs for evaluating and assessing the features of the Testbed.*

Consortium, S. (2016). *D3.3 Guidelines, rules and mechanisms governing the usage of the SoftFIRE Testbed.*

ETSI. (2014). *Network Functions Virtualisation (NFV);.* ETSI.

FED4Fire. (n.d.). *Federation for Future Internet Research and Experimentation*. Retrieved from http://www.fed4fire.eu/.

FIRE. (n.d.). *Future Internet Research and Experimentation*. Retrieved from https://www.ict-fire.eu/.

FITEagle. (n.d.). *A Semantic Resource Management Framework*. Retrieved from http://fiteagle.github.io/.

jFED, A. j.-b. (n.d.). *jFed*. Retrieved from http://jfed.iminds.be/.

OMF. (n.d.). *Open Management Framework*. Retrieved from http://omf.mytestbed.net/projects/omf/wiki/OMF_Main_Page.

ON.Lab. (n.d.). *Bringing openness and innovation to the Internet and Cloud*. Retrieved from http://onlab.us/.

ONOS. (n.d.). *Open Network Operating System*. Retrieved from http://onosproject.org/.

OpenBaton. (n.d.). *An open source Network Function Virtualisation Orchestrator (NFVO)*. Retrieved from http://openbaton.github.io/.

OpendayLight. (n.d.). *Open Source SDN Platform*. Retrieved from https://www.opendaylight.org/.

OpenStack. (n.d.). *Open source software for creating private and public clouds*. Retrieved from https://www.openstack.org/.

Zabbix. (n.d.). *The Ultimate Enterprise-class Monitoring Platform*. Retrieved from http://www.zabbix.com/.

5 List of Acronyms and Abbreviations

Acronym	Meaning
CA	LTE-A Carrier Aggregation
CC	UoS 5G Cluster Member
CM	UoS 5G Cluster Controller
EMM	EPS Mobility Management
EPC	Evolved Packet Core (LTE-A)
HSS	Home Subscriber Server
IaaS	Infrastructure as a Service
LTE-A	Advanced Long Term Evolution
MME	Mobility Management Entity
NF	Network Function
NS	Network Service
PDN	Packet Data Network
PGW	PDN Gateway
PPE	UoE CUPS evolved combined Packet Processing Entity including SGWu and PGWu NF entities
RAN	Radio Access Network
SGW	Serving Gateway
UoS	University of Surrey
vNF	Virtual Network Function