



FUTURE INTERNET TESTBEDS  
EXPERIMENTATION BETWEEN  
BRAZIL AND EUROPE



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## FIBRE-EU

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**D4.5**  
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	<p><b>D4.5</b></p> <p><b><i>Report on the Federation of the facilities</i></b></p>	<p>Doc                    FIBRE-EU D4.5</p> <p>Date                    11/04/2014</p>
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## Abstract

The purpose of this deliverable is to provide a report on the final implementation of the federation of the facilities.



**D4.5**  
**Report on the Federation of  
the facilities**

Doc FIBRE-EU D4.5

Date 11/04/2014

## TABLE OF CONTENTS

1	Acronyms .....	5
2	Scope .....	7
3	Reference Documents .....	8
4	Introduction .....	9
5	FIBRE Federation Architecture.....	10
6	MySlice Portal .....	11
6.1	MySlice Deployment .....	11
6.2	MySlice Authentication & Authorization .....	12
6.3	MySlice gateway to SFA .....	13
7	SFA Layer .....	15
7.1	SFA Registry .....	15
7.2	SFA AM and Drivers .....	15
8	FIBRE testbeds .....	16
8.1	SFA-Compliant OMF.....	17
8.2	SFA-Compliant OCF .....	17
8.2.1	SFA Integration .....	18
9	Physical Interconnection of BR and EU testbeds .....	20
10	Conclusions .....	21



**D4.5**  
**Report on the Federation of  
the facilities**

Doc FIBRE-EU D4.5

Date 11/04/2014

## 1 Acronyms

AM	Aggregate Manager
API	Application Programming Interface
CMF	Control and Monitoring Framework
CNPq	Brazil's Council for Scientific and Technological Development
CPqD	Telecommunications Research and Development Centre
CRUD	Create, Read, Update and Delete
EU	European Union
FI	Future Internet
FIBRE	Future Internet testbeds / experimentation between Brazil and Europe
FOAM	Flowvisor OpenFlow Aggregate Manager
FP7	Seventh Framework Programme
FPGA	Field Programmable Gate Array
GENI	Global Environment for Network Innovations
GID	Global Identifier
HTTP	HyperText Transfer Protocol
I&M	Instrumentation and Measurements
ICT	Information and Communication Technologies
IP	Internet Protocol
LDAP	Lightweight Directory Access Protocol
MS	Milestone
NITOS	Network Implementation Testbed using Open Source platforms
NOC	Network Operations Center
NTP	Network Time Protocol
OCF	OFELIA Control Framework
OF	OpenFlow
OFELIA	OpenFlow in Europe: Linking Infrastructure and Applications
OGF	Open Grid Forum
OMF	cOntrol, Management and Measurement Framework
OML	ORBIT Measurement Library
ORBIT	Open-Access Research Testbed for Next-Generation Wireless Networks
OS	Operation System
RFC	Request for Comments
RNP	National Research and Education Network
RSpec	Resource Specification
RSpec	Resource Specification
UFF	Federal Fluminense University
UFRJ	Federal University of Rio de Janeiro
VM	Virtual Machine
VT AM	Virtualization Aggregate Manager
WP	Work Package

	<p><b>D4.5</b> <b><i>Report on the Federation of the facilities</i></b></p>	<p>Doc FIBRE-EU D4.5 Date 11/04/2014</p>
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WP2

| Building and operating the Brazilian facility

	<p><b>D4.5</b></p> <p><b><i>Report on the Federation of the facilities</i></b></p>	<p>Doc                    FIBRE-EU D4.5</p> <p>Date                    11/04/2014</p>
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## 2 Scope

This document is the result of the tasks T4.2, T4.3 and T4.4 of WP4 of the FIBRE project. The objective of these tasks are to select the right solutions for federation and customize them to the interconnected EU/Brazil facility.

	<b>D4.5</b> <b>Report on the Federation of the facilities</b>	Doc FIBRE-EU D4.5 Date 11/04/2014
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### 3 Reference Documents

- [1] FIBRE D4.3 Report on the Federation solution.
- [2] <http://www.myslice.info>
- [3] <https://www.djangoproject.com>
- [4] <http://trac.top-hat.info/wiki/manifold>
- [5] <git://git.onelab.eu>.
- [6] FIBRE D2.6 Report on the deployment of the second version of the control and monitoring framework at the FIBRE-BR facilities.
- [7] <http://sfawrap.info>
- [8] L. Peterson, R. Ricci, A. Falk, and J. Chase, "Slice-based federation architecture (SFA)," working draft, Version 2.0.
- [9] FIBRE D4.2 Report on the Federation physical interconnection.
- [10] FIBRE D3.5 Final Report on the Operation of the facility.



	<p><b>D4.5</b></p> <p><b><i>Report on the Federation of the facilities</i></b></p>	<p>Doc FIBRE-EU D4.5</p> <p>Date 11/04/2014</p>
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## 4 Introduction

In this document, the final implementation of the FIBRE federated facility is described. The main components of this federation are: the portal, the SFA layer and the testbeds. The FIBRE portal is implemented by MySlice, which is a graphical interface that allows FIBRE users to interact with multiple testbeds through the SFA layer. SFA provides a secure API that allows authenticated and authorized researchers to browse all the available resources and allocate those required to perform a specific experiment, respecting the agreed federation policies. Therefore, SFA is used to federate the heterogeneous resources belonging to different administrative domains as provided by the FIBRE testbed facilities. This will allow FIBRE experimenters to combine all available resources of these testbeds and run advanced networking experiments, involving wireless and OpenFlow-enabled technologies. The FIBRE testbeds are composed of ten islands in Brazil and three islands in EU, which are interconnected through a combination of layer-3 and layer-2 VPNs.

In the following, we describe the deployment of these software components and how they interact among them.

## 5 FIBRE Federation Architecture

The FIBRE Federation Architecture is detailed in the deliverable D4.3 [1]. The Figure 1 depicts this architecture and its components. In the next sections, we will describe the deployment of each one of these components.

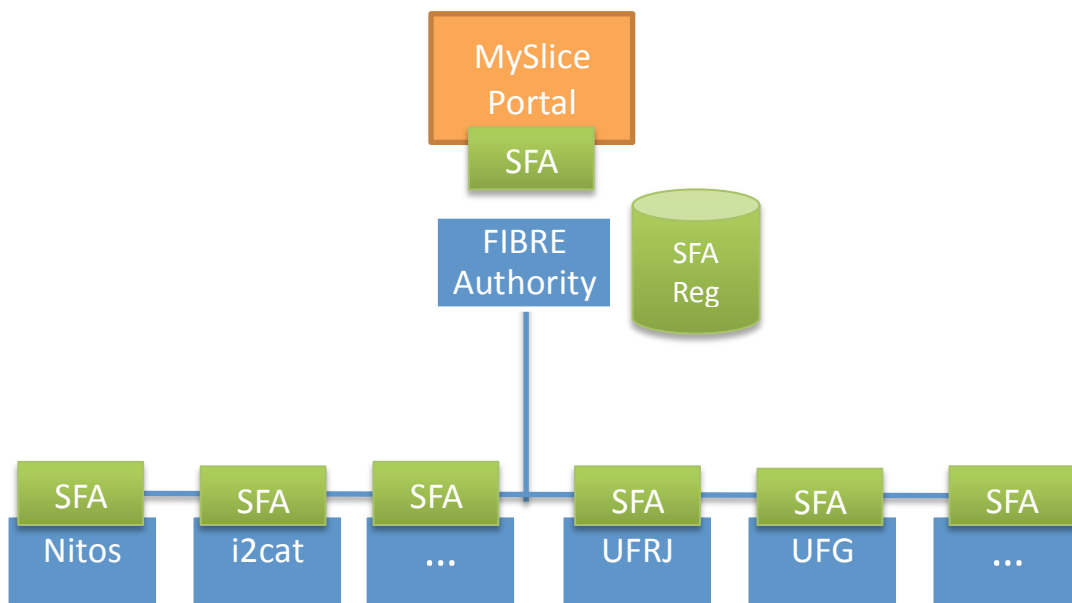


Figure 1: FIBRE Federation Architecture

	<p><b>D4.5</b></p> <p><b>Report on the Federation of the facilities</b></p>	<p>Doc FIBRE-EU D4.5</p> <p>Date 11/04/2014</p>
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## 6 MySlice Portal

MySlice [2] is a graphical user interface, developed on the Django Python web framework [3], which allows users to authenticate, browse all the testbeds resources, and manage their slices. In the following, we describe the deployment of MySlice in FIBRE, the registering process and the different kinds of authentication provided by the FIBRE portal, and the developed plugins that interact with the FIBRE testbeds.

### 6.1 MySlice Deployment

MySlice in FIBRE was deployed in a virtual machine (VM), which is running in a server located in the Brazilian NOC. This VM uses a 64-bits Debian stable release distribution. For the installation of MySlice, the following additional software is needed: Django Python framework and Manifold [4]. The first is a high-level Python Web framework that allows automating as much as possible the construction of high-performing Web applications and Manifold is a Python framework that allows performing SQL-like queries involving one or several sources and to combine the information they provide. The deployment of Manifold and MySlice code in the VM was done through the git repository of Onelab [5]. The MySlice portal in FIBRE is accessible through the following URL: <https://200.130.15.182>.

The basic configuration of MySlice consists on the creation of an admin user and a user to whom all MySlice users could delegate their credentials to the access of the testbed resources. In addition, we have to create in MySlice the information sources, called platforms, which are abstractions for the different testbeds in FIBRE.

Another task concerning the MySlice deployment was the layout customization of the different web pages available for the MySlice users. These pages allow users to register, manage their account (e.g. change the password, generate new key pairs, upload public keys, delegate their credentials, etc.), manage their slices (e.g. create, provision and remove slices) and create tickets to the administrator of the testbed facility. In addition, MySlice allows the PI user to view and validate pending requests.

The Figure 2 shows the main web page of the FIBRE portal, where users can authenticate in order to manage their slices. The Figure 3 shows the list of slices of a specific user authenticated to the portal.

	<b>D4.5</b> <i>Report on the Federation of the facilities</i>	Doc	FIBRE-EU D4.5
		Date	11/04/2014

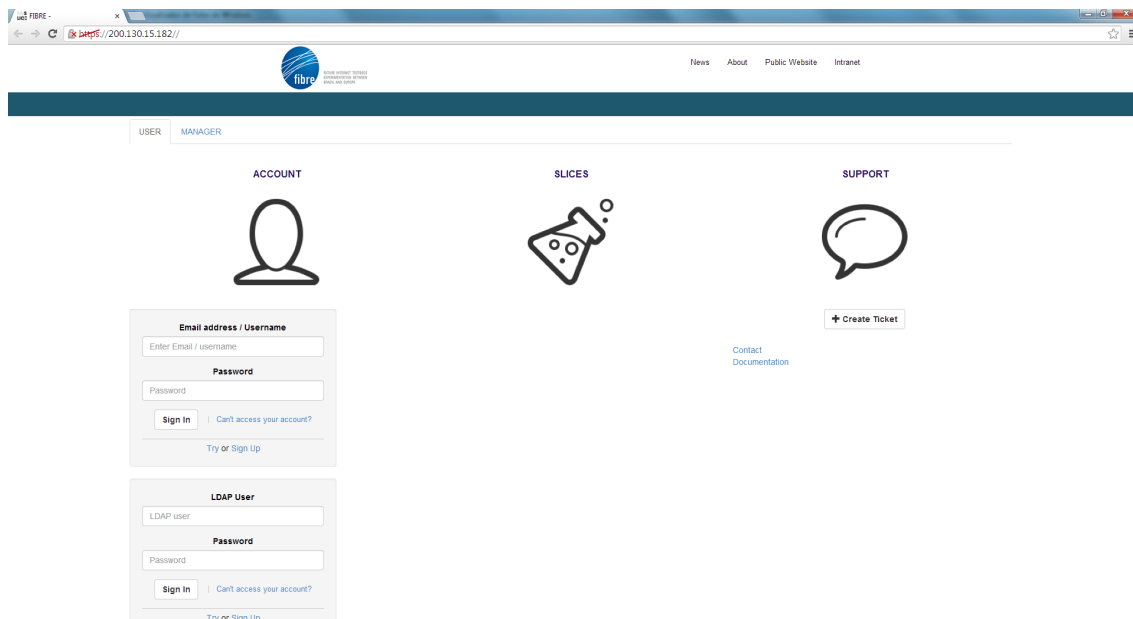


Figure 2: FIBRE portal

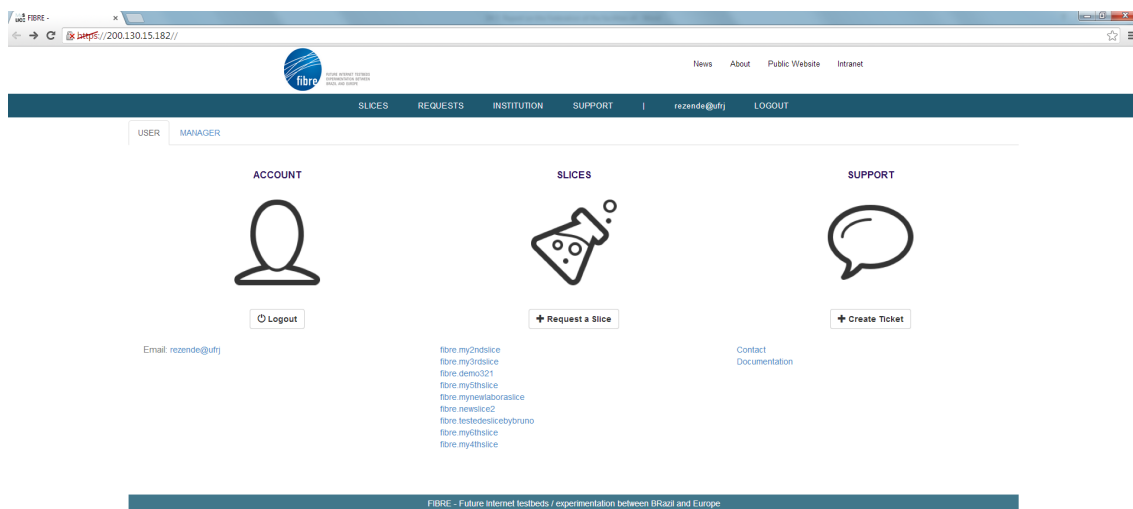


Figure 3: Slice Management in the FIBRE portal

## 6.2 MySlice Authentication & Authorization

In terms of Authentication and Authorization (A&A), SFA provides a simple authentication mechanism based on X.509 certificates and static profiles. In order to circumvent this problem, a new authentication and authorization method by integrating SFA and A&A federations based on Shibboleth or LDAP is used in FIBRE. Therefore, an additional mechanism translates the credentials and checks the attributes for access control. More specifically, SAML credentials generated by the academic federation allow authenticating users. After verifying whether they

have the required attributes to access FIBRE, the portal will create a user account into the SFA Registry database, which will generate an SFA X.509 certificate. This mechanism is completely detailed in deliverable D2.6 [6].

From the point of view of MySlice, it is possible to authenticate a FIBRE user through four different methods: Brazilian CAFe academic federation, FIBRE-BR LDAP, FIBRE-EU LDAP (based on OFELIA LDAP database), and directly from the SFA Registry.

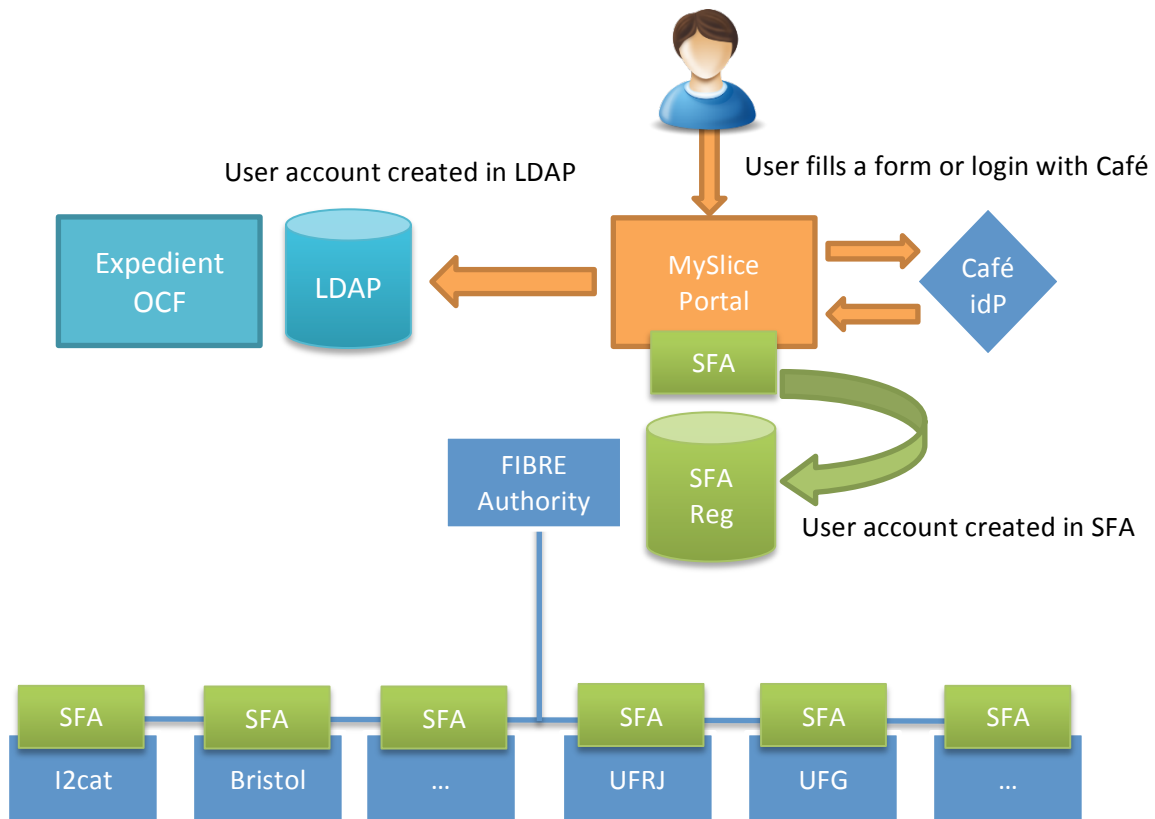


Figure 4: FIBRE users registration process

In addition, the registration of new users is permitted through the fulfillment of a form in a MySlice web page in which the user informs the institution to which he/she will be linked. This account request will be sent to the approval of the PI of this institution. Once this account request is approved by the PI, through a specific web page in MySlice, an entry will be created for this user in the SFA Registry. The Figure 4 shows all these alternatives for the registration process.

### 6.3 MySlice gateway to SFA

In order to enable MySlice to interact with heterogeneous testbeds, MySlice has to be able to generate and parse different types of RSpecs. For a question of modularity, this task is performed by plugins. In FIBRE, we have three types of plugins: the NITOS/Labora Scheduler, the VTAM, and the OPTIN plugins. All these plugins were developed/customized in FIBRE.

	<p><b>D4.5</b></p> <p><b><i>Report on the Federation of the facilities</i></b></p>	<p>Doc                    FIBRE-EU D4.5</p> <p>Date                    11/04/2014</p>
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MySlice is able to interact with SFA-compliant testbeds that implement either the SFAv2 or the SFAv3. In FIBRE, the OMF SFA driver provides a SFAv3 interface and OCF AMs provide a SFAv2 interface.

	<b>D4.5</b> <b>Report on the Federation of the facilities</b>	Doc FIBRE-EU D4.5 Date 11/04/2014
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## 7 SFA Layer

In this section, we describe the components of the SFA layer and their deployment in the FIBRE facility.

### 7.1 SFA Registry

The Registry is the entity in the SFA layer that is responsible for storing the set of objects that make up the federated system, which include users, slices, services and authorities, together with other domain-specific information about the corresponding object. Every object in the system has a global identifier (GID) associated to it, which corresponds to a publickey, i.e. a credential. In addition, these objects have a human-readable name (HRN) that identifies the sequence of authorities that are responsible for the object. The SFA Registry is also responsible for the mapping of HRNs to GIDs.

The SFA Registry implementation used in FIBRE is the one provided by the SFAWrap [7] package version 3.1-2, developed by INRIA. The SFA Registry component consists on a process that exports a XML-RPC registry interface on top of https and stores/read information in/from a postgres DB. These software components (SFA Registry and DB) were deployed in the same VM of MySlice, which eases their interaction. Currently, the SFA Registry process is not accessible from the external world.

The deployment of the SFAWrap package in this VM was also done through the Onelab git repository [5], and its basic configuration consists on enabling the Registry-only and defining the name of the authority, i.e. Fibre, it is responsible for.

### 7.2 SFA AM and Drivers

Another component of the SFA layer is the Aggregate Manager (AM), which is required in each SFA-compliant testbed. It is responsible for exposing an interface that allows the experimenters to browse and reserve resources of a testbed. The SFA AM exports a slice interface that researchers interact with to set up, control, and tear down their slices. When the Control and Management Framework (CMF) of a testbed is not SFA-compliant, a so-called SFA driver is required to translate SFA originated queries into queries for the testbed. This driver wraps the CMF and exposes a standard interface to the AM. In FIBRE, OMF and OCF testbeds required an SFA driver. Both drivers were developed based on the driver implementations of the SFAWrap.

	<p><b>D4.5</b></p> <p><b><i>Report on the Federation of the facilities</i></b></p>	<p>Doc FIBRE-EU D4.5</p> <p>Date 11/04/2014</p>
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## 8 FIBRE testbeds

As already known, one of the objectives of FIBRE project is to establish the federation architecture to be followed by the different control frameworks used in the project: OCF managed testbeds and OMF managed testbeds. To achieve this objective three requirements need to be fulfilled:

- First of all, there is a need of physical connectivity between the testbeds
- Secondly, every testbed has to be able to understand to a certain level all the other testbeds
- Finally, every testbed must accept and trust the other testbeds (i. e. every user registered in a testbed must be able to use another testbed without using/ creating new credentials).

The first requirement is explained in section 9.

In order to cover the second and the third requirements it was decided to integrate SFA on all the testbeds – controlled by two different CMFs (OCF and OMF), which were not originally SFA-compliant – due to this is the one of the most standardized architectures providing a common API (GeniV2/V3) and an Authentication Authorization and Accounting (AAA) system for trust between testbeds. Since SFA uses the GENI API it makes FIBRE project extendable with other testbeds using the same API.

This section describes all the required development to make both kind of CMFs SFA-compliant. Figure 5 shows the interaction among MySlice and the different AMs.



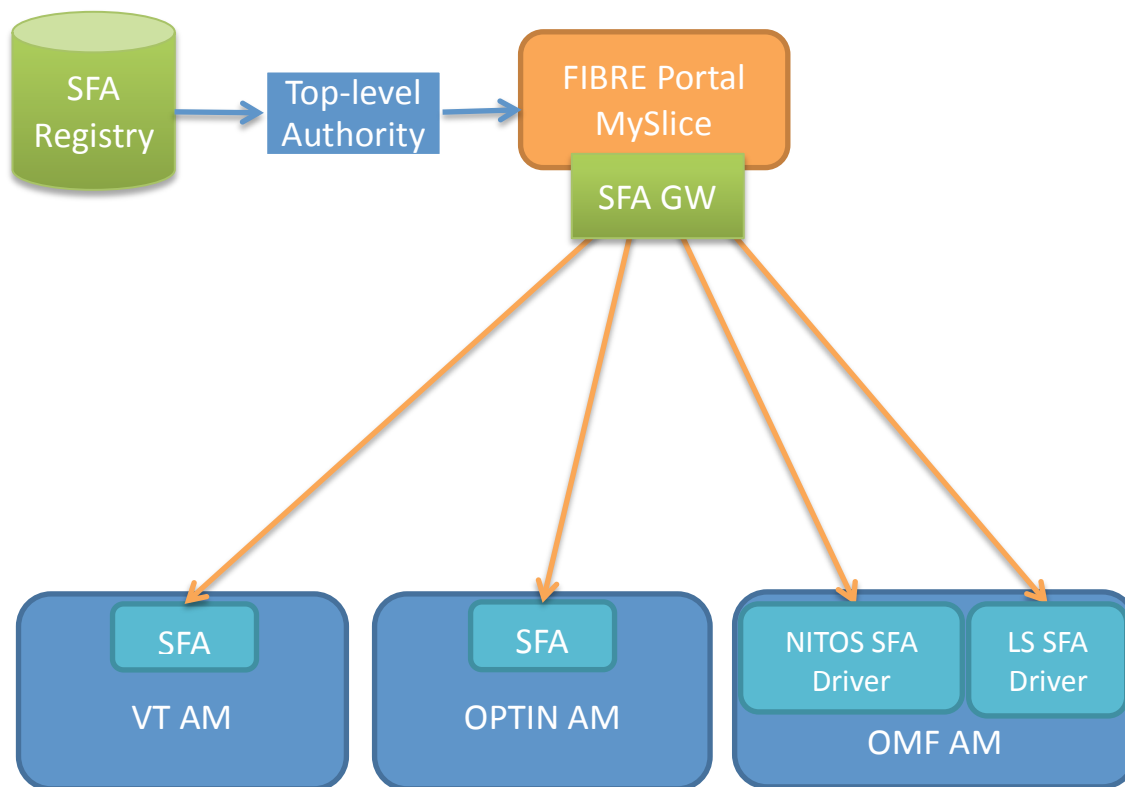


Figure 5: MySlice and the AMs

## 8.1 SFA-Compliant OMF

As mentioned before, the OMF testbeds in FIBRE are wrapped by an SFA driver. Two versions of the driver were developed: NITOS Scheduler and Labora Scheduler drivers. The first one interacts with the NITOS Scheduler, which is a scheduler for OMF developed by UTH. The second driver interacts with the Labora Scheduler, which is a fork of the NITOS Scheduler implemented by UFG in order to integrate LDAP. More details about the Labora Scheduler are provided in the deliverable D2.6 [6].

## 8.2 SFA-Compliant OCF

Although OCF was not originally SFA compliant at an API and authentication level, its architecture always followed the pure SFA principles as described in the original paper [8]. The work done inside the OCF in order to fulfil the missing points was to adapt the SFAWrap package by adding a GENIV2 API and the AAA modules inside every AM of the OCF software packager: VTAM, FOAM and Opt-in manager. By doing this, OCF exports each of its resource controllers by means of an SFA API to a higher level entity, which could be a GUI or another Aggregate Manager.

Regarding the authentication mechanisms, it was needed to modify the OCF or X.509 certificates to convert them into SFA GIDs. This action is basically adding some X.509 V3 extensions to the original certificates.

	<b>D4.5</b> <b>Report on the Federation of the facilities</b>	Doc	FIBRE-EU D4.5
		Date	11/04/2014

The compliance with SFA in OCF is available since the version 0.7. This version of OCF includes the XMLRPC SFA AM interface defined in the SFAWrap package. The SFA driver that wraps the VTAM and the OPTIN AMs are also included in this version of OCF.

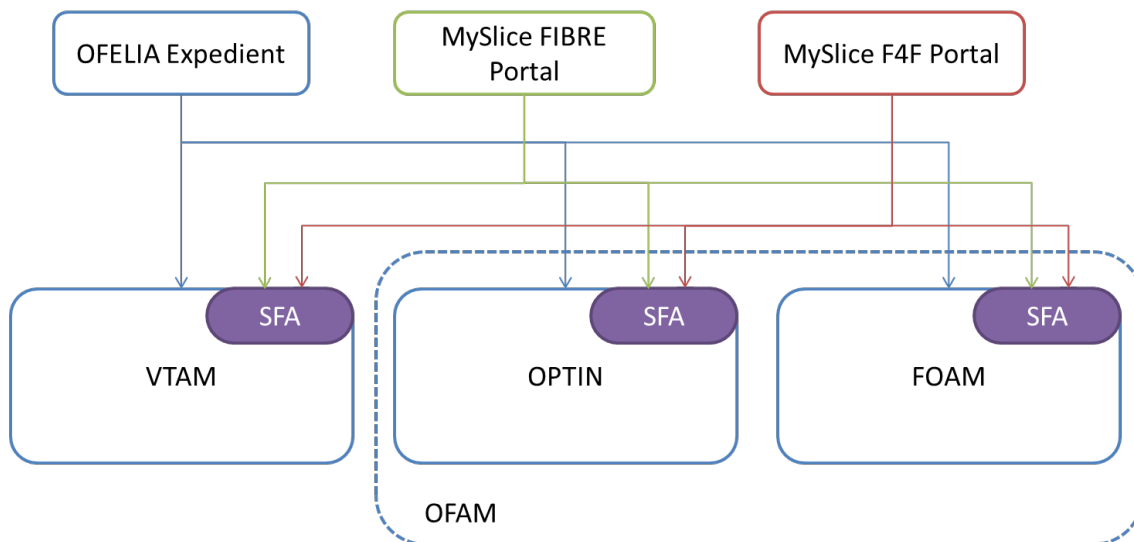


Figure 6: The FIBRE federation architecture

### 8.2.1 SFA Integration

To fully support SFA four main modules were deployed on each AM:

- GENI API v2
- Trust Module
- RSpec Parser
- SFA Driver

The GENI API v2 comprises the main calls of the API and how these methods are related with the role trust system provided by SFA and the core methods of each AM.

The trust module used in OCF were the GENI trust modules already provided by SFA. These modules provide an auto-management of the credentials and permissions of every federated authority or user.

The RSpec parser is the tool devoted to make the testbed understand the AM specific features and by exporting this parser, other testbeds are allowed to understand and able to properly communicate with the AM.

The SFA driver is the set of translators made to fully integrate the SFA management and the core functionalities of the AM.

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		Date	11/04/2014

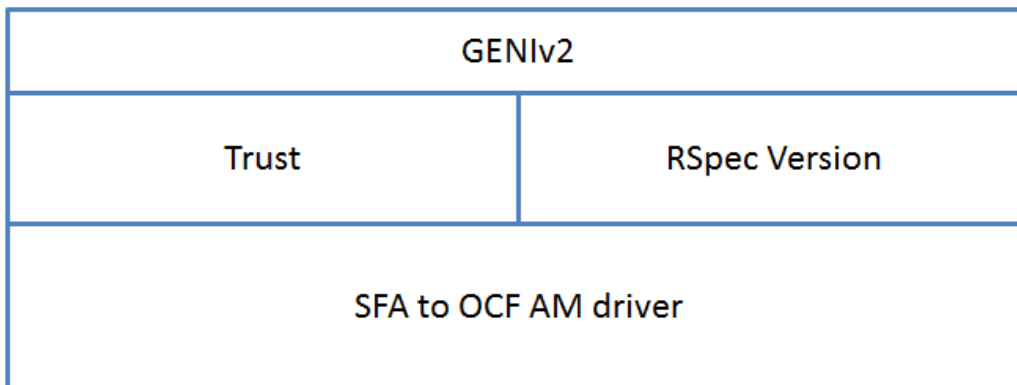


Figure 7: OCF AM SFA Module

#### 8.2.1.1 *VTAM Integration*

For the VTAM SFA integration, all the modules formerly specified were developed. In particular, an RSpec to create VMs in the OCF way was designed.

The driver translates from the GENI methods in the API the CRUD functionalities to manage VMs in the virtualizing servers controlled by VTAM. Moreover, the asynchronous communication model used by the VTAM needed to be proxied by the SFA driver in order to provide a synchronous model to the SFA-compliant entity on top.

#### 8.2.1.2 *FOAM and Opt-in Manager*

For these two AMs the SFA integration was almost identical, since these AMs are devoted to manage OpenFlow resources using FlowVisor. The RSpec parser used in these two AMs was the existing GENIv3 OpenFlow since is the most standardized OpenFlow RSpec and already used by FOAM by default.

The driver was devoted to translate the GENIv2 calls into the internal functions in the AMs. In the case of FOAM the default GENI v2 API was modified to fully support the GENI v2 provided by SFA since FOAM was using a slightly different API.

	<p><b>D4.5</b></p> <p><b><i>Report on the Federation of the facilities</i></b></p>	<p>Doc FIBRE-EU D4.5</p> <p>Date 11/04/2014</p>
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## 9 Physical Interconnection of BR and EU testbeds

The physical interconnection between the FIBRE BR, between the EU testbeds and between the two continents was design as a whole L2 segment by means of using QinQ technology over transport international links. The work done in this regard is reported in [6] for the Brazilian islands, and in [9,10] for the European and intercontinental links.

	<p><b>D4.5</b></p> <p><b><i>Report on the Federation of the facilities</i></b></p>	<p>Doc FIBRE-EU D4.5</p> <p>Date 11/04/2014</p>
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## 10 Conclusions

The FIBRE Federation, which is based on the Slice Federation Architecture (SFA), is composed by three building blocks: the portal, the SFA layer and the SFA-compliant testbeds. The portal is implemented by the MySlice software component, which allows the users to manage their slices through SFA. The SFA layer is composed by the SFA Registry, the SFA AMs and drivers. The SFA Registry is responsible to store the users and their slices with the corresponding credentials. The other components of the SFA layer are needed in the SFA-compliant testbeds. All these components are implemented by the SFAWrap package, which is used in the FIBRE Federation. In addition to the SFA components required to make the testbed SFA-compliant, the CMFs in FIBRE (OMF and OCF) were customized to allow the entire implementation of the lifecycle of a slice.

	<p><b>D4.5</b></p> <p><b><i>Report on the Federation of the facilities</i></b></p>	<p>Doc FIBRE-EU D4.5</p> <p>Date 11/04/2014</p>
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