OFELIA

ICT-258365

Deliverable 12.6

Final Status Report about OFELIA Island at Brazil

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Deliverable nature:	Report (R)
Dissemination level: (Confidentiality)	Confidential (CO)
Contractual delivery date:	12 months after WP12 started (September, 2013)
Actual delivery date:	23 Setember, 2013
Suggested readers:	Project Officer, Reviewers
Version:	1.0
Total number of pages:	19
Keywords:	EDOBRA, Island, Deployment

Abstract

This deliverable presents the status of the OFELIA Island at Brazil. The document describes the deployed hardware at the Island, the addressing scheme and the federation with OFELIA describing the circuit between Brazil and Europe

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Imprint

[Project title]	***OpenFlow in Europe – Linking Infrastructure and Applications***
[short title]	***OFELIA***
[Number and title of work package]	***WP12 – EDOBRA Extending and Deploying OFELIA in BRAzil***
[Document title]	***Final Status Report about OFELIA Island at Brazil***
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Executive summary

The purpose of this deliverable is to report about the OFELIA Island in Brazil.

The island at Brazil increased not only the physical extension and capacities of OFELIA but also its reach by adding new experimenters to the project.

This deliverable begins by describing and detailing the UFU Island, giving an overview of the deployment and presenting the hardware that was deployed and also the addressing scheme used at the Islands. The federation with OFELIA is also described, presenting how UFU site is connected to OFELIA at Europe. Finally, some cooperation actions that were undertaken are also described.

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Abbreviations

ADSL	Asymmetric Digital Subscriber Line
DTH	Direct To Home
DNS	Domain Name Service
DTS	Domain Title Service
EDOBRA	Extending and Deploying Ofelia in BRAzil
ETArch	Entity Title Architecture
IEEE	Institute of Electrical and Electronics Engineers
IoT	Internet of Things
L2	Layer Two
L3	Layer Three
MIH	Media Independent Handover
MIHF	Media Independent Handover Function
NFS	Network File System
NREN	National Research and Education Network
OANA	OFELIA Assigned Number Authority
OCF	OFELIA Control Framework
ODTONE	Open Dot Twenty One
OFELIA	OpenFlow in Europe – Linking Infrastructure and Applications
PoP	Point of Presence
SAP	Service Access Point
SDN	Software Defined Networking
SoC	System on Chip
WLAN	Wireless Local Area Network

1 Introduction

The OFELIA Island at UFU extended the physical facility deployed by OFELIA project. In the context of EDOBRA, the island in Brazil hosts several experiments regarding multicast, mobility and energy efficiency by using the Entity Title Architecture (ETArch) that are in the scope of EDOBRA project, i.e., WP12. Moreover, the island provides to all OFELIA users the opportunity to run their experiments considering scenarios where trans-oceanic links that are used to connect distant sites and also the outcomes from EDOBRA will be available to all research community enabling new kinds of experiments specially the ones related with mobility by using IEEE 802.21 standard (Media independent handover) [1] provided by the integration between OpenFlow [2] and ODTONE [3], the implementation of IEEE 802.21.

The remainder of the document is organized as follows: Section 2 presents the OFELIA Island at UFU and details the equipments that are being deployed and the addressing scheme that will be used; Section 3 describes the circuit that interconnects UFU to OFELIA; Section 4 describe some cooperation actions that were undertaken regarding potential users to the OFELIA infrastructure and Section 5 presents some concluding remarks.

2 UFU Island

In this section we describe the infrastructure deployed for OFELIA facility testbed at UFU. The Island consists of L2 (Ethernet) switches and computational substrate.

The island is deployed at Campus Santa Mônica, located at Uberlândia, Minas Gerais state in Brazil. Figure 1 presents the campus deployment and the buildings where related infrastructure was installed.

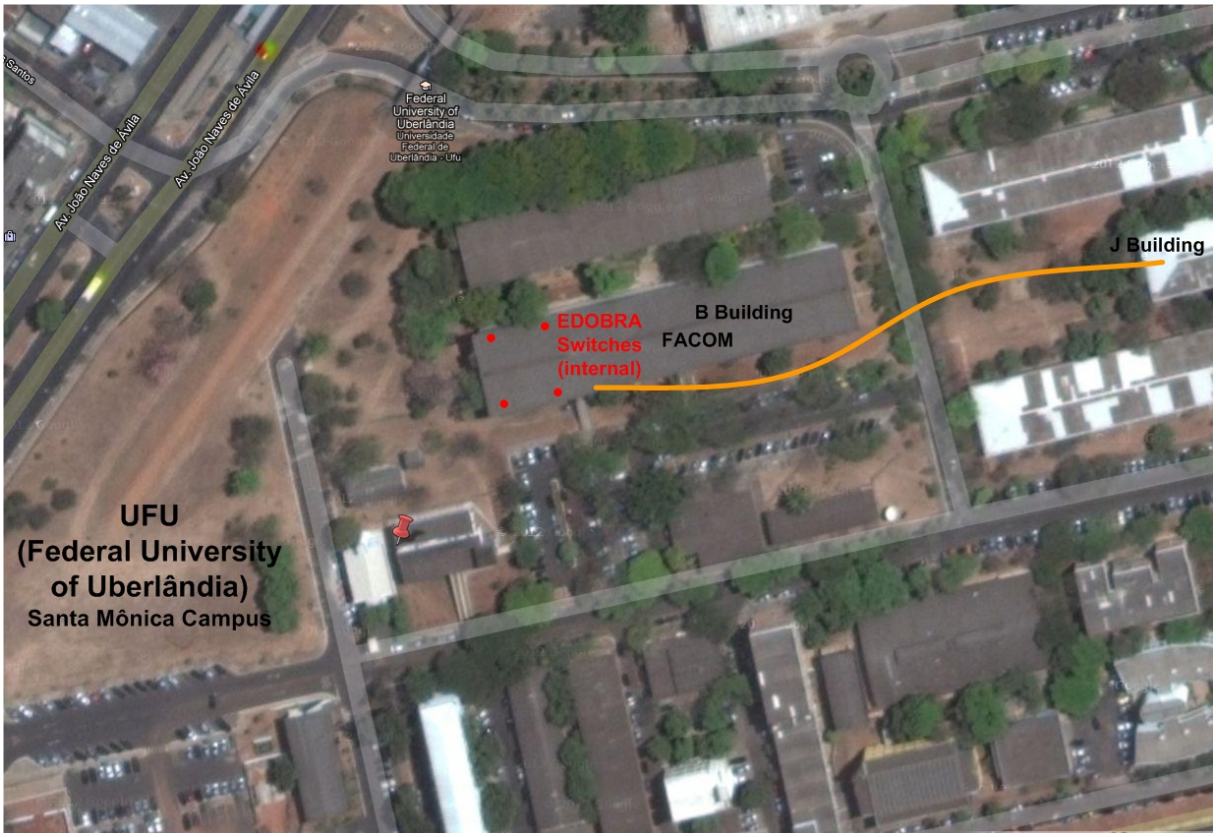


Figure 1 - Campus Deployment.

2.1 Inventory Overview

The current topology is composed by wired and wireless switches and servers that are accommodated in two racks exclusive for OFELIA project. The wireless switches were distributed near the rack installation internally at B building, where the Faculty of Computing (FACOM) is located. Figure 2 presents an overall picture of the OFELIA racks and the equipment that is installed on it.

The rack is composed by the following equipments:

- **TOR Switch** – responsible for interconnection between all the equipment and to provide the control and management network;
- **NETFPGA Switch** – OpenFlow switch based on a NetFPGA card. This switch will also be enabled with NVIDIA GPU cards enabling future experimentation by using GPU enabled versions of OpenFlow software based switches;
- **VM Server** – Dedicated to host VMs that will be created and used by OFELIA users during experiments;
- **CONTROL Server** – Hosts several services and applications used to control, manage and monitor the Island such as: OCF (OFELIA Control Framework) [4], FlowVisor; VPN Gateway; DNS Service; LDAP, NFS and ZenOSS;
- **OpenFlow Switch** – Hardware based switch, compatible with OpenFlow 1.0;

- **EDOBRA Switch** – Based on TP-Link TL-WR1043ND hardware is an OpenFlow switch with IEEE 802.21 capabilities. Besides an OpenFlow implementation on top of OpenWRT [5] [6] , this switch contains a MIHF (Media Independent Handover Function) and Server Access Points (SAPs) provided by ODTONE.

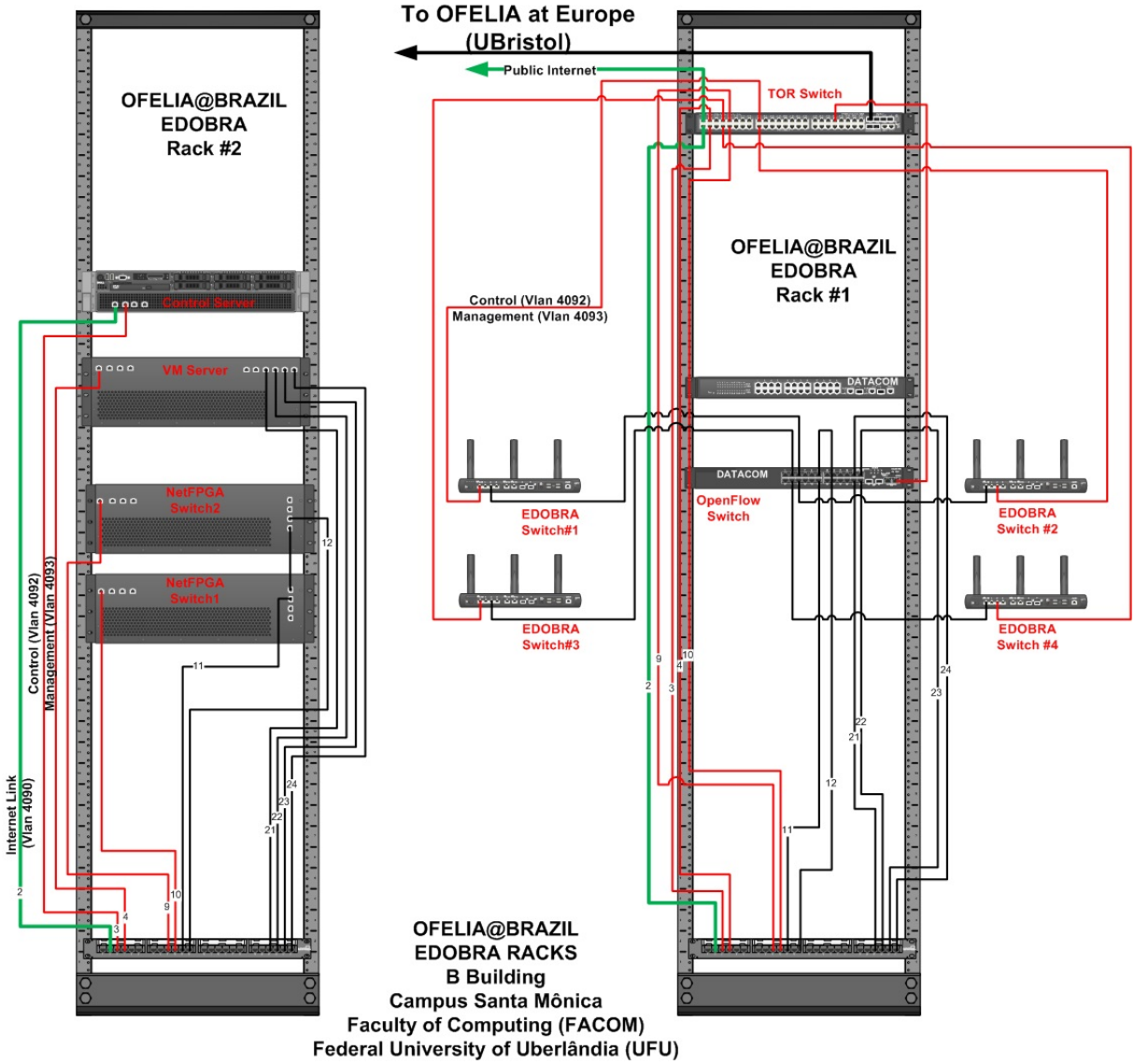


Figure 2 - OFELIA Racks at Brazil.

As defined to other OFELIA islands, the island has three logical networks:

- **Experimental Network** – This network, represented by the black lines at Figure 2, interconnects the OpenFlow Switches and the Virtual Machines (VMs). This network is used handle the experimental traffic produced by the experiments that is conducted inside OFELIA island. To create several virtual topologies, the OpenFlow and NETFPGA switches and also the VM Server are interconnected using several physical ports;
- **Control Network** – Represented by the red lines at Figure 2, this network interconnects the entire infrastructure to the Control Server. This network will give users access to their experiments, i.e., slices and to control services, such as OCF at the island and also will allow them to access their VMs using SSH. This network will be connected to other OFELIA islands through L2 OpenVPN tunnels. At this network, the frames will be tagged with VLAN 4092;

- **Management Network** – By using this network, the local managers of the island has a separate access to all equipment at the infrastructure in order to configure and monitor island's equipments. This network will not be accessed by OFELIA users. At this network, the frames will be tagged with VLAN 4093.

2.2 Addressing

Considering the OFELIA Assigned Number Authority (OANA) definition regarding addressing and prefix to the islands, the Island ID (IsID) of the OFELIA Island at UFU was defined as the number fifteen (15).

Thus, Control network IP addresses will be in the range 10.216.60.0/22 and the management network addresses will be in the range 10.216.188.0/22. The MAC addresses will be assigned with the prefix **02:0F:xx:xx:xx:xx** and the datapath-IDs for OpenFlow switches will have the prefix **0F:xx:xx:xx:xx:xx:xx:xx**.

Table 1 presents the control and management address defined to each equipment (server and switches) deployed at OFELIA Island at Brazil:

Table 1 – Equipment Addresses

Name	Ctrl Address	Mgmt Address
Gateway rtr	**Ext. primary: 10.216.0.15**	**10.216.188.1**
	Ext. backup: 10.216.2.15	
	Internal: 10.216.60.1	
Control Server	**10.216.60.2**	**10.216.188.2**
VM Server (Buriti)	**10.216.60.20**	**10.216.188.2**
NETFPGA1	**10.216.60.30**	**10.216.188.30**
NETFPGA2	**10.216.60.31**	**10.216.188.31**
TOR Switch	**10.216.60.254**	**10.216.188.254**
OpenFlow Switch	**10.216.60.40**	**10.216.188.40**
EDOBRA Switch #1	**10.216.60.41**	**10.216.188.41**
EDOBRA Switch #2	**10.216.60.42**	**10.216. 188.42**
EDOBRA Switch #3	**10.216.60.43**	**10.216. 188.43**
EDOBRA Switch #4	**10.216.60.44**	**10.216. 188.44**

2.3 Hardware Description

This subsection provides a detailed description about the hardware that was deployed at the Brazilian island.

2.3.1 Network Equipment

The OFELIA Island at UFU will have OpenFlow switches based on dedicated hardware and at NetFPGA cards. Also the island will have software based switches, such as the EDOBRA switch that is based on a user mode OpenFlow 1.0 switch [6], as presented in Table 2.

Table 2 - Network Equipments

Role	Manufacturer	Model	Control IP	Management IP	Description
OpenFlow Switch	DATACOM	DM4000 ETH24GX+2x10GX	10.216.60.40	10.216.188.40	Ethernet switch with support to L2 and L3 functions; Form Factor 1U; 24 ports 1000Base-X (SFP); 2 ports 10Gbps (XFP); MAC Address Table with 512K entries; 4096 VLANs; 192 GPS switch fabric;
OpenFlow Switch #2	DATACOM	DM ETH20GP+4GC	10.216.60.50*	10.216.188.50*	Ethernet switch with support to L2 and L3 functions; Form Factor 1U; 20 ports 1000Base-T; 4 combo ports (10/100/1000Base-T or 1000Base-X); 802.3at PoE+ support; MAC Address Table with 32K entries; 4096 VLANs; 152 GPS internal switch matrix
NETFPGA Switch	Not Applicable	Assembled rack mounted server	10.216. 60.30 (NETFPGA1) and 10.216.60.31 (NETFPGA2)	10.216. 188.30 (NETFPGA1) and 10.216.188.31 (NETFPGA2	Intel Xeon E3-2630 processor; Motherboard Intel S2600COEIOC with 4 Ethernet x 1 Gb and dual LGA 2011 CPU socket; 32 GB DDR3 ECC 1333 MHz; 2 x 1 TB Sata III 7.2Krpm hard drive; DVD Reader/Writer; Digilent NetFPGA Board Xilinx Virtex-II Pro; GPU GeForce GTX 560 Ti
TOR Switch	HP	A5500-48G-PoE+ EI Switch (model JG240A)	10.216.60.254	10.216.188.254	48 RJ-45 autosensing 10/100/1000 PoE+ ports (IEEE 802.3 Type 10BASE-T, IEEE 802.3u Type 100BASE-TX, IEEE 802.3ab Type 1000BASE-T, IEEE 802.3at PoE+). 192 Gbps of routing and or switching capacity. Routing table size with 12K entries (IPv4)
EDOBRA Switch	TP-LINK	TL-WR1043ND	10.216.60.41 to 10.216. 60.47	10.216.188.41 to 10.216. 188.47	Wireless N Gigabit Router based on Atheros AR9001AP-3NG wireless SoC; 4 1000Base-T ports; 1 1000Base-T WAN port; 1 USB 2.0 port; VLAN support; 802.11b/g/n; frequency 2.4 to -2.4835GHz;

2.3.2 Servers

The island has basically one server dedicated to host VMs and the other to host the services and applications that are necessary to control it. Additionally, the NETFPGA switches can also hosts VMs but initially they are planed to be exclusively used for switching. Table 3 summarizes the description of each server.

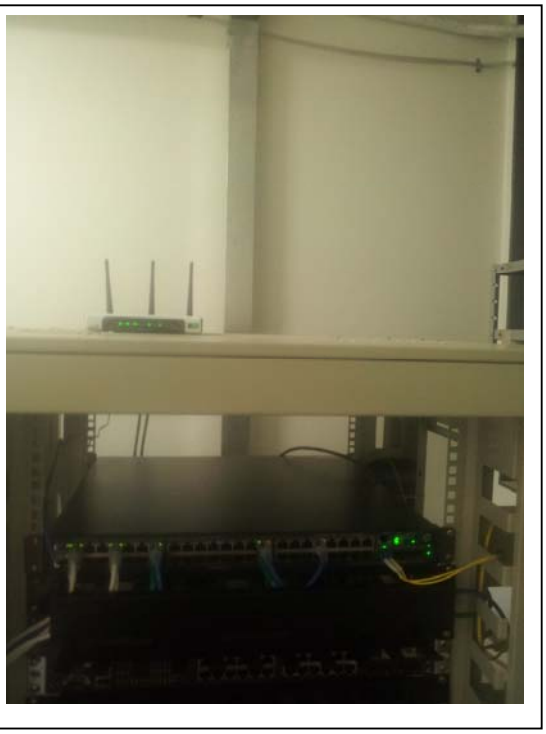
Table 3 - Servers Description

Role	Architecture	OS (host)	RAM	Networking Interfaces	Duties	Description
VM Server	64 bit	Debian Squeeze 64-bit	256 GB	10 Ethernet x 1 Gb	XEN VMs	IBM Model X3650 M4; 2U rack mounted; 2 x Intel Xeon E5-2650 processor; Motherboard with 4 x 1Gb Ethernet ports; three additional I340-T2 dual 1 Gb Ethernet ports; 256 GB DDR3 1333 MHz LP RDIMM; 6 x IBM 1TB 2.5in 7.2Krpm SATA III hard disks; redundant power supply
CONTROL Server	64 bit	Debian Squeeze 64-bit	32 GB	4 Ethernet x 1 Gb	OCF; FlowVisor; DNS and ZenOSS	IBM Model X3650 M4; 2U rack mounted; 1 x Intel Xeon E5-2630 processor; Motherboard with 4 x 1Gb Ethernet ports; 32 GB DDR3 1333 MHz LP RDIMM; 2 x IBM 1TB 2.5in 7.2Krpm SATA III hard disks; redundant power supply

Figure 3 presents some pictures and details some aspects of the hardware deployed at the OFELIA Island in Brasil.

(a) Openflow and TOR Switches.

(b) Island Servers



(d) EDOBRA Switch on top of Rack.

(c) Partial View of Racks.

Figure 3 - Deployed Hardware.

3 OFELIA Federation

The OFELIA Island at UFU will be directly connected to UBristol and then will reach the central hub at IBBT. The circuit between UFU and UBRistol is presented at Figure 4.

The island is located at B Building at Campus Santa Mônica and by using a single mode fiber it will be connected to a switch from ALGAR Telecom, located at J Building. This switch is also part of the ALGAR's metro network and by using a fiber connection provided and sponsored by ALGART Telecom, Uberlândia (MG) will be connected to Campinas (SP), a city 500 kilometers far way. At Campinas the circuit is connected to GIGA Network [7], a high speed experimental network coordinated by CPqD (Centro de Pesquisa e Desenvolvimento) that also is interconnected with the Rede Nacional de Pesquisa (RNP) PoP at São Paulo. RNP is the Brazilian National Research and Education Network (NREN).

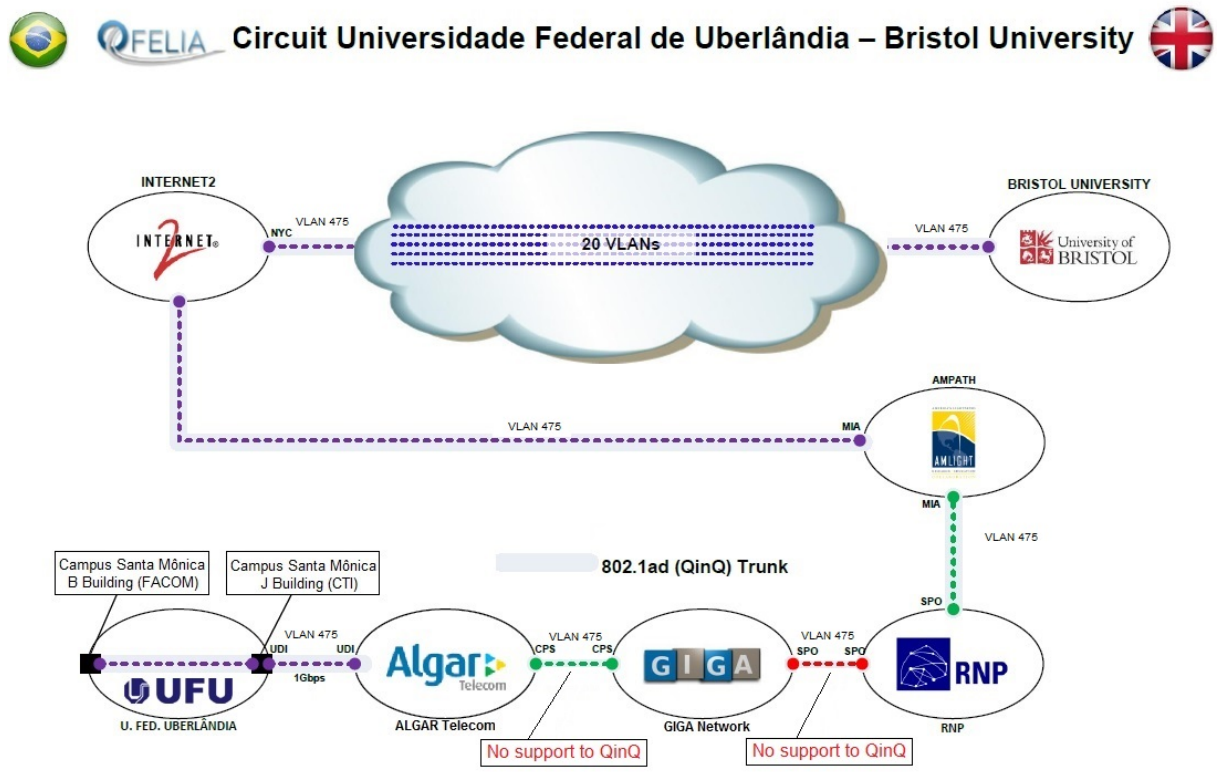


Figure 4 - Circuit with OFELIA.

By using a RNP dedicated circuit at GLIF [8] infrastructure, São Paulo PoP is connected to the AMPATH (Americas Path International Exchange Point) [9]. Then using the Atlantic Wave infrastructure the circuit connects at MANLAN [10] exchange point at New York. Then by using Internet2 [11] and GEANT [12] international connection, through JANET [13] the circuit will reach UBristol.

Due a limitation at GIGA Network, that does not support 802.1ad (QinQ) in some links of the circuit it was necessary to create a VLAN to isolate the traffic. This VLAN was extended until UBristol.

The circuit was successfully tested from Uberlandia until AMPATH. Between Internet2 and UBristol, the VLAN is configured and it is necessary to verify the connectivity. After this verification, federation tests between the Brazilian and European OFELIA islands will be conducted.

4 Cooperation

The OFELIA Island at UFU is being considering by some researchers from the industry and also from the academy that are interested in using its facilities to conduct research and experimentation. This section briefly presents these initiatives, which are beyond EDOBRA (i.e., WP12) scope.

4.1 ALGAR Telecom

ALGAR Telecom is a Brazilian telecommunication operator which offers several services such as fixed and mobile telephony, broadband Internet access (ADSL and 3G), TV (DTH and cable) and domestic long distance and international calls. The portfolio of services is offered by using two different brands: CTBC, used for retail services and ALGAR Telecom for enterprise services.

With more than 800,000 customers, Algar Telecom was founded in Uberlândia, MG and operates for more than 58 years in the market and is now present in all major regions of Brazil, such as Minas Gerais, São Paulo, Distrito Federal, Rio de Janeiro, Mato Grosso do Sul, Goiás and Paraná.

By having a focus on innovation some service platforms used ALGAR Telecom were developed internally by a team of researchers and developers, most of them, alumni from UFU.

ALGAR Telecom also is a key sponsor of EDOBRA project by providing a fiber link between Uberlândia and Campinas, in order to reach Europe by using a dedicated circuit. ALGAR Telecom is planning to use OFELIA facility to perform some experiments and due the liaison between UFU and ALGAR Telecom another action that is being planned is the use of ALGAR telecom cellular network to perform vertical handover experiments between wireless access technologies.

4.2 UFRN (Federal University of Rio Grande do Norte)

At UFRN, more specifically at DIMAP (Departamento de Informática e Matemática Aplicada) [14], some researchers, are working with the ETArch in order to exploit and develop QoS support and the scenarios being considered in this research will be deployed and experimented at OFELIA island at Brazil.

4.3 FIBRE Project

The partnership with OFELIA and FIBRE [15] will also be extend to the OFELIA Island at UFU. In this case, the island will also be interconnected with FIBRE project, thus leveraging the capacity to attract to OFELIA new users. The interconnection with Europe is also being supported by FIBRE partners RNP, CPqD and UBristol.

5 Conclusion

This deliverable presented a report about the deployed OFELIA Island in Brazil.

The island equipments were described and also the addressing scheme that was used. Moreover, the federation with OFELIA was detailed by presenting the circuit that interconnects UFU to OFELIA through UBristol.

OFELIA Island at Brazil will continue its operation after the official end of the project, lasting investments and being an opportunity to other researchers, inside and outside Brazil, to exploit the deployed infrastructure.

The island at Brazil is increasing not only the physical extension of OFELIA, but also is increasing reach by adding new the users that are interested in the research and experimentation regarding SDN at current and also future networks.

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