A L I E N

ABSTRACTION LAYER FOR IMPLEMENTATION OF EXTENSIONS IN PROGRAMMABLE NETWORKS

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Dissemination Level

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Abstract

This deliverable summarizes the dissemination activities, undertaken within the ALIEN project, during the second year of operation (since October 2013 till September 2014). The activities are categorized into the following headings: project website; leaflets, posters and hands-out; conferences and papers; standardization activities; workshops and live demonstrations. The project consortium always placed great importance on all dissemination activities to widely communicate project's results and to emphasize the meaningful impact of project's achievements on research and commercial world. This report presents how the ALIEN project ideas, solutions and results were published and presented as well as where they are available for the future use by people who are not involved in the ALIEN project. In the last part of this report an impact assessment of the project dissemination activities and impact of the ALIEN work are presented. This report is concluded with a summary of dissemination done in the second year of the ALIEN project.

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0 Executive Summary

This report summarizes all dissemination activities of ALIEN project during the second year of operation, since October 2013 till September 2014. The plan for these activities was presented in deliverable D6.4. All dissemination activities were always considered as leadership events which allowed spreading of the ALIEN achievements and in general the knowledge about the ALIEN project, through the project website, technical papers, conference presentations, live demonstrations, posters, and leaflets. The target group for these activities consisted of SDN (Software Defined Networks) experts, telecom operators, IT industry management staff, SDN consultants, students of technical universities and general public interested in OpenFlow protocols, and equipment ready for connection to OpenFlow network. The relevant and well-attended events were selected for the ALIEN demonstrations and dissemination activities.

In the second year of activity, the ALIEN project was focused mainly on the HAL (Hardware Abstraction Layer) implementation on selected platforms, integration under the OFELIA Control Framework (OCF), and testing proposed solutions. The obtained results were very promising and enabled us to announce proposed solution to the target groups through the media. We tried to use all available media to promote the ALIEN project results, described in Section 2. Very important role in dissemination processes played the project website. It shows all information concerning the ALIEN project, and offers an open access to all public deliverables. It is continuously updated with all news and project's achievements. Leaflets and hand-outs were distributed to attract attention of conferences participants and help them be informed about project's concept. One set of the ALIEN project leaflets was printed and disseminated. The posters presented at European Workshop on Software Defined Networks (EWSDN) 2013, Supercomputing Conference (SC) 2013, Future Internet Assembly (FIA) 2014, IEEE/IFIP Network Operations and Management Symposium (NOMS) 2014, TERENA Networking Conference (TNC) 2014, IEICE Information and Communication Technology Forum (ICTF) 2014, IEEE 15th International Conference on High Performance Switching and Routing (HPSR) 2014, ACM Special Interest Group on Data Communication (SIGCOMM) 2014, European Workshop on Software Defined Networks (EWSDN) 2014, 30th National Symposium on Telecommunications and Teleinformatics (KSTiT) 2014 showed the architecture of ALIEN devices with the HAL, and hardware platforms use for HAL implementation. The members of ALIEN community were keen on presenting papers and posters during various events. During the duration of ALIEN project 16 technical papers and 13 posters were presented at scientific conferences and workshop. 4 papers were published in journals. In the Y2 of the ALIEN project 12 standardization contributions were prepared and presented during the IRTF and the SDNRG meetings.

The achievements of the ALIEN project were presented not only to European, but also to American and Asian specialists during conferences at international level (SC 2013, FIA 2014, NOMS 2014, ICTF 2014, HPSR 2014, SIGCOMM 2014). The ALIEN project standardization activity was also presented to worldwide community (SDNRG IETF 88 2013, SDNRG IETF 89 2014, ICNRG IETF 90 2014, and SDNRG IETF 90 2014). The most important event, where the ALIEN project results were presented, was European Workshop on Software Defining Networks organized this year in Budapest, Hungary (1-3

September 2014). The final ALIEN workshop was organized in close coordination with EWSDN. During this conference a special tutorial titled: "ALIEN Tutorial on advanced technologies in OpenFlow networks" was taught by ALIEN specialists. In addition, five papers, three posters and one demonstration were presented to EWSDN participants.

The main achievement of the ALIEN project – HAL (Hardware Adaptation Layer) proposal, specification and implementation on selected platforms – was verified during live demonstrations. These demonstrations were treated as a proof of concept and were always under serious consideration of the ALIEN consortium. All live demonstrations were taking place during (see Section 3): FIA 2014 in Athens (3 demos), TNC 2014 in Dublin (2 demos), EWSDN 2014 in Budapest (1 demo)m and ONS 2014 in Santa Clara, California (1 demo).

Within standardization activities (Section 2.4) the ALIEN project has contributed to a document concerning SDN reference terminology and architecture titled: "SDN Layers and Architecture Terminology". This document can be used as a foundation for further work in the IETF and the IRTF. Under the leadership of EICT several drafts of the "SDN Layers and Architecture Terminology" document were prepared and presented at IETF meetings (IETF 88, IETF 89, and IETF 90). The draft is currently in IESG review and we expect that it will become an RFC in the near future. Moreover, the ALIEN project was introduced in the following ICNRG (Information-Centric Networking Research Group) contribution: "Information-centric Networking: Evaluation Methodology". We expect that the ALIEN project achievements in the area of ICN (Information-Centric Networking) evaluation will be introduced in this draft.

This report includes also evaluation of Key Performance Indicators (KPIs), impact assessment of dissemination activities, and impact of the ALIEN work. In the second year of the ALIEN project there were planned 30 KPIs and we achieved 28, 1 KPI was achieved partially, 1 KPI was not achieved, and we achieved 5 additional KPIs. It should be also noted that in the first year of the ALIEN project there were planned 16 KPIs and 15 was and 1 was not achieved. Hence, total there were planned 46 different ALIEN targets and KPIs and 49 such targets were achieved (including 1 KPI achieved partially and 5 KPIs achieved additionally) and 2 were not achieved. The exact list of KPIs is delivered in Section 4.

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1 Introduction

This deliverable provides a summary of dissemination activities done during the second year of the ALIEN project (period since October 2013 to September 2014). It includes all events, workshops, conferences, live demonstrations, journals, and information materials like for example posters, leaflets, and hand-outs which made the ALIEN project better-known in the research and industrial community. We are very proud that we became in last days a part of the SDN history because in the prepared SDN encyclopedia "Software-Defined Networking: A Comprehensive Survey" our solution proposed in the ALIEN project has been mentioned and described, and few our articles have been cited [1].

This report gives also information how the project ideas, solutions and results were published, presented and where these publications are available (or some part of them) for the future use by other researchers and scientists as well as for, or maybe special for, people who were not involved in the ALIEN project. We prepared a special GitHub Section where repositories of the source code implemented in the ALIEN project are available [2], [3], [4], [5], [6], and [7]. However, due to some license restriction not all code is available – exceptions are Cavium Octeon and EZappliance platforms.

In comparison to the first year (Y1) of the ALIEN project (according to deliverable D6.3 "Report on the dissemination activities in the first year of the project" [8]), in the second year (Y2) much more publications were done. We attended several conferences addressed to European- or worldwide-range community. We prepared also few live demonstrations where ALIEN project results and solutions were shown to wide audience. In Y2 we attended few meetings the most important for the Software Defined Networks community where our solution was presented and introduced. We exchanged there also our experience with people from other European projects concentrating on the Future Internet aspects.

Our window to the world is the official ALIEN project website [9]. We use this website to disseminate all important information about our progress in implementation of HAL, ideas, available publications, and future plans as quick as it was possible.

Long term vision of impact of the ALIEN project results on the research and commercial world

The achievements of ALIEN project have a large impact on research and commercial world. As a result, non-OpenFlow devices can be connected to OFELIA infrastructure (OpenFlow network) creating unique heterogeneous environment for

testing protocols as well as control and management mechanisms. The research concerning the three components seems to be crucial for SDN deployment models. Three such models were proposed till now:

- switch based – SDN controller can send messages directly to the data plane implemented in network equipment;
- overlay network (tunnel based overlay approach) – hypervisor environment is implemented in a data source and end host; the SDN controller sends control messages directly to the SDN hypervisor switches;
- and hybrid (a combination of the switch based and overlay models) – this approach can be used to gradually migrate existing equipment to a new switch based model.

It is very likely that the hybrid model will be used by companies to evolutionary transform existing networks to SDN networks. Furthermore, in transition period they will require non-SDN equipment to communicate with SDN-native equipment. To perform this migration smoothly it is necessary to use a Hardware Adaptation Layer (HAL), which can help to force the non-SDN equipment to be controlled by the SDN controller. The hardware adaptation layer for applying the OpenFlow protocol to the non-OpenFlow hardware which was proposed by the ALIEN project seems to be a good solution of this problem. The ready-to-use software enabling selected non-OpenFlow devices to communicate with OpenFlow controller within OFELIA infrastructure is an outcome of the project.

In the heterogeneous environment consisted of non-OpenFlow and OpenFlow equipment it is possible to do a research on SDN network control and management issues, traffic control, scalability, security etc.

The results of ALIEN project show that HAL allows using the non-OpenFlow equipment in the OpenFlow environment. The impact of ALIEN project achievements to commercial world lies mainly in application of the HAL functionalities and extensions of OpenFlow protocol to selected non-OpenFlow devices. This shows that it is possible to extend OpenFlow functionality on different kind of programmable devices, and transition to the SDN network does not mean that all network equipment has to be a new and SDN-native. The software produced by the ALIEN project may be used to connect selected devices to the OpenFlow network.

Structure of the deliverable

This deliverable has the following structure. Section 2 covers all dissemination activities done in Y2:

- in subsection 2.1 the official ALIEN project website is described;
- in subsection 2.2 all leaflets, had-outs and posters used by ALIEN project in Y2 are described;
- in subsection 2.3 all planned and attended by the ALIEN community members conferences are described;
- in subsection 2.4 the ALIEN project standardization activities are described;
- in subsection 2.5 workshops are presented.

In turn, in Appendix A the full list of ALIEN's publications is available. In Section 3 all live demonstrations prepared by the ALIEN project are described. In the next section (Section 4) discussion about planned and achieved as well as not achieved Key Performance Indicators (KPIs) is provided with the proper explanation if needed. In Section 5 the impact assessment of dissemination activities in Y2 is described. In the next part of this report (Section 6) the impact of work done under the ALIEN project is delivered. This deliverable is concluded in Section 7

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2 Dissemination Activities

2.1 Project Website

The ALIEN project website is accessible through the address http://www.fp7-alien.eu [9]. Project website is the main dissemination channel of the ALIEN project. The screenshot from the main page is depicted in Figure 2.1. The web page is the central place for ALIEN up to date news, information about the project goals and constitutes the main contact form. It contains also a list of project deliverables accessible as PDF files. The ALIEN website structure and content was described earlier in deliverables D6.1 [10] and D6.3 [8].

ALIEN project website is also the central information point about the software designed and developed within the ALIEN FP7 project (Figure 2.2). The 'Software' tab provides a list of software packages divided into four main groups:

- Framework for Hardware Abstraction Layer development
- ALIEN Control Framework – software packages for integration with OFELIA
- Framework for tests
- Hardware Specific Parts (HSPs) prototypes

All software packages listed on the website link to proper code source archives or to external code managers like GitHub [2], [3], [4], [5], [6], and [7] (see Figure 2.4). Each software package contains code, description of the components and proper README files with guidelines what it is, for what, and how to install it.

ALIEN project website is maintained by PSNC with cooperation with Work Packages leaders and code developers. In order to analyze the ALIEN website activity the visitor's statistics tool has been installed. The next subsections present more detailed statistics of the ALIEN project website. All presented statistics refer to the period from October 2013 to September 2014 (second year of the ALIEN project). Statistics from the first year of the ALIEN project are included in the deliverable D6.3 [8].

Figure 2.1 ALIEN project website

Figure 2.2 ALIEN website – software contact point

Figure 2.3 ALIEN publications listed on the official website

During the second year of the ALIEN project several papers were published. Most of them cover ALIEN Hardware Abstraction Layer concept for set of non-OpenFlow network devices, new control framework for integration with OFELIA with novel methods of AAA (Authentication, Authorization and Accounting) as well as extensions to OpenFlow protocol and SDN concept.

The ALIEN project publications are listed on the official ALIEN project website (see the 'Software' tab in the menu on the right part of the official project website) under link: http://www.fp7-alien.eu/?page_id=28 (see Figure 2.3). Two of them (TNC 2014 and SIGCOMM 2014) are publicly accessible from the ALIEN website.

The full list of ALIEN publications done in Y2 is available in Appendix A.

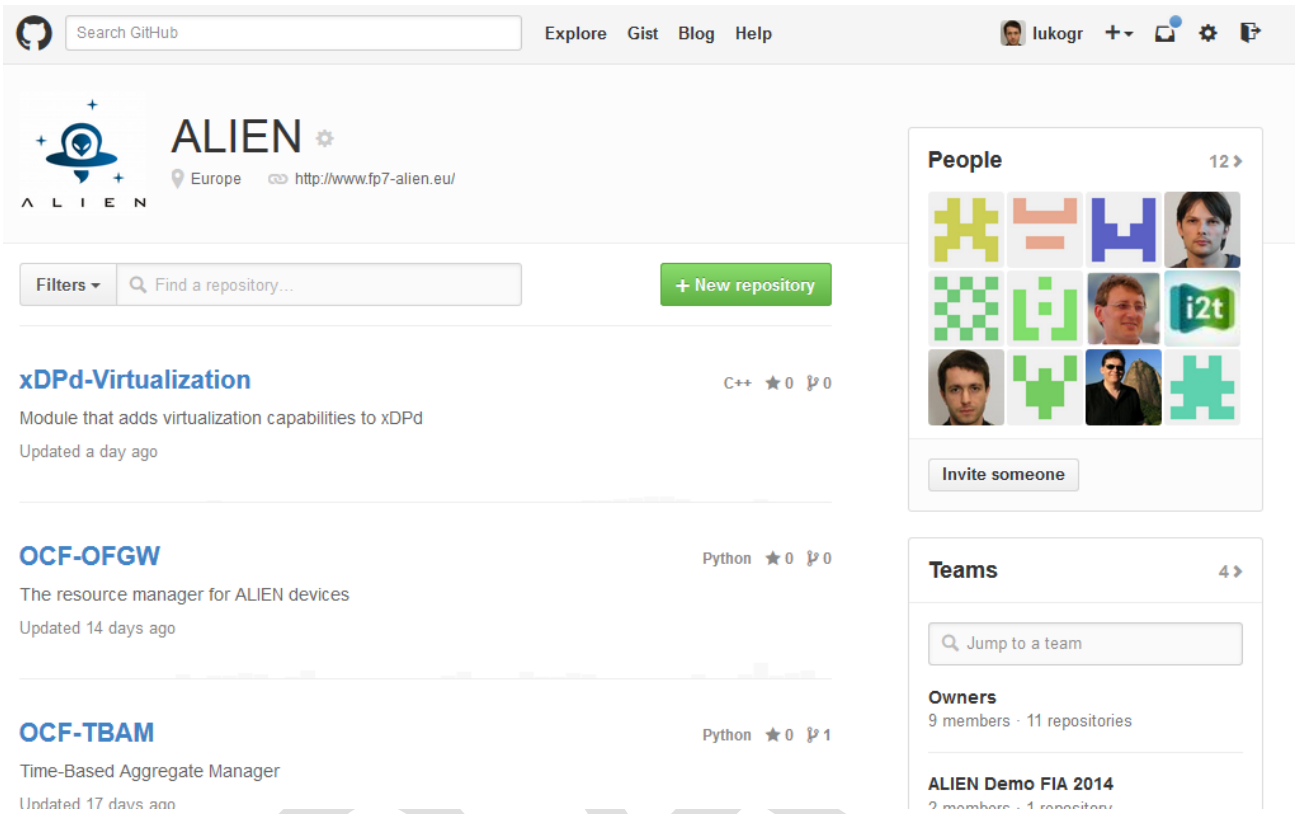

Figure 2.4 ALIEN software on GitHub

Except the official ALIEN website [9], which is public, we used also the private website for internal use only. We uploaded there all partners' contributions to many deliverables and papers, all device's configuration information, actual state of the work, minutes from weekly videoconferences, and many more. The final result of our work constituted papers or deliverables (if they were for public use according to the DoW) which were then available for public at the official project website [9].

2.1.1 Unique visitors

A unique visitor should be understand as a person or a computer that has made at least 1 hit on one page of the web site during the specified period. If the visitor makes several visits during this period, it is counted only once. Visitors are tracked by the IP address. So, if multiple users are accessing project's site from the same IP (such as a home or office network), they will be counted as a single unique visitor.

Figure 2.5 presents ALIEN website unique visitors statistics in the second year of the project (period from October 2013 to September 2014).

Figure 2.5 ALIEN website statistics – unique visitors

2.1.2 Visits of the project's website

Definition of the "visit" is a user activity on website on specified period of time – in this case it is one month. During that period all activity (requesting many pages) regards 1 visit.

Figure 2.6 presents statistics of visits of the ALIEN website in the second year of the project (period from October 2013 to September 2014).

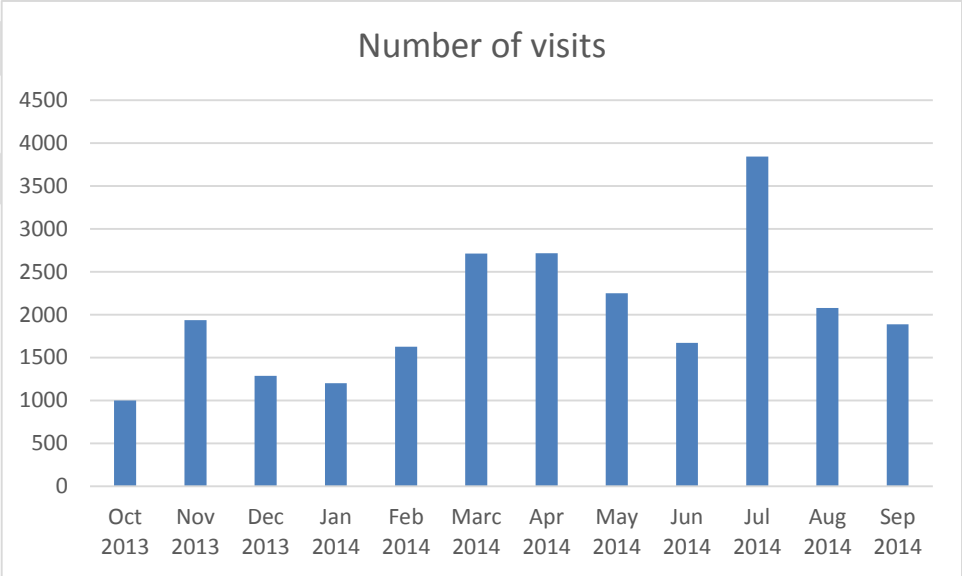

Figure 2.6 ALIEN website statistics – number of visits

2.1.3 Average pages per visit

This subsection presents the number of "pages" viewed by visitors. “Pages” are only the HTML and PHP files, not images or other files requested as a result of loading a "Page".

Figure 2.7 presents statistics of number of visited pages of ALIEN websites per visit in the second year of the project (period from October 2013 to September 2014).

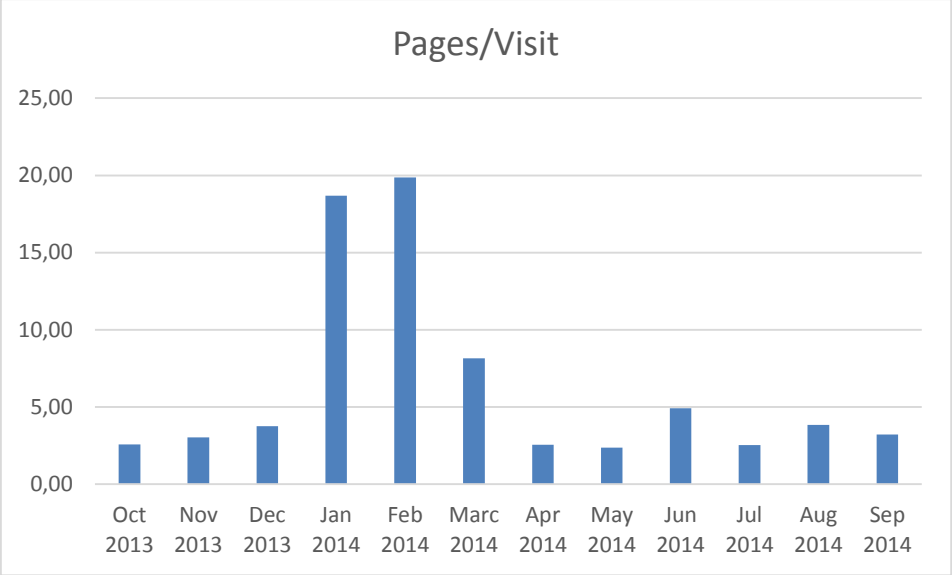

Figure 2.7 ALIEN website statistics – pages per visits

2.2 Leaflets, Posters, Hand-outs

During the second year of activity the ALIEN project prepared several posters and leaflets presented at European and international conferences and workshops. The list of printed dissemination materials is as follows:

1. European Workshop (EWSDN 2013) – Berlin, Germany, 10-11 October 2014 [11]

   It was prepared a special tall and narrow poster according to the organizers requirements:

   - This poster is presented in Figure 2.8 and Figure 2.9. It contains:
     - ALIEN hardware platforms,
     - HAL architecture.

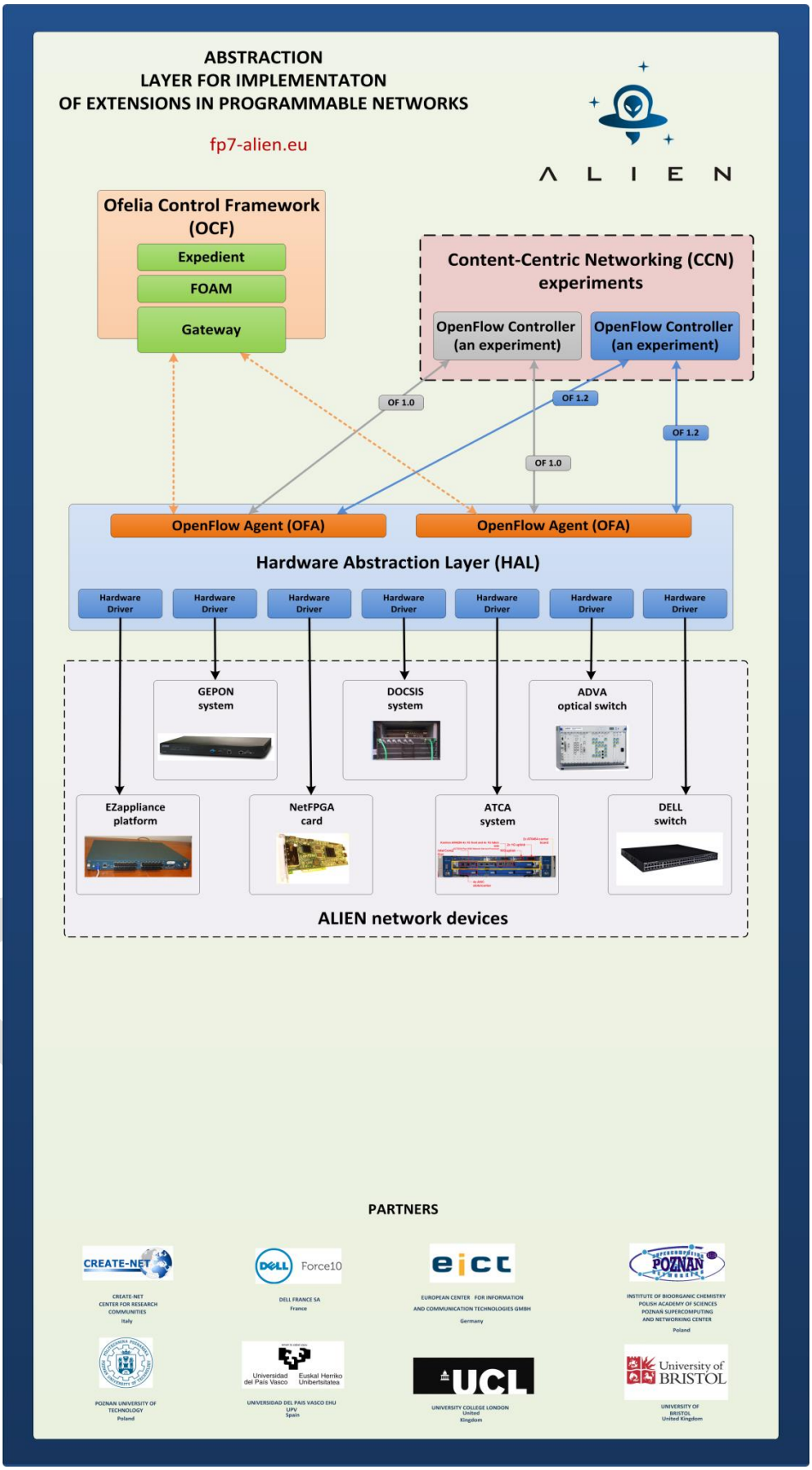

Figure 2.8 ALIEN project poster from EWSDN 2013 conference (Berlin, Germany)

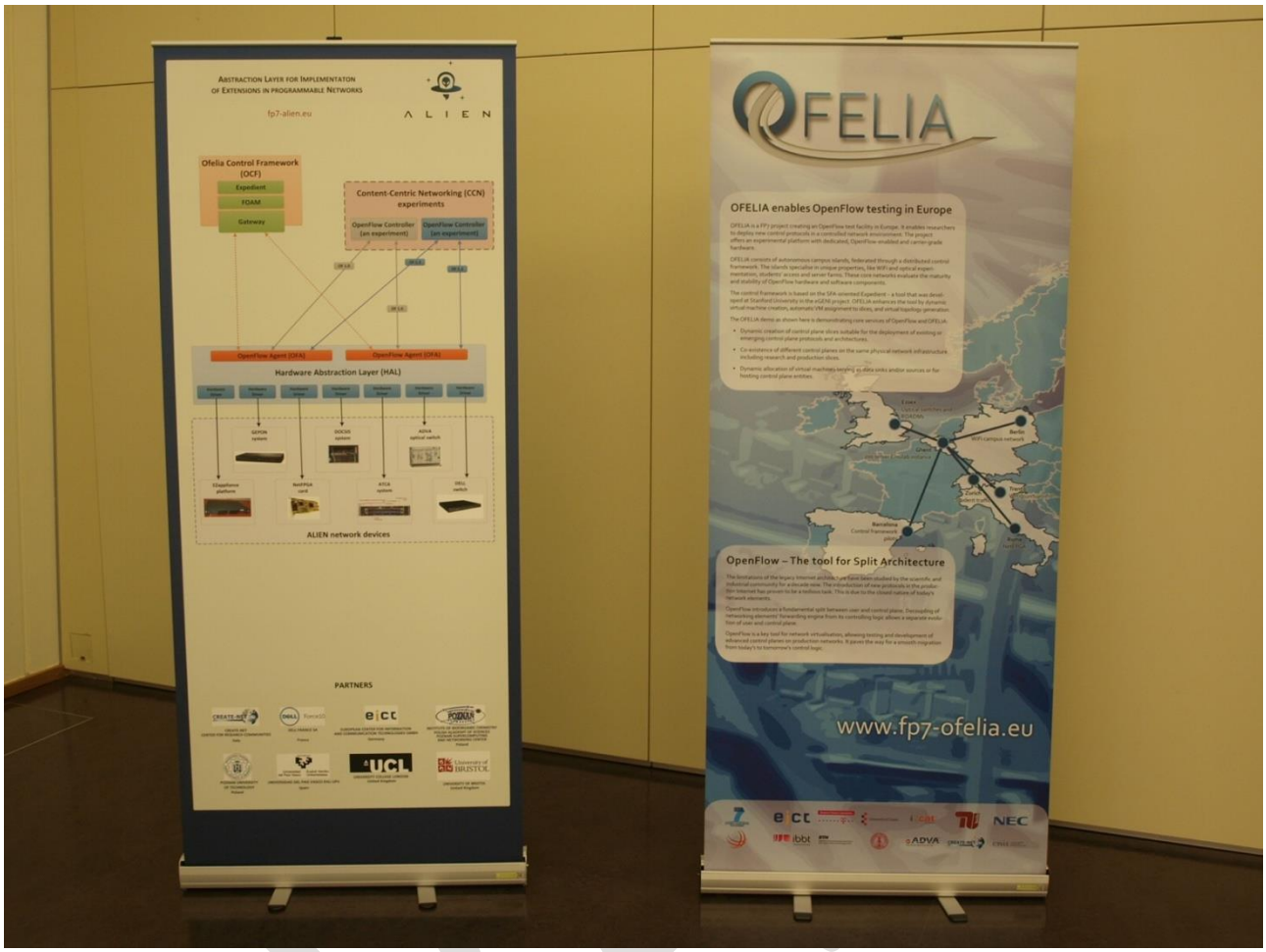

Figure 2.9 Photo of ALIEN poster from EWSDN 2013 conference (Berlin, Germany)

2. Supercomputing Conference 2013 (SC 2013) – Denver, USA, 17-20 November 2013 [12]

   It was prepared especially for this event ALIEN poster connected with other projects:

   - This poster could be seen in Figure 2.10 and it includes:
     - information about ALIEN project objectives,
     - ALIEN hardware platforms,
     - HAL architecture

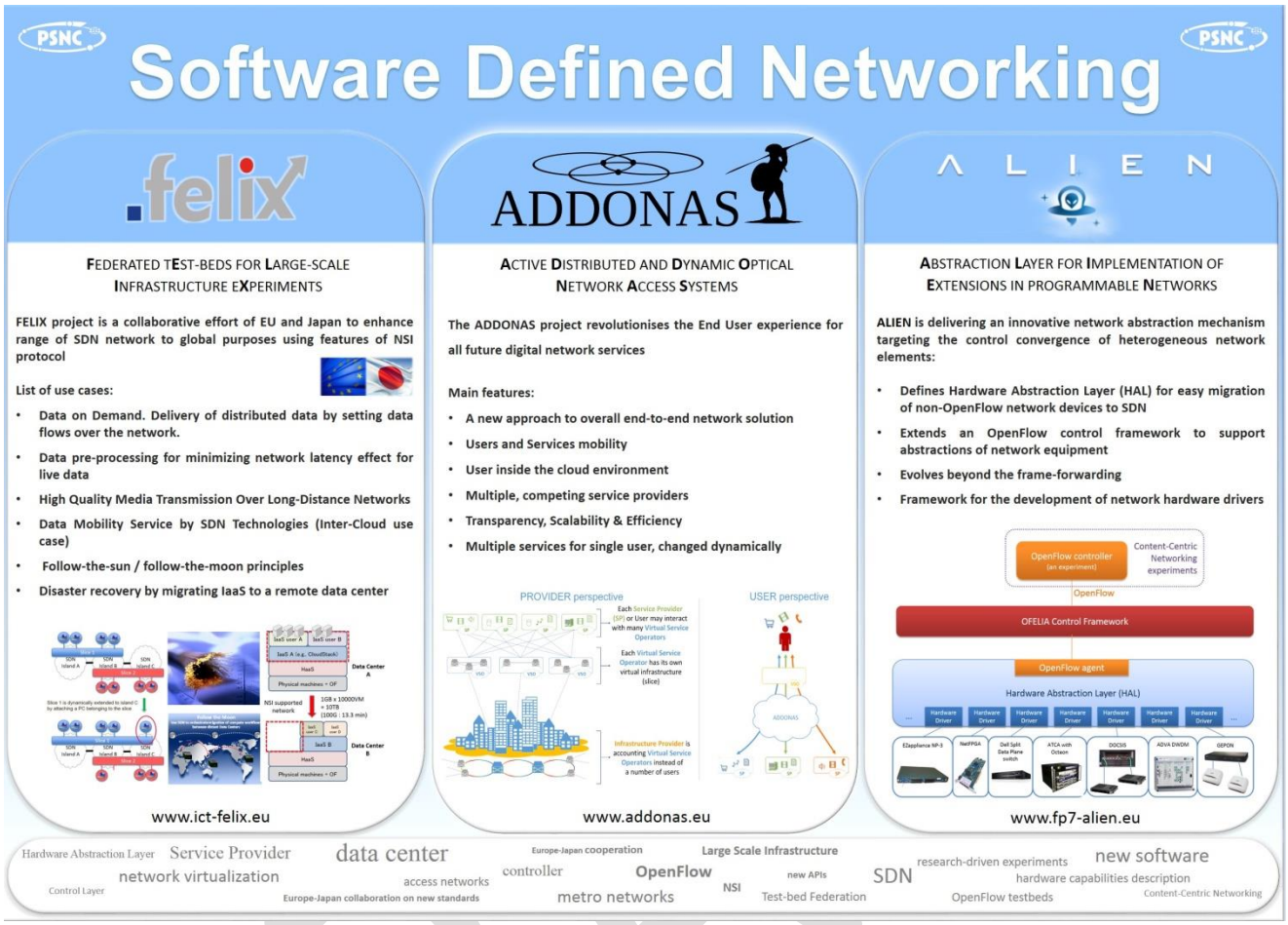

Figure 2.10 The ALIEN poster from SC 2013 conference (Denver, USA)

3. Future Internet Assembly 2014 (FIA 2014) – Athens, Greece, 18-20 March 2014 [13]

There were prepared especially for this event leaflets and two ALIEN posters:

- Two-sided leaflet, which is presented in Figure 2.11 and Figure 2.12, contains:
  - information about ALIEN project objectives,
  - ALIEN hardware platforms,
  - HAL architecture
  - framework for HAL implementation.

Figure 2.11 Front side of the ALIEN leaflet from FIA 2014 conference (Athens, Greece)

Figure 2.12 Back side of the ALIEN leaflet from FIA 2014 conference (Athens, Greece

- The first poster is presented in Figure 2.13 and Figure 3.6. It contains:
  - ALIEN project objectives,
  - ALIEN HAL architecture,
  - ALIEN framework for HAL implementation based on xDPd/ROFL [14], [15].
- The second poster is presented in Figure 2.14 and it contains:
  - ALIEN demonstration themes,
  - Demo 1 – streaming on demand in OF networks,
  - Demo 2 – introduced distributed virtualization in OF networks,
  - Demo 3 – integration of legacy DOCSIS access network under OF control.

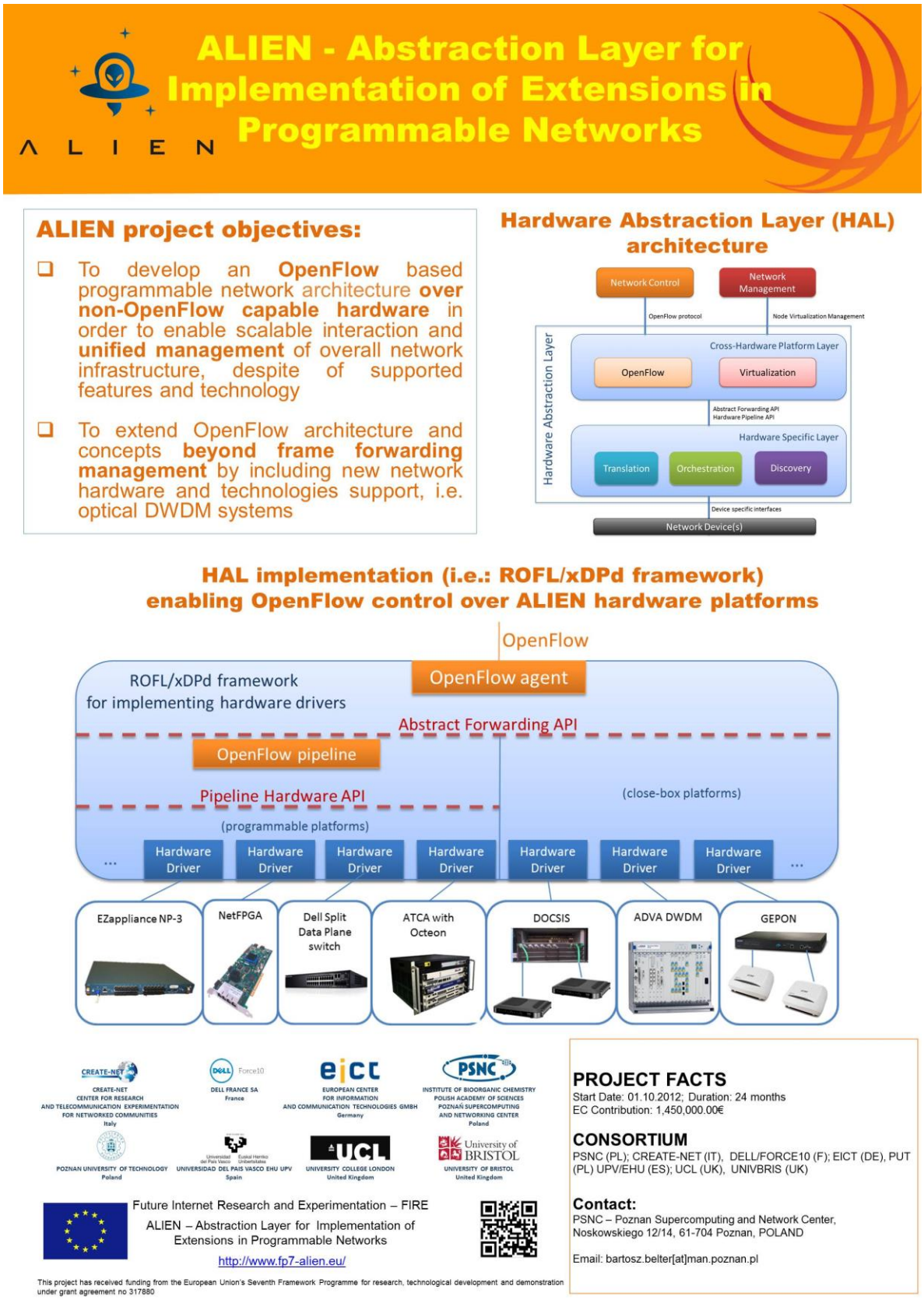

Figure 2.13 ALIEN project poster no 1 from FIA 2014 conference (Athens, Greece)

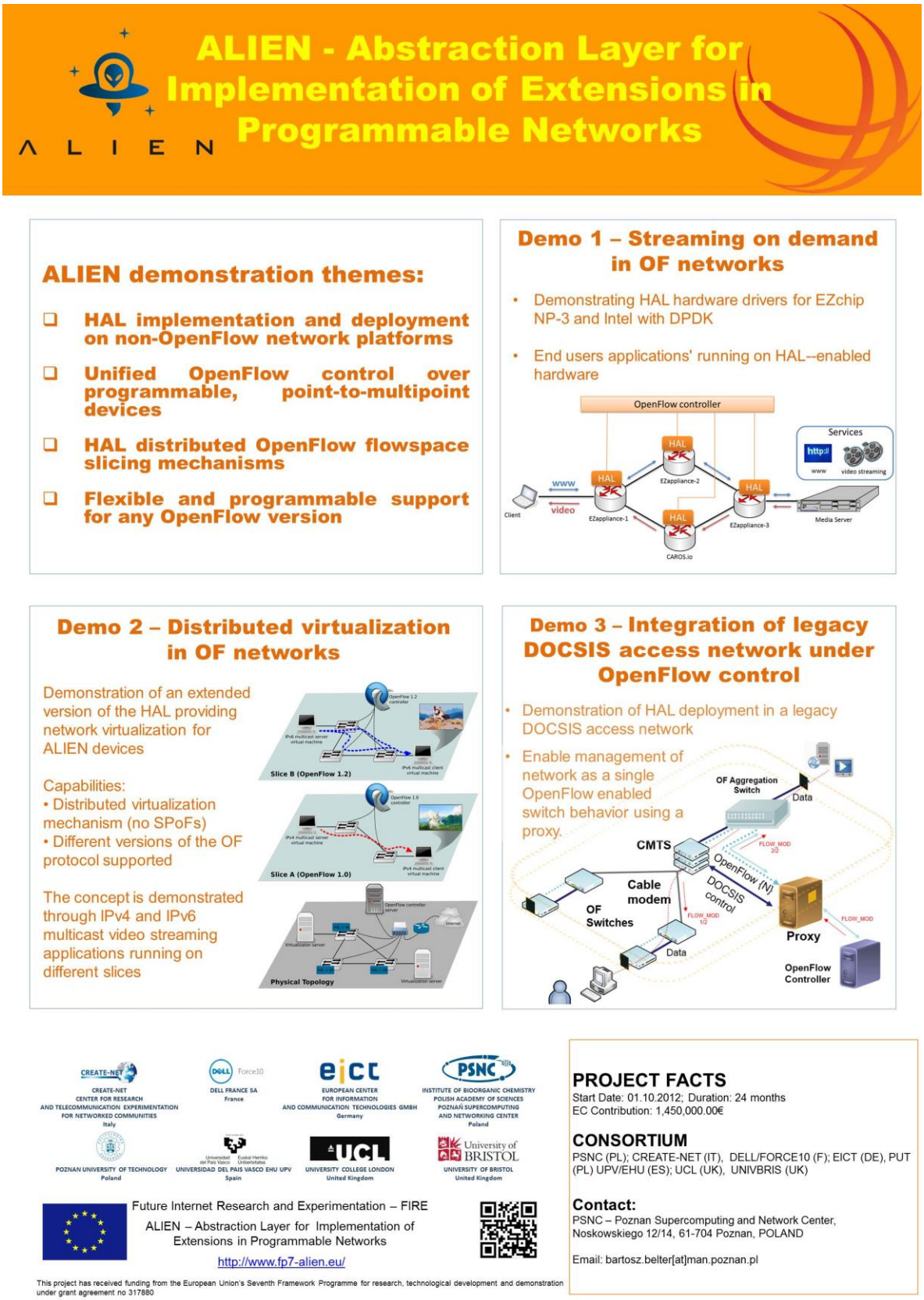

Figure 2.14 ALIEN project poster no 2 from FIA 2014 conference (Athens, Greece)

4. TERENA Networking Conference 2014 (TNC 2014) – Dublin, Ireland, 19-22 May 2014 [16]

   During this conference there were used leaflets prepared for FIA 2014 meeting and we also prepared a new poster especially for this event:

   - Leaflet used to during event were exactly the same as this used for the Future Internet Assembly 2014 meeting. Project of such a leaflet can be seen in Figure 2.11 and Figure 2.12.
   - The poster is presented in Figure 2.15 and Figure 3.7. It contains:
     - ALIEN demonstration themes,
     - Demo 1 – introduced streaming on demand in OF networks,
     - Demo 2 – covered DOCSIS platform integration in OFELIA.

5. IEICE Information and Communication Technology Forum 2014 (ICTF 2014) – Poznan, Poland, 28-30 May 2014 [17]

   During this conference we used our designed earlier leaflets and additionally we prepared a new ALIEN poster:

   - These leaflets were designed for the FIA 2014 meeting and were used by us also during other conferences. Project of these leaflets can be seen in Figure 2.11 and Figure 2.12.
   - This poster can be seen in Figure 2.16 and Figure 2.23. It contains:
     - ALIEN project objectives,
     - ALIEN HAL architecture,
     - ALIEN framework for HAL implementation based on xDPd/ROFL [14], [15].

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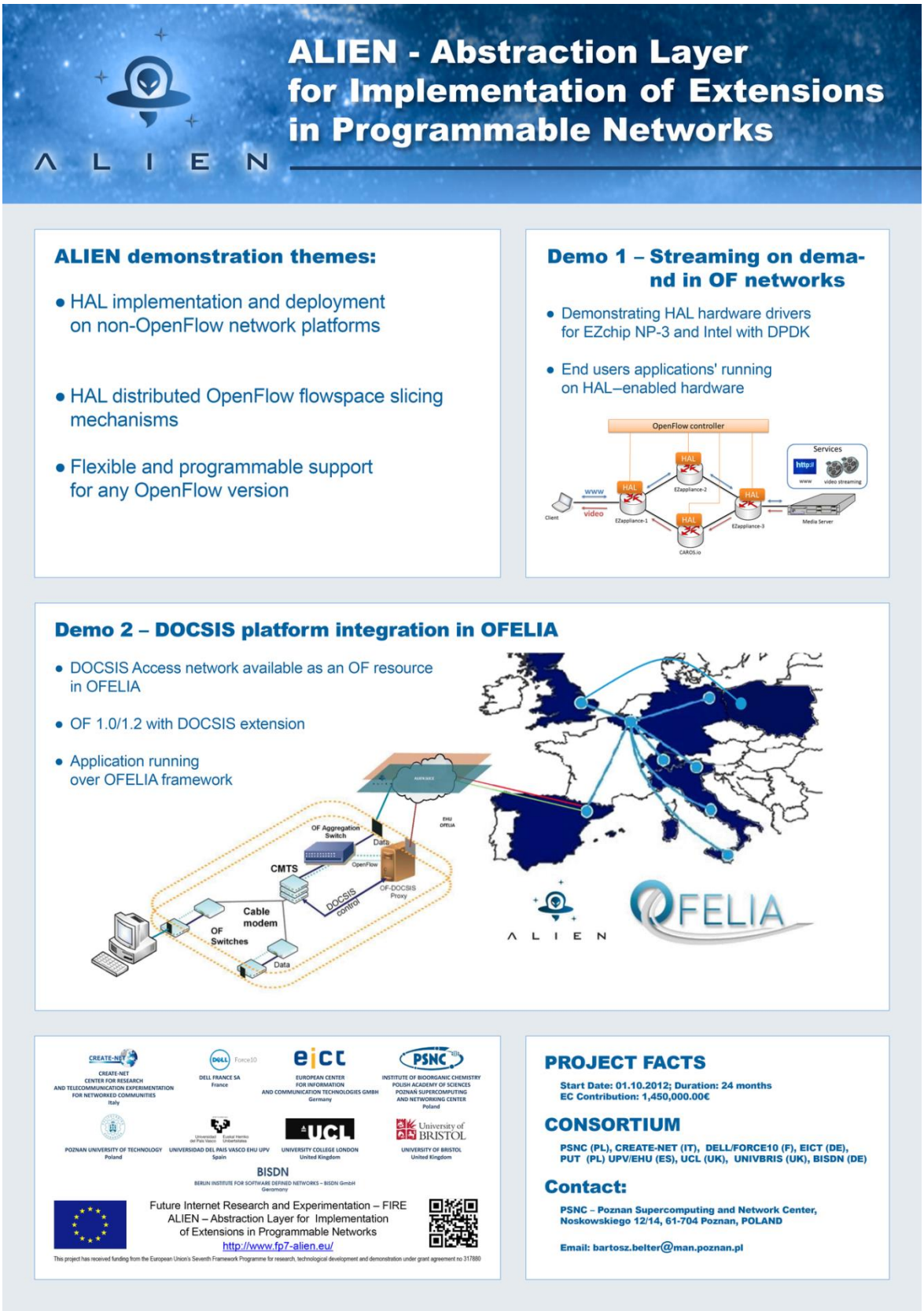


Figure 2.15 ALIEN project poster from TNC 2014 conference (Dublin, Ireland)

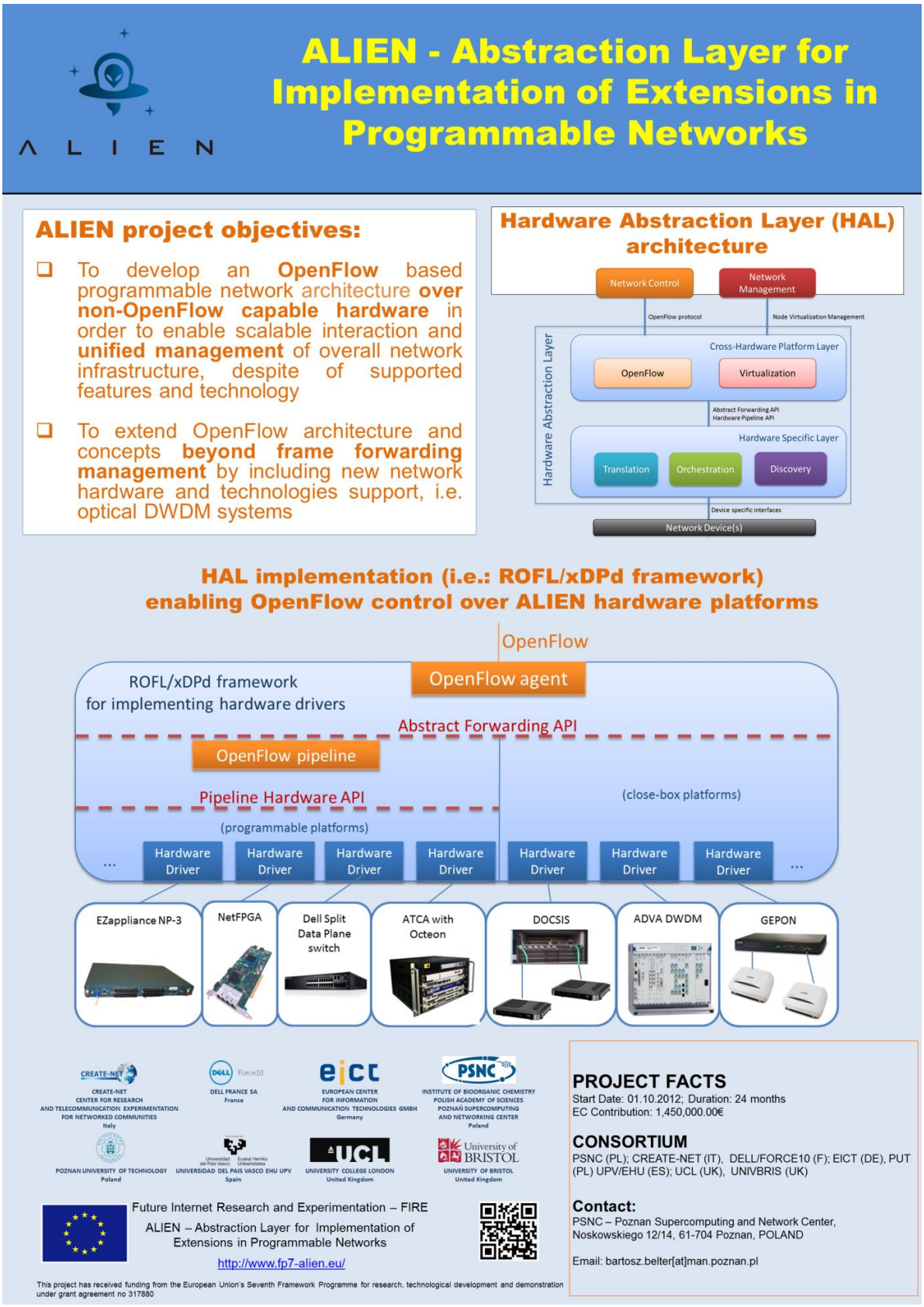


Figure 2.16 ALIEN project poster from ICTF 2014 conference (Poznan, Poland)

6. European Workshop on Software Defined Networks 2014 (EWSDN 2014) – Budapest, Hungary, 1-3 September 2014 [18]

   During this workshop we used leaflets and specially designed for the event four new posters:

   - These leaflets were designed for the FIA 2014 meeting and were used by us also during other conferences. Project of these leaflets can be seen in Figure 2.11 and Figure 2.12.
   - The first poster is presented in Figure 2.17 and it contains:
     - ALIEN HAL features,
     - introduction to ROFL libraries,
     - introduction to xDPd daemon,
     - HAL implementation on OCTEON.
   - The second poster is presented in Figure 2.18 and it contains:
     - information about target hardware,
     - ALIEN HAL framework for HAL implementation,
     - HAL implementation in EZappliance,
     - HAL implementation in DOCSIS.
   - The third poster is presented in Figure 2.19 and it contains:
     - OFELIA facility introduction,
     - the OFELIA Control Framework,
     - two different approaches to allow OpenFlow>1.0 experimentation on the OFELIA testbed:
       - the time-based architecture,
       - the distributed slicing architecture.
   - The fourth poster is presented in Figure 2.20 and it contains:
     - introduction to FlowVisor,
     - demo setup,
     - demo description.

An OpenFlow Implementation for Network Processors

Marc Suñé, Victor Alvarez, Tobias Jungel, Umar Toseef, Kostas Pentikousis

Hardware Abstraction Layer – HAL

HAL Features

- Provides **OpenFlow** based programmable network architecture **over non-OpenFlow capable hardware**.
- Enables scalable interaction and **unified management** of the overall network infrastructure, irrespective of the supported features and technology

Revised OpenFlow Libraries (ROFL)

i. *ROFL-common* library serves as a building block for developing **OpenFlow Endpoints.**

ii. *ROFL-pipeline* library, written in ANSI C, helps building **OpenFlow pipelines** that can be integrated into any hardware platform.

iii. *ROFL-HAL* library implements **AFA** interface between the hardware independent **CMM** and the hardware-dependent platform drivers.

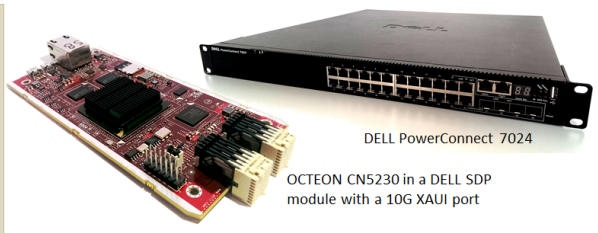
eXtensible DataPath daemon (xDPd)

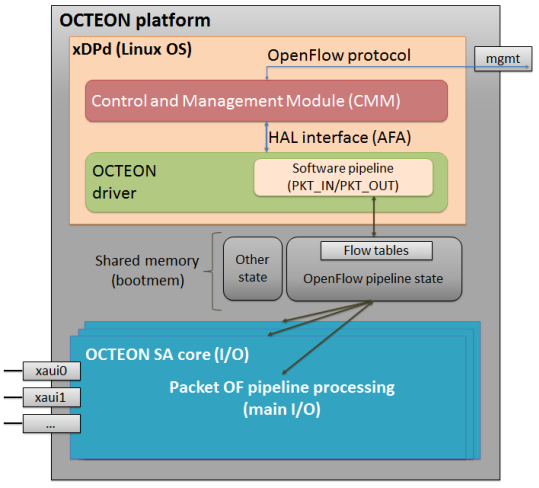
- **A ROFL based framework** for developing OpenFlow datapath elements.
- Easily **extensible** to support new forwarding devices and platforms, new OpenFlow versions and extensions.
- Capable of being **configured and managed** by plugins through the simple C++ native management API.

HAL Implementation on OCTEON

OCTEON Platform

- Cavium OCTEON is a Programmable Network Platform with **multi-core** MIPS64 processors.
- One **management core** runs the GNU/Linux OS executing xDPd's process (i.e. CMM, plug-ins, etc.) and the OCTEON specific driver.
- The other cores run in **standalone** mode (SE-S) to perform fastpath packet processing (I/O).
- **Shared memory** (bootmem) allows sharing *ROFL-pipleline* data structures between management and I/O cores.
- **Packet flow** goes entirely through the I/O cores, except in the event of a `packet_in`.
- The management core deals with the configuration of the **fastpath rules** in the OpenFlow pipeline as well as with **OpenFlow controller** via the OpenFlow protocol.





BISDN Berlin Institute for Software Defined Networks

European Center for Information and Communication Technologies EICT GmbH

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 317880

Figure 2.17 ALIEN project poster no 1 from EWSDN 2014 conference (Budapest, Hungary)

Hardware Abstraction Layer as an SDN-enabler for non-OpenFlow network equipment

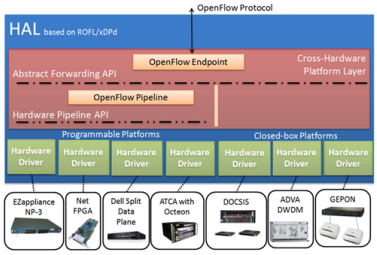
B. Belter, D. Parniewicz, Ł. Ogrodowczyk, A. Binczewski, M. Stroiński
V. Fuentes, J. Matias, M. Huarte, E. Jacob

Hardware Abstraction Layer

Target Hardware Themes

- **X86-based packet processing devices**
  General purpose network devices that perform packet handling in software
- **Programmable network processors**
  Network devices which allow their data plane to be programmed to perform packet processing
- **Lightpath devices**
  Optical devices such as reconfigurable optical add-drop multiplexer (ROADM) systems
- **Point to multi-point access networks**
  Gigabit Ethernet Passive Optical Network (GEPON) or Data Over Cable Service Interface Specification (DOCSIS)

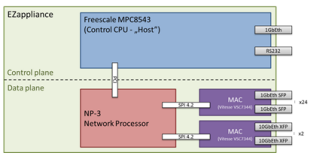
HAL implementation over different hardware platforms



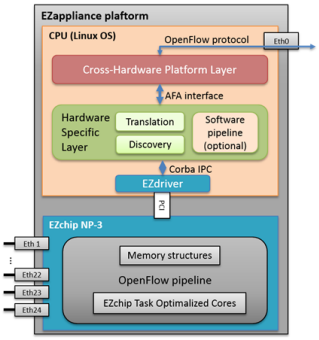
HAL implementation on EZappliance

EZappliance Platform

- Compact hardware platform based on EZchip NP-3 network processor
- Evaluation system for easy development and deployment of new efficient network applications
- Produced by EZchip Technologies from Israel (http://www.ezchip.com)

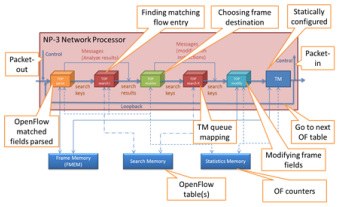


Software Architecture

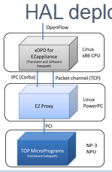


Implementation

- OpenFlow pipeline over TOPs in NP-3



- HAL deployment on EZappliance

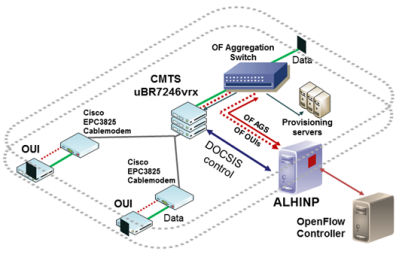


- Language: C++
- License: Mozilla Public License 2.0
- HAL interface used: AFA
- Language: C/C++
- License: proprietary (NDA)
- Language: EZchip assembler
- License: proprietary (NDA)

HAL implementation on DOCSIS

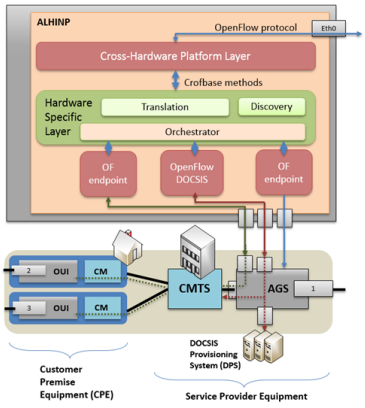
DOCSIS Platform

- DOCSIS Access network exposed as a single OpenFlow switch.



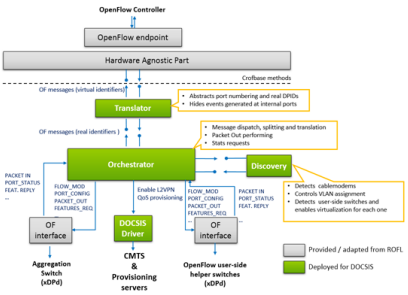
ALHINP: ALien Hardware INtegration Proxy
OUI: OpenFlow User Instance
AGS: Aggregation Switch

Software Architecture



Implementation

- HAL deployment on DOCSIS



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This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 317880

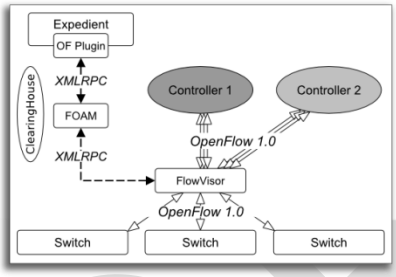
Figure 2.18 ALIEN project poster no 2 from EWSDN 2014 conference (Budapest, Hungary)

3rd European Workshop on Software Defined Networks - EWSDN 2014 | 1-3 September 2014, Budapest - Hungary

Leading the OFELIA Facility Beyond OpenFlow 1.0 Experimentations

M. Santuari, R. Doriguzzi Corin, M. Gerola, E. Salvadori — CREATE-NET
U. Toseef, A. Zaalouk — EICT GmbH
K. Dombek, D. Parniewicz — PSNC
A. Hammad, M. Rashidi-Fard — University of Bristol
E. Jacob, J. Matias — UPV/EHU

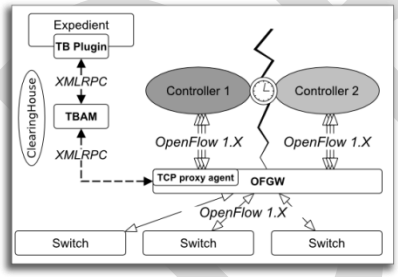
The OFELIA (www.fp7-ofelia.eu) is a programmable network facility designed to offer an OpenFlow-enabled infrastructure to allow Software Defined Networking (SDN) experimentation. Unfortunately, OFELIA does not provide support for versions of the OpenFlow protocol beyond v1.0. Therefore, it is hard for the research community to explore and test the newest functionalities of the protocol in realistic environments.
In this poster, two different architectures are proposed to overcome this limitation of the OFELIA experimental facility.



The OFELIA Control Framework (OCF)

To enable experimenters to register to the facility, configure their experiments, request, setup and release resources, OFELIA provides an experiment orchestration software called OFELIA Control Framework (OCF).
The OCF's architecture comprises different components: (i) **Expedient** provides a Graphical User Interface (GUI) that can be connected to different Aggregate Manages (AM) through a plug-in system. (ii) The **ClearingHouse** is the entity which hands out the identities of the experiments and user certificates and credentials. (iii) **FOAM** is an Aggregate Manager for OpenFlow resources developed by Stanford University. It is used to handle (create, approve, reject, disable, etc.) the OpenFlow slices.
(iv) **FlowVisor** allows the slicing of the flowspace, enabling the sharing of OpenFlow resources between several experiments at the same time.

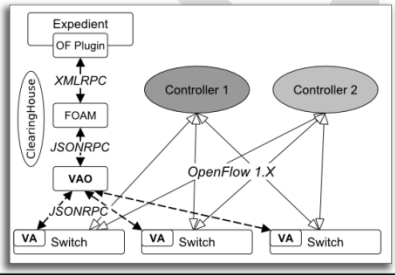
FlowVisor only supports OpenFlow version 1.0, therefore OFELIA only allows sharing OFv1.0 resources due to its tight relation with FlowVisor.



The Time-Based architecture

The primary purpose of this approach is to avoid the inspection of the protocol by replacing FlowVisor with a **TCP proxy agent** that forwards the control messages to the user's controller. Since no flowspace slicing operations are performed on the control channel, with this approach only one experiment is allowed at a time. The **TB Plugin** exposes a calendar interface where the user is allowed to book a time-slot for his/her experiment. The Time-Based Aggregate Manager (**TBAM**) replaces FOAM and is in charge of storing the time-slots and managing the concurrent requests.

PROS: (i) It does not inspect the control protocol; therefore it supports any SDN-enabled device (even non-OpenFlow). (ii) The user can access the devices during the experiment for monitoring or configuration purposes.
CONS: (i) No sharing mechanism, therefore only one experiment at a time is allowed. (ii) The OFGW represent a Single Point of Failure in the architecture. A failure of the OFGW would bring down the running experiment.



A distributed slicing architecture

The distributed slicing aims to avoid Single Points of Failure and to provide a multi-version OpenFlow protocol slicing mechanism. The slicing operations are performed by the Virtualization Agent (**VA**) which is implemented as a plugin for the datapath firmware running on the switches and supports as many versions of the OpenFlow protocol as the datapath firmware does. The Virtualization Agent Orchestrator (**VAO**) is the glue between the VA-enabled devices and the OCF and in charge of configuring the VA instances running on the network devices.

PROS: (i) Multiple concurrent experiments are allowed at the same time. (ii) Being the slicing process performed at the datapath level, Single Points of Failure are avoided. (iii) Easy integration within the current OCF.
CONS: (i) The distributed slicing mechanism depends on the datapath firmware implementation (currently only xDPd (www.xdpd.org) is supported) for both hardware platforms and versions of the OpenFlow protocol supported.

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 317880

Figure 2.19 ALIEN project poster no 3 from EWSDN 2014 conference (Budapest, Hungary)

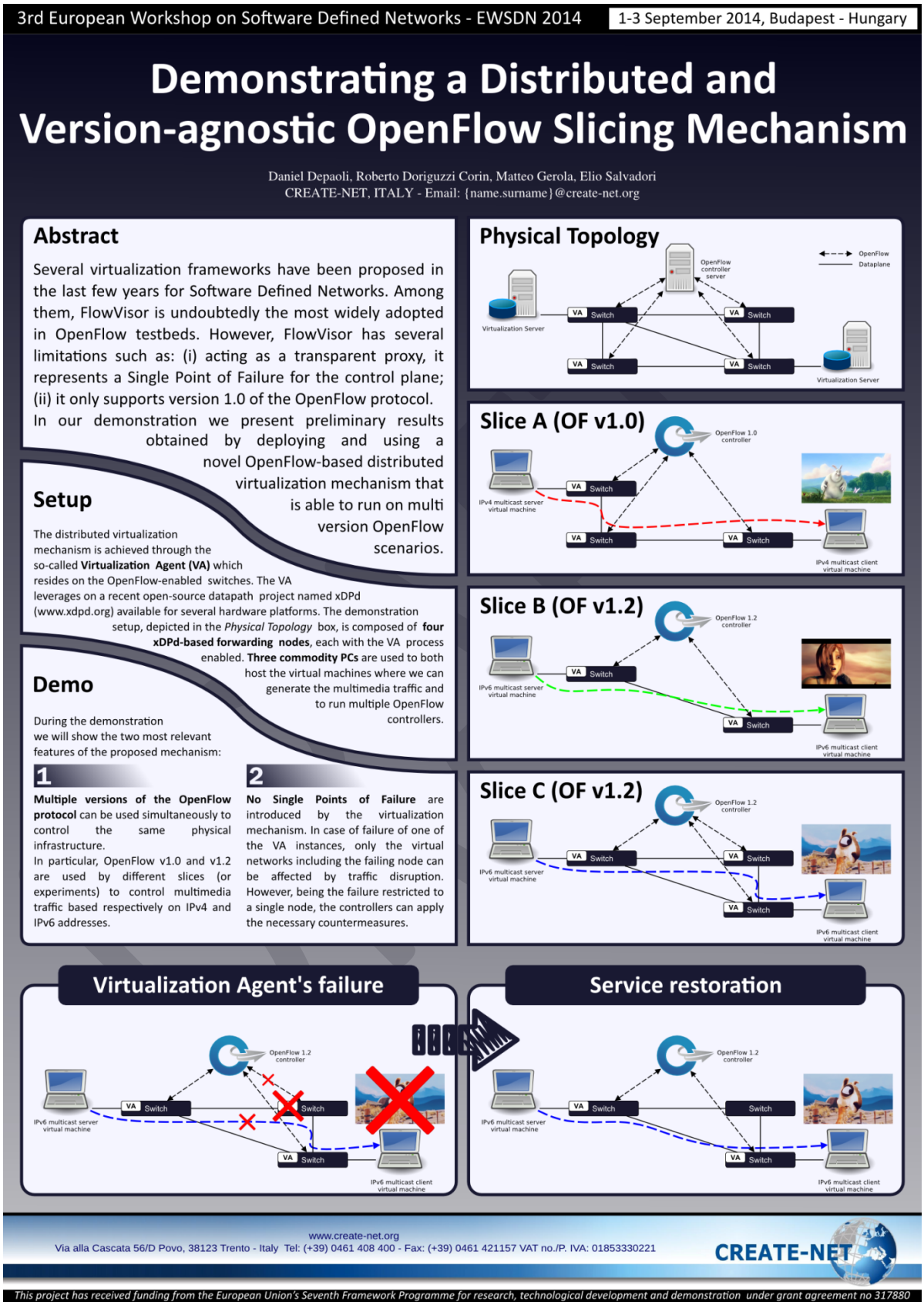


Figure 2.20 ALIEN project poster no 4 from EWSDN 2014 conference (Budapest, Hungary)

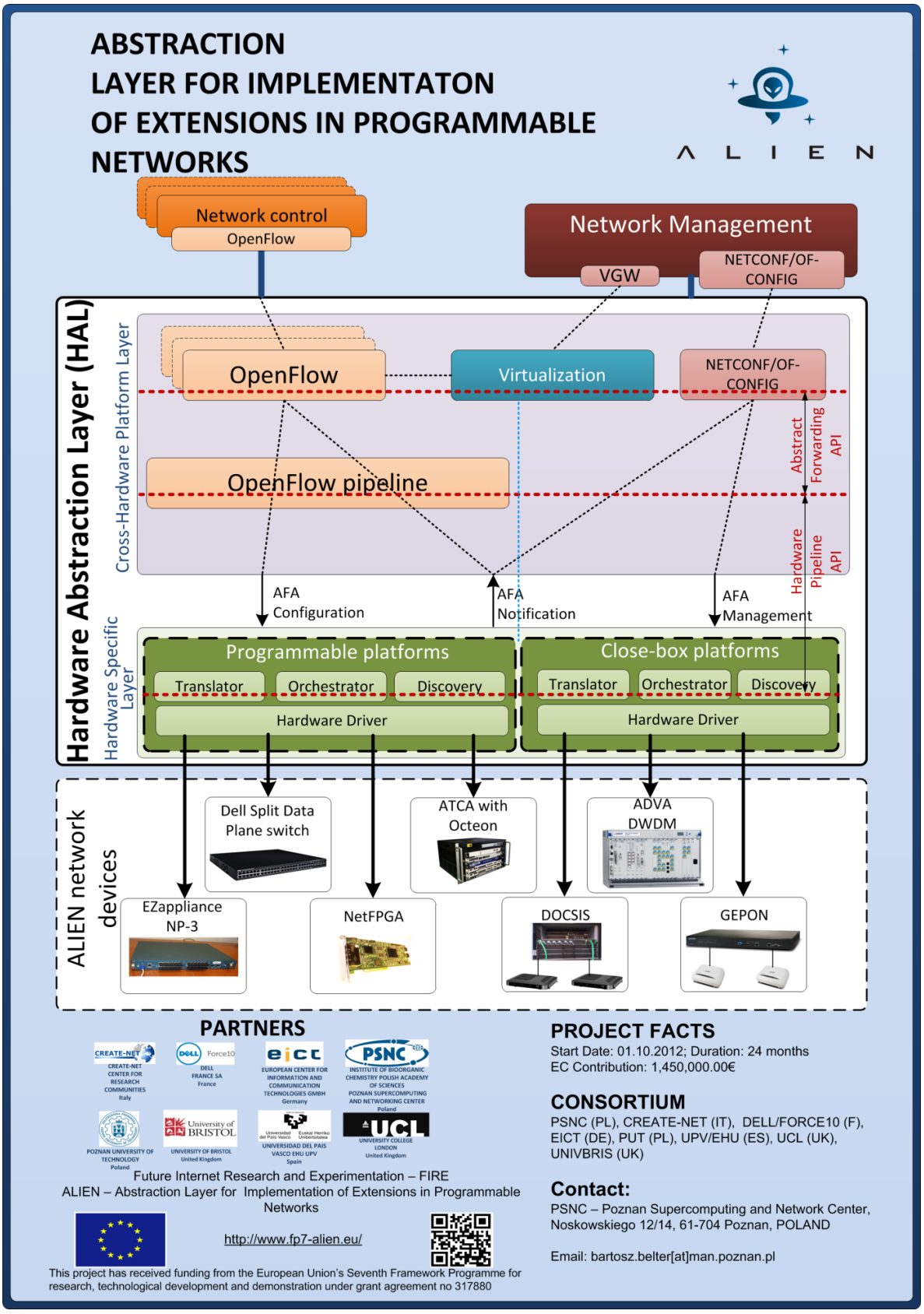


Figure 2.21 ALIEN project poster from KSTiT 2014 conference (Poznan, Poland)

7. 30th National Symposium on Telecommunications and Teleinformatics (KSTiT 2014) – Poznan, Poland, 3-5 IX 2014 [19]

   During this conference leaflets and one specially designed for this event poster were used:

   - The leaflet used during this conference can be seen in Figure 2.11 and Figure 2.12. This is exactly the same leaflet which was used during TNC 2014 and IEICE ICTF 2014 conferences and it was designed for FIA 2014 meeting.

   - The KSTiT 2014 poster can be seen in Figure 2.21 and it contains:

     - ALIEN HAL architecture,

     - ALIEN framework for HAL implementation,

     - ALIEN hardware platforms.

2.3 Conferences and Papers

To measure the progress of dissemination activities in the ALIEN project, a set of Key Performance Indicators (KPIs) have been identified per each event, providing a clear indicator of the impact assessment of the activity. All events which were planned in deliverable D6.3 are described below. There is also information which of them were and which were not achieved (and in such a case with explanation why) in the second year of the ALIEN project. There are also added a description of additional events, not planned in D6.3 [8], however, they were achieved by ALIEN in the second year of the project. These all events are as follows:

- **European Workshop on Software Defined Networks 2013 (EWSDN 2013)**, 10-11 October 2013 – Berlin, Germany

  - Official website: http://www.ewsdn.eu/previous/ewsdn13.html.

  - The European Workshop on Software Defined Networks (EWSDN) has been established within the framework of the FP7 OFELIA under the leadership of EICT. EWSDN focuses on the traditional strengths of European research and development such as optical transmission and wireless networks. A key goal is to bring together industry and academia on the topics of SDN; in particular the workshop will feature an "industry forum", i.e. a session with presentations of key industrial players. The full program, with presentations available for most of the talks, is available at http://www.ewsdn.eu/previous/ewsdn13.html.

  - This meeting has already occurred and it was sponsored by the SCOPE Alliance and Deutsche Telekom T-Labs. SCOPE Alliance is a group of leading Network Equipment Providers (NEPs) that formed in early 2006 to promote an ecosystem that produces components of Carrier-Grade Base Platforms (CGBPs); for more details see http://scope-alliance.org/.

  - EWSDN was attended by approximately 100 experts in the area of Software Define Networks, focusing on topics related to traditionally strong European R&D such as optical, mobile and wireless networks.

- ALIEN was well-represented in EWSDN 2013. The consortium as a whole presented a poster which was observed by dozens of attendees, and served as a great complement to the introduction of the ALIEN project one year before. In addition, EICT contributed to the presentation entitled "xDPd: eXtensible DataPath Daemon", which is publicly available at http://ewsdn.org/presentations/Presentations_2013/xdpd.pdf.

- All ALIEN targets and KPIs for this workshop were achieved (see Table 1).

Table 1 KPIs for the EWSDN 2013 workshop

Key Performance Indicator (KPI)	ALIEN target	Status
ALIEN poster	During the workshop the poster was available in the most visible manner, thus allowing attendees to be informed about the latest developments in the project. A minimum of 10 individuals asked about ALIEN progress and development plans.	**Achieved**
xDPd presentation	The open-source datapath element software xDPd, which is used extensively in ALIEN was presented to a full house as part of the Industry Session I. Several questions were asked after the presentation, and we perceive this as a clear indication of the interest in this line of software development line of work in ALIEN. Approximately 100 people attended EWSND 2013.	**Achieved**

- **Supercomputing Conference 2013 (SC 2013)**, 17-20 November 2013 – Denver, USA

  - Official website: http://sc13.supercomputing.org

  - It is the premier international conference on a high performance computing, networking and storage. It explores ways in which the High Performance Computing (HPC), networking, storage and analysis lead to advances in research, education and commerce. The SC conference always attracts a very large number of scientists, researchers, department managers, lab directors and decision makers from all corners of HPC and networking industry.

  - As in previous years, PSNC has organized the PIONIER (Polish Optical Internet) consortium booth in SC in order to present the latest PIONIER's achievements. One of main topic presented in PIONIER booth were SDN solutions developed within PSNC. This topic was visualized by a poster presenting three main SDN projects coordinated by PSNC: ALIEN, ADDONAS and FELIX. The presentation of the ALIEN project was performed by Bartosz Belter who was available (together with the ALIEN coordinator: Artur Binczewski) for visitors at the booth. The ALIEN slideshow presenting the project overview was displayed and

discussed with many attendees. This event was a great chance to share and discuss the ALIEN ideas in the large world-wide community, especially with US partners. We hope this will be a way to establish new cooperation agreements with similar US projects.

- KPI (see Table 2) initially planned at beginning of the project [10]: "The first demo of ALIEN outcomes is performed" was abandoned because the project decided to move software demonstration efforts for the conference FIA 2014 for which more ALIEN results should be then available. In retrospect the KPI planned for SC 2013 conference was achieved during FIA 2014 meeting.

Table 2 The KPI for the CN 2013 conference

Key Performance Indicator (KPI)	ALIEN target	Status
Number of visitors at the booth	A minimum of 10 unique visitors (company representatives) are expected at the booth, interested in project outcomes.	**Achieved**

- **Future Internet Assembly 2014 (FIA 2014)**, 18-20 March 2014 – Athens, Greece
  - Official website: http://www.fi-athens.eu.
  - FIRE addresses the need to experiment with networks, creating a multidisciplinary environment for investigating and experimentally validating highly innovative and revolutionary ideas for new networking and service paradigms. FIRE offers a discipline, a platform and tools for trying out innovative ideas for the Future Internet. FIRE was promoting the concept of experimentally-driven research. This event was conducted by various research projects, combining visionary academic research with the wide-scale testing and experimentation that is required for industry. FIRE helps to create a dynamic, sustainable, large-scale European Experimental Facility, which is constructed by gradually connecting and federating existing and upcoming testbeds for Future Internet technologies.
  - ALIEN participated in the FIRE 2014 workshop. It helped the ALIEN project to take hand on the newest trends in the Future Internet topic. ALIEN also performed software prototypes demonstration and shared ALIEN ideas and results with other researchers and scientists. The ALIEN project had its own booth and posters. Leaflets were placed on the table at booth and there were a representative of the ALIEN project consortium who answered visitor's questions.
  - The ALIEN project presented three live demonstrations on the FIRE booth (see Section 3.1):
    - Video on Demand in OpenFlow networks,
    - Distributed and Version-agnostic OpenFlow slicing mechanism,
    - Integration of legacy DOCSIS access network under OpenFlow control.

- During FIA 2014 ALIEN project leaflets (Figure 2.11 and Figure 2.12) and two posters (Figure 2.13 and Figure 2.14) were used. This flyer were distributed among the participants.

- All ALIEN targets and KPIs for this event were achieved (see Table 3).

Table 3 KPIs for the FIA 2014 meeting

Key Performance Indicator (KPI)	ALIEN target	Status
The public demonstration of the ALIEN prototypes	During the workshop the public demonstration of the ALIEN software prototypes to the FIRE community will be provided.	**Achieved**
Number of visitors at the booth	A minimum of 10 unique visitors (company representatives) are expected at the booth, interested in project outcomes.	**Achieved**
Software Demonstrations	Then main ALIEN concept (the implementation of the HAL on few chosen ALIEN platforms) will be demonstrated with usage of available software prototypes functionalities. A simple use-case demonstration will be performed.	**Achieved**

- **Optical Network Design and Modeling (ONDM 2014)**, 19-20 May 2014 – Stockholm, Sweden

  - We decided to exchange ONDM 2014 conference to NOMS 2014 event. It was due to lack of time. We planned at first to participate in four conferences, all in May 2014. During papers preparation process we decided that we can participate in four conferences in May, however, we cannot be at the same time in two places (ONDM and TNC conferences were organized too close to each other, in the same period of time – ONDM date was 19-20 May and TNC date was 19-22 May). Therefore, we decided to contribute to NOMS 2014, which was organized a little bit earlier – on 5-9 May 2014.

- **IEEE/IFIP Network Operations and Management Symposium (NOMS 2014)**, 5-9 May 2014 – Krakow, Poland

  - Official website: http://noms2014.ieee-noms.org

  - The conference theme, *Management in a Software Defined World*, aims at capturing from management perspective new paradigms, such as the Cloud and SDN.

  - Due to SDN themes, NOMS symposium was a great time to present ALIEN project achievements. NOMS symposium was dedicated to researchers and scientists as well as to people who are familiar with SDN network issues. It was a great opportunity to exchange experiences between other researchers and scientists from different worldwide projects.

- It was submitted and presented one paper for this conference:
  - J. Araujo, R. Landa, R. Clegg, R. Landa, "Software-defined network support for transport resilience", NOMS 2014, Krakow, Poland, May 2014
- All ALIEN targets and KPIs planned for ONDM 2014 conference were achieved during NOMS 2014 conference (see Table 4).

Table 4 KPIs for the NOMS 2014 conference

Key Performance Indicator (KPI)	ALIEN target	Status
Number of submitted papers	A minimum of 1 paper presenting work done in the ALIEN project.	**Achieved**
Number of audience	More than 100 person from industry and 50 researchers and scientists	**Achieved**

- **TERENA Networking Conference 2014 (TNC 2014)**, 19-22 May 2014 – Dublin, Ireland
  - TERENA Networking Conference is the EU organization in the forefront of Internet development. TERENA brings together National Research and Education Networks (NRENs) from across Europe to exchange information between themselves and with representatives from industry, academia, research institutions and the government. The conference presents an overview of the latest developments in research networking, both in the technical field and in the areas of application and management.
  - During “Advanced networking” session ALIEN presented Hardware Abstraction Layer for non-OpenFlow capable devices paper. The presentation showed a way forward for adding SDN-based control on network devices that are not compatible with OpenFlow and introduces a Hardware Abstraction Layer (HAL) for non-OpenFlow capable devices that addresses this problem and discusses its advantages. In particular, the presentation explained how a HAL-based architecture can support different classes of network devices.
  - One ALIEN project paper was presented:
    - Ł. Ogrodowczyk, B. Belter, A. Binczewski, K. Dombek, A. Juszczyk, I. Olszewski, D. Parniewicz, R. Doriguzzi Corin, M. Gerola, E. Salvadori, K. Pentikousis, U. Toseef, H. Woesner, M. Rashidi Fard, M. Huarte, E. Jacob, J. Matias, V. Fuentes, M. Michalski, R. Rajewski, “Hardware Abstraction Layer for non-OpenFlow capable devices”, Proc. TERENA 2014, ISBN 978-90-77559-24-6, May 2014, Dublin, Ireland.
  - The ALIEN project submitted and presented two live demonstrations on the PIONIER booth (see Section 3.2):
    - Streaming on demand in OpenFlow networks,

- DOCSIS platform integration in OFELIA.

- During TNC 2014 ALIEN project leaflets (Figure 2.11 and Figure 2.12) and one poster (Figure 2.15) were used. This flyers were distributed among the participants.

- All ALIEN targets and KPIs for this conference were achieved (see Table 5).

Table 5 KPIs for the TNC 2014 conference

Key Performance Indicator (KPI)	ALIEN target	Status
The publication of ALIEN paper at the conference	It is planned to answer for TNC'14 paper call.	**Achieved**
Number of submitted papers	A minimum of 1 unique paper presenting work done in ALIEN project.	**Achieved**

- **IEICE Information and Communication Technology Forum (ICTF 2014)**, 28-30 May 2014 – Poznan, Poland

  - Official website: http://www.ictf2014.org

  - The 2014 IEICE ICTF aims at encouraging the collaboration of researchers in academia and industry. The Forum gathers the researchers, professors, PhD students and experts from industry to exchange ideas and discuss major trends and challenges in information and communication technologies. The 2014 IEICE ICTF was focused on presenting trends in the Future Communication Technologies and Applications and was held on 28-30 May 2014 in the beautiful city of Poznan, Poland.

  - Topics for this conference can be found at http://ictf2014.org/index.php?_m=2&id=0&layout=2

  - During the ICTF 2014 conference PUT organized a special session, dedicated to the ALIEN project. A separate session was a great opportunity to exchange experience between other researchers and scientists from different European projects. At this session ALIEN partners submitted and presented three papers:

    - B. Belter, A. Binczewski, K. Dombek, A. Juszczyk, J. Kleban, M. Michalski, Ł. Ogrodowczyk, I. Olszewski, D. Parniewicz, R. Rajewski, M. Stroiński, "ALIEN Project – Abstraction Layer for Implementation of Extensions in programmable Networks", Proc. IEICE ICTF 2014, Poznan, Poland, May 2014

    - B. Belter, A. Binczewski, A. Juszczyk, K. Dombek, Ł. Ogrodowczyk, I. Olszewski, D. Parniewicz, "Hardware Abstraction Layer on EZchip NP-3" , Proc. IEICE ICTF 2014, Poznan, Poland, May 2014

    - M. Michalski, T. Sielach, "Adding Support for NetFPGA10G Cards in xDPd", Proc. IEICE ICTF 2014, Poznan, Poland, May 2014 (see Figure 2.22)

- It was reserved space, where ALIEN poster (see Figure 2.16 and Figure 2.23) was presented. ALIEN flyers prepared for FIA 2014 were distributed among the participants as well. During coffee breaks, conference visitors were able to ask questions about solutions and ideas which were assumed in the ALIEN project. It was a great time to discuss and explain to other researchers and scientists some ALIEN project ideas and aspects. The ALIEN team during coffee break can be visible in Figure 2.24.

- All ALIEN targets and KPIs planned for this conference were achieved (see Table 6).

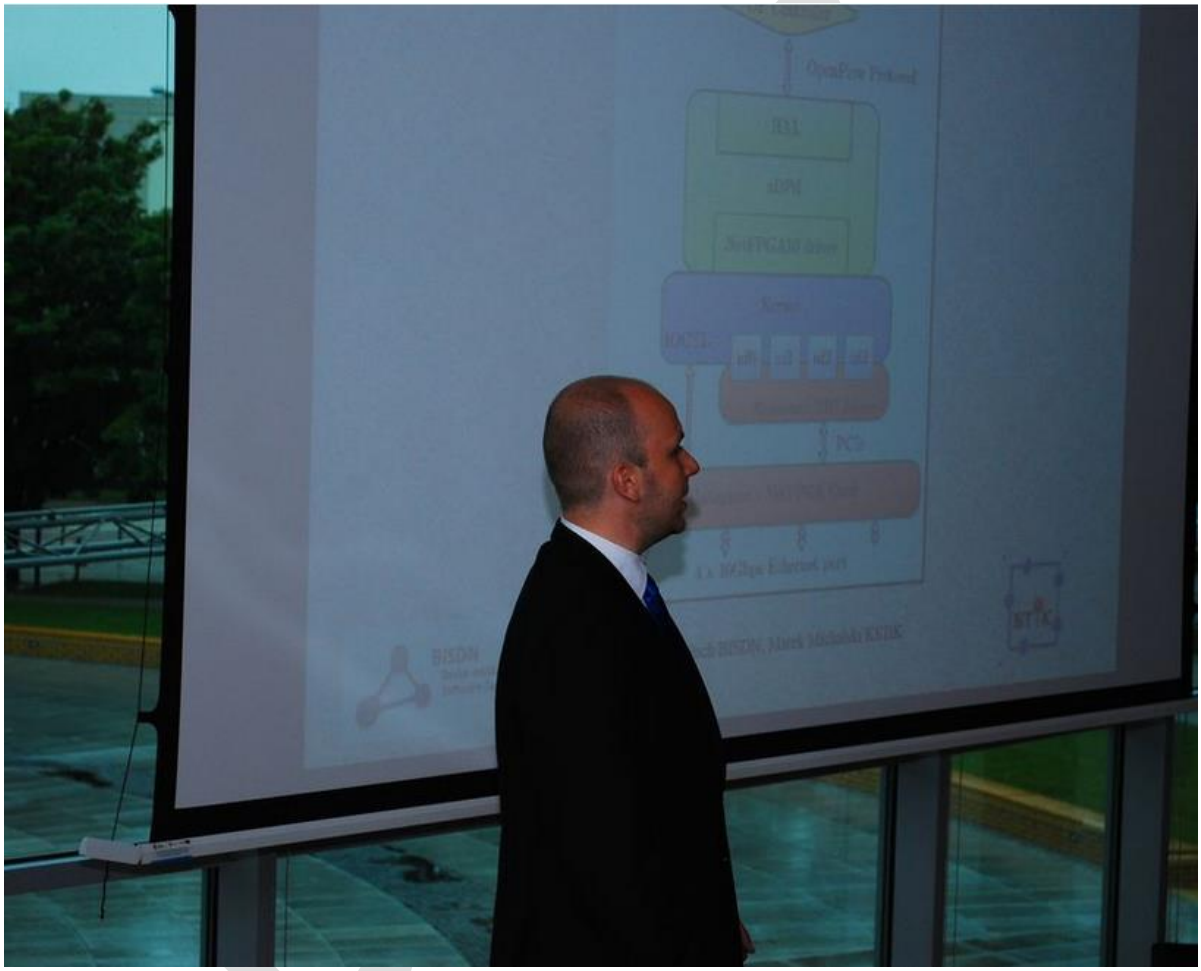


Figure 2.22 Tytus Sielach is presentating implementation of xDPd on NetFPGA card – ICTF 2014 conterence (Poznan, Poland)

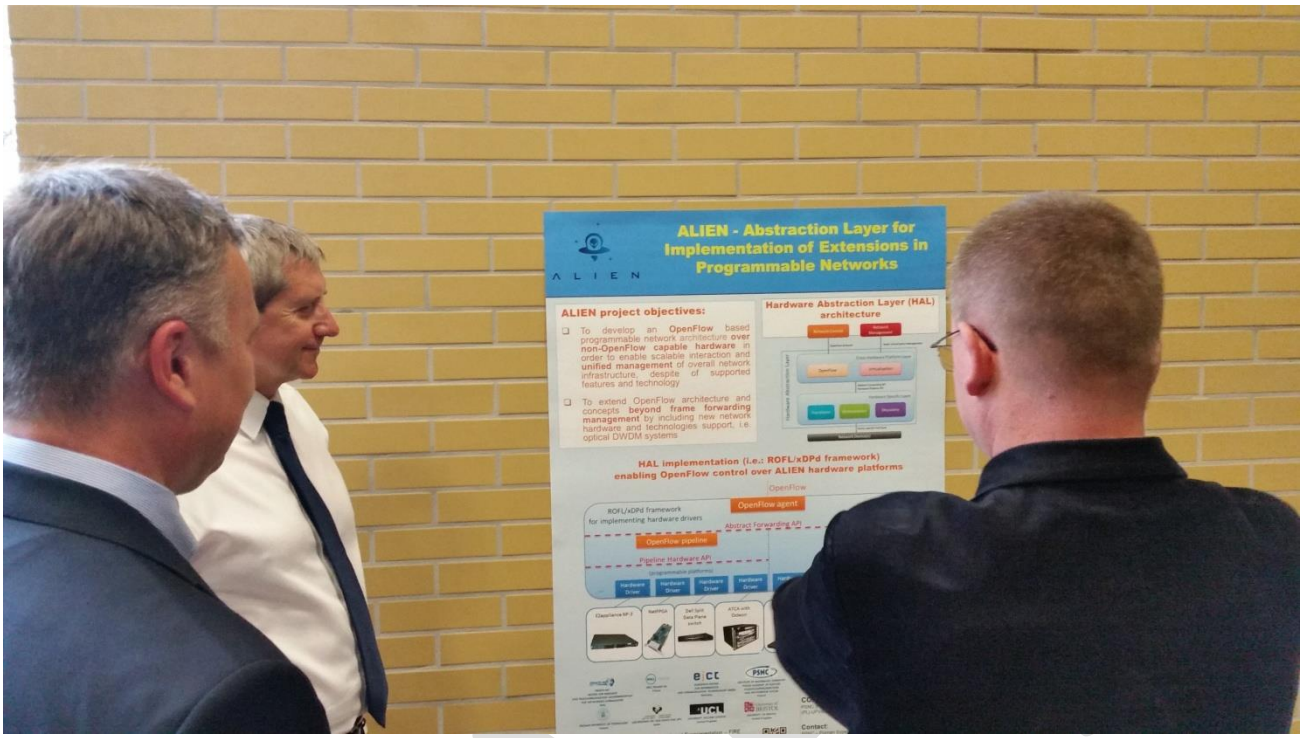


Figure 2.23 Discusion about HAL during ICTF 2014 conference (Poznan, Poland)

Figure 2.24 The ALIEN team during coffe break at ICTF 2014 conference (Poznan, Poland)

Table 6 KPIs for the ICTF 2014 conference

Key Performance Indicator (KPI)	ALIEN target	Status
ALIEN posters	PUT will prepare a poster to disseminate ALIEN results.	**Achieved**
Number of audience	About 50 people from industry, researchers and scientists.	**Achieved**

- **European Conference on Networks and Communications (EUCNC 2014)**, 23-26 June 2014 – Bologna, Italy
    - Official website: http://www.eucnc.eu/2014/www.eucnc.eu/index.html
    - EUCNC'2014 is the 23rd edition of a successful series of a technical and scientific conference open to the world research community, sponsored by the European Commission, in the area of Telecommunications, focusing on communication networks and systems, and reaching services and applications. It aims at showcasing the results of the consecutive programs on R&D and projects co-financed by European programs, as well as presenting the latest developments in this area. The conference has a not for profit organization, hence, registration fees are as low as possible, and all surplus will be made available in grants.
    - This conference followed the series of previous ones, hence, claiming the heritage and continuity of these EC sponsored conferences, being the 23rd and 24th editions in the series. On the other hand, it if felt that there is a strong need to create an EU brand on networks and communications research, for which this conference will serve as an instrument.
    - The ALIEN project submitted two papers, however, they were rejected:
        - D. Parniewicz, R. Doriguzzi Corin, L. Ogrodowczyk, J. Matias, M. Gerola, U. Toseef, A. Zaalouk, B. Belter, E. Jacob, K. Pentikousis, "The ALIEN Hardware Abstraction Layer in Practice", EUCNC 2014
        - T. Rothe, A. Vico–Oton, V. Kotronis, M. Suñé, R. Riggio, E. Salvadori, K. Pentikousis, "An Open–Source Orchestration Framework for OpenFlow Experimental Facilities", EUCNC 2014
    - This conference was not planned in deliverable D6.4 [20] therefore no KPIs were determined for it.
- **IEEE 15th International Conference on High Performance Switching and Routing (HPSR 2014)**, 1-4 July 2014 – Vancouver, Canada
    - Official website: http://www.ieee-hpsr.org
    - The IEEE 15th International Conference on High Performance Switching and Routing 204 was held in Vancouver, British Columbia, Canada from July 1 to July 4, 2014. Vancouver is world renowned for its

diversity of many cultures and ethnicities. It is an ideal place for scientists and engineers from around the world to gather and share their ideas. Past HPSR events were held in Heidelberg (2000), Dallas (2001), Kobe (2002), Torino (2003), Arizona (2004), Hong Kong (2005), Poznan (2006), New York (2007), Shanghai (2008), Paris (2009), Dallas (2010), Cartagena (2011), Belgrade (2012), and Taipei (2013). IEEE HPSR has a long tradition, starting from 1993 when it was held for the first time. HPSR got its current name in 2000, when two workshops merged into HPSR: ATM Workshop and International Workshop on Broadband Switching Systems.

- With the unprecedented growth of the Internet as a backbone for communications and information services, it is essential that researchers gather to share their ideas and progress on solving the future challenges that the Internet faces. They include bridging the digital-divide and providing advantages of the Internet to developing countries; handling the bandwidth and delay requirements of multimedia, P2P, and cloud computing applications; implementing IPv6 and migrating from IPv4; deploying large datacenters and enhancing their switching capabilities; and achieving energy efficiency of switching and routing equipment. These are only a few of the topics that have demanded switching and routing capabilities that are more intelligent, efficient, and reliable than ever before. IEEE HPSR 2014 addressed topics listed at http://www.ieee-hpsr.org/cfp.html

- PUT submitted one paper about NetFPGA card – the hardware platform which is used in the ALIEN project. This paper was presented by Marek Michalski from PUT:

  - M. Michalski, "The System for Delay Measurement in Ethernet Networks on NetFPGA Cards", IEEE 15th HPSR 2014, Vancouver, Canada, July 2014

- All ALIEN targets and KPIs planned for this conference were achieved (see Table 7).

Table 7 KPIs for the HPSR 2014 conference

Key Performance Indicator (KPI)	ALIEN target	Status
Number of submitted papers	A minimum 1 paper presenting work done in the ALIEN project.	**Achieved**
Number of audience	About 200 people from industry, researchers and scientists.	**Achieved**

- **IRTF SDNRG meeting at IETF 90**, 20-25 July 2014 – Toronto, Canada

  - The ALIEN project and, in particular, the key design choices for the HAL concept were presented and discussed in the full audience of the SDNRG meeting during IETF 90 in Toronto, Canada. The SDNRG meeting was very well attended: More than 200 people, the vast majority of them being experts from industry, have signed the attendance "blue sheets", and some more may have opted not to sign for privacy concerns as the record of attendance becomes available online. In addition, the publicly available proceedings of the SDNRG meeting reach more than 1000 subscribers of the mailing list and are archived at http://www.ietf.org/proceedings/90/sdnrg.html

- The ALIEN project presentation [21] was allocated a slot of 20 minutes and a vivid discussion followed. The session was streamed live to a global audience of remote attendees and was also recorded. The recording of the presentation is now archived and publicly available at http://recordings.conf.meetecho.com/Playout/watch.jsp?recording=IETF90_SDNRG&chapter=chapter_1

- There were not determined ALIEN targets and KPIs, because this event was not planned in deliverable D6.4 [20], however, we achieved two additional KPIs (see Table 8).

Table 8 KPIs for the SDNRG 2014 meeting

Key Performance Indicator (KPI)	ALIEN target	Status
Presentation of ALIEN ideas	A minimum 1 presentation demonstrating ideas suggested and done in the ALIEN project.	**Achieved**
Number of audience	About 200 people from industry, researchers and scientists.	**Achieved**

- **European Workshop on Software Defined Networks (EWSDN 2014)**, 1-3 September 2014 – Budapest, Hungary

  - Official website: http://ewsdn.eu

  - The European Workshop on Software Defined Networks (EWSDN) has been established within the framework of the FP7 OFELIA under the leadership of EICT. EWSDN focuses on the traditional strengths of European research and development such as optical transmission and wireless networks. A key goal is to bring together industry and academia on the topics of SDN; in particular the workshop featured an "industry forum", i.e. a session with presentations of key industrial players.

  - Five ALIEN project papers were presented:

    - B. Belter, A. Binczewski, A. Juszczyk, K. Dombek, Ł. Ogrodowczyk, I. Olszewski, D. Parniewicz, M. Stroiński, "Programmable Abstraction of Datapath", Proc. EWSDN 2014, Budapest, Hungary, September 2014

    - U. Toseef, A. Zaalouk, T. Rothe, M. Broadbent, K. Pentikousis, "C-BAS: Certificate-based AAA for SDN Experimental Facilities", Proc. EWSDN 2014, Budapest, Hungary, September 2014

    - R. Doriguzzi Corin, E. Salvadori, M. Gerola, M. Suñé, H. Woesner, "A Datapath-centric Virtualization Mechanism for OpenFlow Networks", Proc. EWSDN 2014, Budapest, Hungary, September 2014

- V. Fuentes, J. Matias, A. Mendiola, M. Huarte, J. Unzilla, E. Jacob, "Integrating complex legacy systems under OpenFlow control: The DOCSIS use case", Proc. EWSDN 2014, Budapest, Hungary, September 2014

- R. G. Clegg, M. Thakur, J. Spencer, J. Mitchell, M. Rio, R. Landa, "Pushing Software Defined Networking to the access", Proc. EWSDN 2014, Budapest, Hungary, September 2014

- During EWSDN 2014 ALIEN project leaflets (Figure 2.11 and Figure 2.12) and four posters (Figure 2.17, Figure 2.18, Figure 2.19, Figure 2.20 and Figure 2.25) were used. This flyers were distributed among the participants.

- ALIEN prepared also three poster papers:

  - M. Santuari, R. Doriguzzi Corin, M. Gerola, E. Salvadori, U. Toseef, A. Zaalouk, K. Dombek, D. Parniewicz, A. Hammad, M. Rashidi-Fard, E. Jacob, J. Matias, “Leading the OFELIA Facility Beyond OpenFlow 1.0 Experimentations”, EWSDN 2014 – poster paper, Budapest, Hungary. September 2014

  - B. Belter, D. Parniewicz, Ł. Ogrodowczyk, A. Binczewski, M. Stroiński, V. Fuentes, J. Matias, M. Huarte, E. Jacob, “Hardware Abstraction Layer as an SDN-enabler for non-OpenFlow network equipment”, EWSDN 2014 – poster paper, Budapest, Hungary. September 2014

  - M. Suñe, V. Alvarez, T. Jungel, U. Toseef, K. Pentikousis, “An OpenFlow Implementation for Network Processors”, EWSDN 2014 – poster paper, Budapest, Hungary. September 2014

- One demonstration (see Section 3.3) was also prepared:

  - D. Depaoli, R. Doriguzzi Corin, M. Gerola, E. Salvadori, “Demonstrating a Distributed and Version-agnostic OpenFlow Slicing Mechanism”, EWSDN 2014 – demo paper, Budapest, Hungary, September 2014

- During this event the ALIEN tutorial was done. Detailed description is included in Section 2.5.1.

- All ALIEN targets and KPIs planned for this workshop were done (see Table 9).

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Figure 2.25 Discusion about ALIEN solutions during EWSDN 2014 workshop (Budapest, Hungary)

Table 9 KPIs for the EWSDN 2014 workshop

Key Performance Indicator (KPI)	ALIEN target	Status
Number of visitors to the ALIEN presentation booth at EWSDN	A minimum of 30 unique visitors (company representatives) are expected at the booth, interested in project outcomes. This presence will be tightly coordinated with the demo session detailed later in this deliverable.	Achieved
ALIEN Poster(s)	The consortium will prepare 1-2 posters to disseminate its final results. This will be part of the overall participation of ALIEN in EWSDN as a supporting-sponsoring project.	Achieved
Academic paper(s) and/or Industry Track presentations	We envisage that at least one paper describing the overall achievements in ALIEN (architecture to implementation) will be submitted, and we expect that one or more solution-specific papers will be submitted as well.	Achieved
Software Demonstrations	All ALIEN results (i.e.: HAL implementation for all ALIEN hardware, OCF integration, CCN usage) will be presented in form of one or many parallel software prototypes demonstrations. The ALIEN project will demonstrate more advanced use cases.	Achieved
	In addition to the overall ALIEN demonstrations, EICT aims to demo in more detail the Member and Project Authority, which is compliant with GENI Federation API, and is currently under development within the framework of ALIEN will be demonstrated. As part of the presentation the capabilities of the Aggregate Manager Framework AMsoil will also be illustrated. Since this is an enabling technology for the overall demonstration, this demo will focus on the work that goes on under the hood in order to facilitate a better understanding, which may not be attained when all the pieces of the ALIEN demonstration are presented.	Achieved

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- **30th National Symposium on Telecommunications and Teleinformatics (KSTiT 2014)**, 3-5 September 2014 – Poznan, Poland

    - Official website http://kstit2014.pl

    - This conference was devoted to researchers and companies associated with telecommunication. KSTiT is an annual discussion forum for researches, research teams and telecommunication operators. Symposium will be accompanied by the exhibitions. Similar to previous years, there was organized an exhibition of research results teams, as well as all Polish and international companies which presented their equipment/devices. It was a good time to present also ALIEN Partners achievements. KSTiT conference is special because research and industrial worlds meet each another in the same time and in the same place. The atmosphere at the symposium, presentations and exhibitions provide the foundations to establish new contacts and plan for the future, common research work.

    - During the KSTiT conference it was organized a special session dedicated to international projects. At this session the ALIEN papers were presented. A separate session was a great opportunity to exchange experience between researchers and scientists involved in other European projects. At this session ALIEN partners presented three papers:

        - G. Danilewicz, M. Dziuba, J. Kleban, M. Michalski, R. Rajewski, M. Żal, B. Belter, A. Binczewski, Ł. Ogrodowczyk, D. Parniewicz, M. Stroiński, "ALIEN – warstwa abstrakcji dla urządzeń niezgodnych z OpenFlow w sieciach SDN" (in Polish), Przegląd Telekomunikacyjny, no. 8-9, September 2014, pp. 1297-1304 (see Figure 2.26)

        - M. Michalski, T. Sielach, “Implementacja moduł kart NetFPGA 1G I NetFPGA 10G w xDPd” (in Polish), Przegląd Telekomunikacyjny, no. 8-9, September 2014, pp. 1305-1312.

Figure 2.26 Łukasz Ogrodowczyk is presenting HAL implementation for EZappliance – KSTiT 2014 conference (Poznan, Poland)

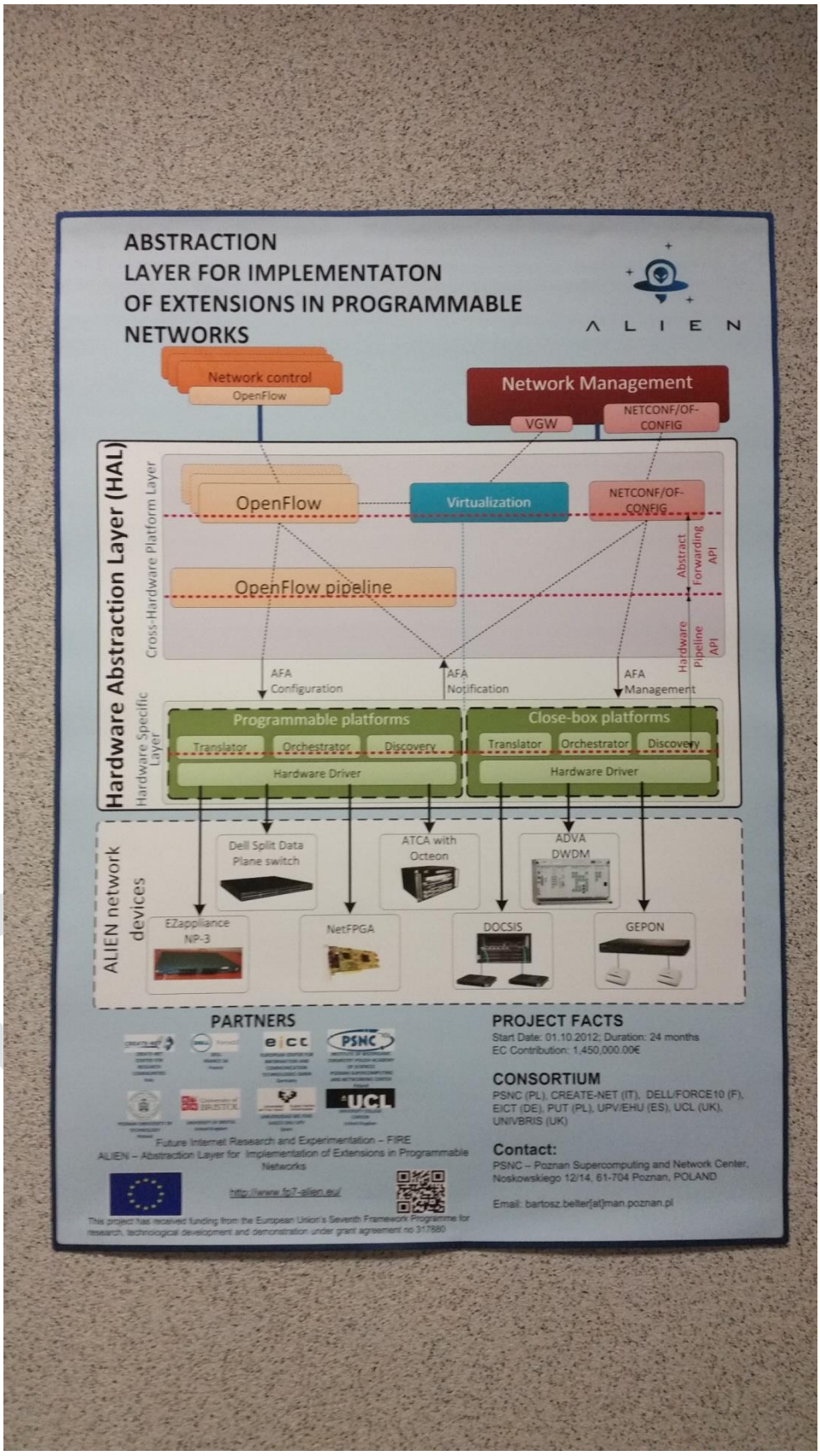

Figure 2.27 The ALIEN poster from KSTiT 2014 conference (Poznan, Poland)

- M. Michalski, “Karty NetFPGA jako podstawa sprzętowego pomiaru czasu transmisji ramek Ethernetowych w przełącznikach OpenFlow” (in Polish), Przegląd Telekomunikacyjny, no. 8-9, September 2014, pp. 1313-1320.

- At the exhibition PUT reserved space, where ALIEN poster (see Figure 2.21 and Figure 2.27) was presented. Poster was prepared by PUT and it presents general solutions and ideas which were achieved in the ALIEN project. More details were included at leaflets (see Figure 2.11 and Figure 2.12 – prepared by PUT for FIA 2014 meeting) which were distributed among the participants. There were also discussion between visitors and the ALIEN project specialists.

- All ALIEN targets and KPIs planned for this conference were achieved (see Table 10).

Table 10 KPIs for the KSTiT 2014 conference

Key Performance Indicator (KPI)	ALIEN target	Status
ALIEN posters	The ALIEN consortium will prepare few posters to disseminate its final results.	**Achieved**
Number of participant	A minimum 6 ALIEN participants.	**Achieved**
Number of submitted papers	A minimum 3 papers presenting work done in the ALIEN project.	**Achieved**
Number of audience	About 50 people from industry and 100 researchers and scientists.	**Achieved**

- **Paper in IET journal**

  - It was planned to submit some paper to the IET journal which will describe the ALIEN project work and achieved results. We submitted this paper, however, unfortunately our paper was rejected. It should be mentioned that greater part of this article was used to prepare articles to the EWSDN 2014 workshop. All our submitted articles to this conference were accepted. In fact, we still gathering an experience concerning HAL implementation and its performance on different platforms. It will be possible to prepare complete, high level paper after different kind of tests, unfortunately after the end of the ALIEN project.

  - The ALIEN target and KPI for this journal was not achieved.

Table 11 KPI for the IET journal

Key Performance Indicator (KPI)	ALIEN target	Status
Number of submitted papers	A paper presenting work done in the ALIEN project.	**Not achieved**

- **Paper in the FIRE Magazine** – February 2014

- We decided also to submit another paper to other journal. Because the ALIEN project is connected strongly with Future Internet, we decided to submit an article "Empowering SDN: Hardware Abstraction Layer for non-OpenFlow equipment" to the FIRE Magazine. Our article was accepted and appeared on February's number of this magazine.

- This event was not planned in deliverable D6.4 [20], therefore there was no KPIs and ALIEN targets. However, they can be determined (see Table 12).

Table 12 KPI for the FIRE Magazine

Key Performance Indicator (KPI)	ALIEN target	Status
Number of submitted papers	A paper presenting work done in the ALIEN project.	**Achieved**

- **34th Annual IEEE International Conference on Computer Communications (INFOCOM 2015)**, 26 April-1 May 2015, Hong Kong, China

  - This conference will be organized after the ALIEN project and we wanted to achieve KPIs devoted to this event. Therefore, we decided to participate in SIGCOMM 2014 conference – it was organized on August 2014 (in period of Y2 of the ALIEN project). From that reason all planned in deliverable D6.4 [20] ALIEN targets and KPIs were moved to SIGCOMM 2014 event.

- **ACM Special Interest Group on Data Communication (SIGCOMM 2014)**, 17-22 August 2014 – Chicago, USA

  - Official website: http://conferences.sigcomm.org/sigcomm/2014/index.php

  - SIGCOMM is the flagship annual conference of the ACM Special Interest Group on Data Communication (SIGCOMM) Workshop on Distributed Cloud Computing (DCC) on the applications, technologies, architectures, and protocols for computer communication This event is interdisciplinary and touches both distributed systems and networking aspects as well as cloud computing.

  - SIGCOMM conference is dedicated to researchers and people who are familiar with today's telecommunication issues. The atmosphere at the symposium, presentations provide the foundations to establishing new contacts and plan for the future research work. The ALIEN project ideas had positive response and good prognosis for the future, because OpenFlow control protocol gaining more and more sympathizers in telecommunication environment.

  - The workshop attracted experts primarily from North America and leading researchers from European academia. Vendor participation and sponsorship attracted a larger than expected audience (more than 50 people). The presentation took place in the afternoon session which also included the best paper award.

- Two ALIEN project papers were submitted, however, the only one was accepted and presented during this conference:
  - D. Parniewicz, R. Doriguzzi Corin, L. Ogrodowczyk, M. Rashidi Fard, J. Matias, M. Gerola, V. Fuentes, U. Toseef, A. Zaalouk, B. Belter, E. Jacob, K. Pentikousis, "Design and Implementation of an OpenFlow Hardware Abstraction Layer", Proc. SIGCOMM DCC 2014, Chicago, USA, August 2014
- One paper was rejected:
  - B. Belter, A. Juszczyk, K. Dombek, Ł. Ogrodowczyk, I. Olszewski, D. Parniewicz, "Advanced Programmability of Heterogeneous Datapath Elements through Hardware Abstraction", SIGCOMM HotSDN 2014
- The presentation slides are available from the SIGCOMM web site: http://conferences.sigcomm.org/sigcomm/2014/doc/slides/175.pdf.
- This is an additional event where we participated in the Y2, therefore its KPIs were not included in the deliverable D6.4 [20]. We planned to participate in the INFOCOM 2015 conference; however, it was an opportunity to participate additionally in other conference – ACM SIGCOMM 2014. Thus, the first ALIEN target and KPI planned for INFOCOM 2015 conference were done in SIGCOMM 2014 conference, however, the second ALIEN target and KPI was done only partially due to smaller audience than it was planned (see Table 13).

Table 13 KPIs for the SIGCOMM 2014 conference

Key Performance Indicator (KPI)	ALIEN target	Status
Publication of the ALIEN experiments results	Publicise results from the ALIEN experiments in WP5 at a top international venue.	**Achieved**
Number of audience	About 1000 people from industry, researchers and scientists.	**Partially achieved**

- **6th International Conference on Mobile Networks and Management (MONAMI 2014)**, 22-24 September 2014 – Wuerzburg, Germany
  - Official website: www.mon-ami.org
  - MONAMI is a single-track research conference which focuses on management aspects for mobile networks. This year, MONAMI was hosted by the University of Wuerzburg and supported by the IEEE Communications Society Germany Chapter featured special sessions on SDN. Among others, the highly relevant program also featured keynotes on “Networks in Times of Virtualisation” and “From Virtualization to Network and Service Programmability – A Research Agenda for 5G Networks”, and a panel on “Cloudification of mobile networks – Expectations, Challenges, and Opportunities”. The

conference was attended by more than 60 people. More details are available on the conference web site.

- The ALIEN project was represented with a peer-reviewed paper which discusses the solution designed by ALIEN as part of the work described in the recent amendment. In particular, the paper describes a combined programmability mechanism in which the application takes both control and management plane considerations into its sphere of implementation. This paper is well-aligned also with the standardization work that the ALIEN project has been participating:

  - A. Zaalouk, K. Pentikousis, "Network Configuration in OpenFlow Networks", Proc. MONAMI 2014, Wuerzburg, Germany, September 2014.

- This an additional conference not planned before in deliverable D6.4 [20]. Therefore all ALIEN targets and KPIs were achieved additionally (see Table 14).

Table 14 KPIs for the MONAMI 2014 conference

Key Performance Indicator (KPI)	ALIEN target	Status
Number of submitted papers	A paper presenting work done in the ALIEN project.	**Achieved**
Number of audience	About 50 people from industry, researchers and scientists.	**Achieved**

2.4 Standardization

During the second year of the ALIEN project under the leadership and active participation of EICT, ALIEN has been contributing to the development of a reference terminology and architecture document which can be used as a foundation for further work in the IETF and the IRTF. In particular, EICT has been active in the text contributions, editorial responsibilities, discussion and participation in the mailing lists, teleconferences and physical meetings. It is important to note that the aforementioned contributions are both well-aligned and assisted in forming the final presentation on the HAL system design architecture. In short, standardization actions and architecture specification moved forward in a coordinated fashion.

ALIEN standardization actions started with the preparation of the first revision of the "SDN Layers and Architecture Terminology" draft (draft-haleplidis-sdnrg-layer-terminology) for the IETF 88 meeting in Vancouver, Canada. For this meeting the following versions/contributions were produced:

- E. Haleplidis, S. Denazis, K. Pentikousis, J. Hadi Salim, O. Koufopavlou, "SDN Layers and Architecture Terminology", Internet Draft, draft-haleplidis-sdnrg-layer-terminology-01 (work in progress), September 2013.

- E. Haleplidis, S. Denazis, K. Pentikousis, J. Hadi Salim, O. Koufopavlou, "SDN Layers and Architecture Terminology", Internet Draft, draft-haleplidis-sdnrg-layer-terminology-02 (work in progress), November 2013.

Version -02 of the draft was presented in IETF 88 [22] right after the RG Chairs presentation on "Defining SDN for IETF Purposes". The meeting was very well attended, with more than 250 people signing the attendance "blue sheets". During this meeting a lot of discussion and engagement with key standardization experts took place and the draft that ALIEN contributed to started to emerge as a key work item the first half of 2014 in the context of SDNRG and IRTF in general.

In preparation of the subsequent meeting (IETF 89) in London, UK, the following SDNRG contributions were made based on the discussion of the draft in the IETF 88 meeting as well as in the follow-up discussion in the mailing list:

- E. Haleplidis, S. Denazis, K. Pentikousis, J. Hadi Salim, D. Meyer, O. Koufopavlou, "SDN Layers and Architecture Terminology", Internet Draft, draft-haleplidis-sdnrg-layer-terminology-03 (work in progress), December 2013.

- E. Haleplidis, S. Denazis, K. Pentikousis, J. Hadi Salim, D. Meyer, O. Koufopavlou, "SDN Layers and Architecture Terminology", Internet Draft, draft-haleplidis-sdnrg-layer-terminology-04 (work in progress), March 2014.

Version -04 of the draft was presented in IETF 89 [23] as the first item in the agenda. The meeting was very well attended, with more than 200 people signing the attendance "blue sheets". During this meeting further discussion and engagement with key standardization experts took place and the key achievement was that the draft that ALIEN contributed was practically affirmed as a key work result for the SDNRG during 2014.

In preparation of the subsequent meeting (IETF 90) in Toronto, Canada, the following SDNRG contributions were made based on the discussion of the draft in the IETF 89 meeting as well as in the follow-up discussion in the mailing list:

- E. Haleplidis, S. Denazis, K. Pentikousis, J. Hadi Salim, D. Meyer, O. Koufopavlou, "SDN Layers and Architecture Terminology", Internet Draft, draft-haleplidis-sdnrg-layer-terminology-05 (work in progress), July 2014.

- E. Haleplidis, S. Denazis, K. Pentikousis, J. Hadi Salim, D. Meyer, O. Koufopavlou, "SDN Layers and Architecture Terminology", Internet Draft, draft-haleplidis-sdnrg-layer-terminology-06 (work in progress), July 2014.

Version -06 of the draft was presented in IETF 90 [24] as the first item in the agenda. The meeting was very well attended, with about 200 people signing the attendance "blue sheets". During this meeting the process of accepting the draft as an official work result of SDNRG to be published in the IRTF stream was initiated. This is a major success for the contributions of ALIEN in this direction, as within a short period of time (i.e. in less than a year), the work was appreciated by a key research group with global participation. It is important here to highlight that the contributions of ALIEN were well aligned with other key publications of the project, e.g. the ACM SIGCOMM DCC and TNC papers.

Since IETF 90, the draft has been officially adopted by SDNRG and further revised based first on the RG last call review, then the IRSG review and finally during the IESG review and (at the time of this writing) the following SDNRG contributions have been made:

- E. Haleplidis, S. Denazis, K. Pentikousis, J. Hadi Salim, D. Meyer, O. Koufopavlou, "SDN Layers and Architecture Terminology", Internet Draft, draft-haleplidis-sdnrg-layer-terminology-07 (work in progress), August 2014.

- E. Haleplidis (Ed.), K. Pentikousis (Ed.), S. Denazis, J. Hadi Salim, D. Meyer, O. Koufopavlou, "SDN Layers and Architecture Terminology", Internet Draft, draft-irtf-sdnrg-layer-terminology-00 (work in progress), August 2014.

- E. Haleplidis (Ed.), K. Pentikousis (Ed.), S. Denazis, J. Hadi Salim, D. Meyer, O. Koufopavlou, "SDN Layers and Architecture Terminology", Internet Draft, draft-irtf-sdnrg-layer-terminology-01 (work in progress), September 2014.

- E. Haleplidis (Ed.), K. Pentikousis (Ed.), S. Denazis, J. Hadi Salim, D. Meyer, O. Koufopavlou, "SDN Layers and Architecture Terminology", Internet Draft, draft-irtf-sdnrg-layer-terminology-02 (work in progress), October 2014.

- E. Haleplidis (Ed.), K. Pentikousis (Ed.), S. Denazis, J. Hadi Salim, D. Meyer, O. Koufopavlou, "SDN Layers and Architecture Terminology", Internet Draft, draft-irtf-sdnrg-layer-terminology-03 (work in progress), October 2014.

The draft is currently in IESG review and we expect that it will move forward to become an RFC in good order.

In addition to the contributions to IRTF SDNRG, the ALIEN project was also presented in ICNRG. In particular, EICT has been exploring how SDN experimental facilities could contribute to the evaluation methodology work item of ICNRG and thus the work of the ALIEN project was introduced in the following ICNRG contribution:

- K. Pentikousis (ed.), et al., "Information-centric Networking: Evaluation Methodology", Internet Draft, draft-irtf-icnrg- evaluation-methodology-01 (work in progress), July 2014.

This work item is currently under further development within ICNRG and we expect that the ALIEN project achievements in the area of ICN evaluation could continue be introduced in this draft, even though the ALIEN project has officially ended.

2.5 Workshops

During Y2 the ALIEN project participated in four workshops. One was locally (the NetFPGA workshop 2014), three were international. The EWSDN 2014 workshop was the most important because results achieved during the ALIEN project were there presented during technical sessions, live demonstrations, poster sessions, and tutorial sessions.

2.5.1 EWSDN 2014 Workshop

The European Workshop on Software Defined Networks (EWSDN) (1-3 September 2014, Budapest, Hungary) was considered by the ALIEN project consortium as an extremely important opportunity for dissemination of the ALIEN project results. This event gathered a large number of specialists and people from industry interested in the area of SDN and OpenFlow. The workshop audience was the main target group for the dissemination task. The ALIEN project organized a special session dedicated to the advanced technologies in OpenFlow networks (1 September at 9.00) titled: "ALIEN Tutorial on advanced technologies in OpenFlow networks". It was organized by Bartosz Belter (PSNC), Kostas Pentikousis (EICT), Marc Suñé (BISDN) and Eduardo Jacob (UPV/EHU). The tutorial was focused on the Hardware Abstraction Layer (HAL), defined and developed within the ALIEN project, as an experimentally-verified concept for describing network device capabilities and controlling the forwarding behavior of all OpenFlow and non-OpenFlow capable hardware throughout a network. This tutorial provided a detailed overview of the ALIEN HAL, discussed implementation issues, and lessons learned from the implementation. After the general presentation the project experts explained how to use the project outcomes to develop OpenFlow stack for non-OpenFlow equipment. Also network management in SDN based networks including

the new approach towards virtualization of SDN networks, which overcomes the well-known issues of FlowVisor [25] was presented. Additionally, during this session the certificate-based AAA framework for SDN networks was explained in detail. The tutorial was complemented by a set of comprehensive demonstrations scheduled to the second day of EWSDN 2014, including the use of proof-of-concept prototypes as stand-alone applications or validated services over OFELIA.

The ALIEN tutorial outline is as follows:

1. **SESSION 1 (9:00 – 10:30)**

    1) Introduction to SDN experimental facilities in Europe: OFELIA and ALIEN (H. Woesner, 15 min – see Figure 2.28)

    2) The ALIEN HAL architecture, implementation & lessons learned (U. Toseef, 30 min – see Figure 2.29)

        i. Octeon (M. Suñé, 15 min – see Figure 2.30)

        ii. EZappliance (Ł. Ogrodowczyk, 15 min – see Figure 2.31)

        iii. DOCSIS (J. Matias, 15 min – see Figure 2.32)

2. **SESSION 2 (11:00 – 12:30)**

    1) Network Management in SDN-based networks

        i. Designing and orchestrating experiments on ALIEN devices (R. Doriguzzi Corin, 30 min – see Figure 2.33)

        ii. AAA Framework (U. Toseef, 15 min)

    2) Experimentation experience and results (E. Jacob, 30 min – see Figure 2.34)

    3) Summary & Conclusions (B. Belter & K. Pentikousis, 15 min – see Figure 2.35)

The tutorial was mainly aimed at network engineers and networked software developers from research and academia, SME and industry targeting the SDN market. The tutorial was complemented by a set of comprehensive demonstrations and references to relevant literature.

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Figure 2.28 "Introduction to SDN experimental facilities in Europe: OFELIA and ALIEN" presentation during EWSDN 2014 workshop (Budapest, Hungary)

Figure 2.29 "The ALIEN HAL architecture, implementation & lessons learned" presentation during EWSDN 2014 workshop (Budapest, Hungary)

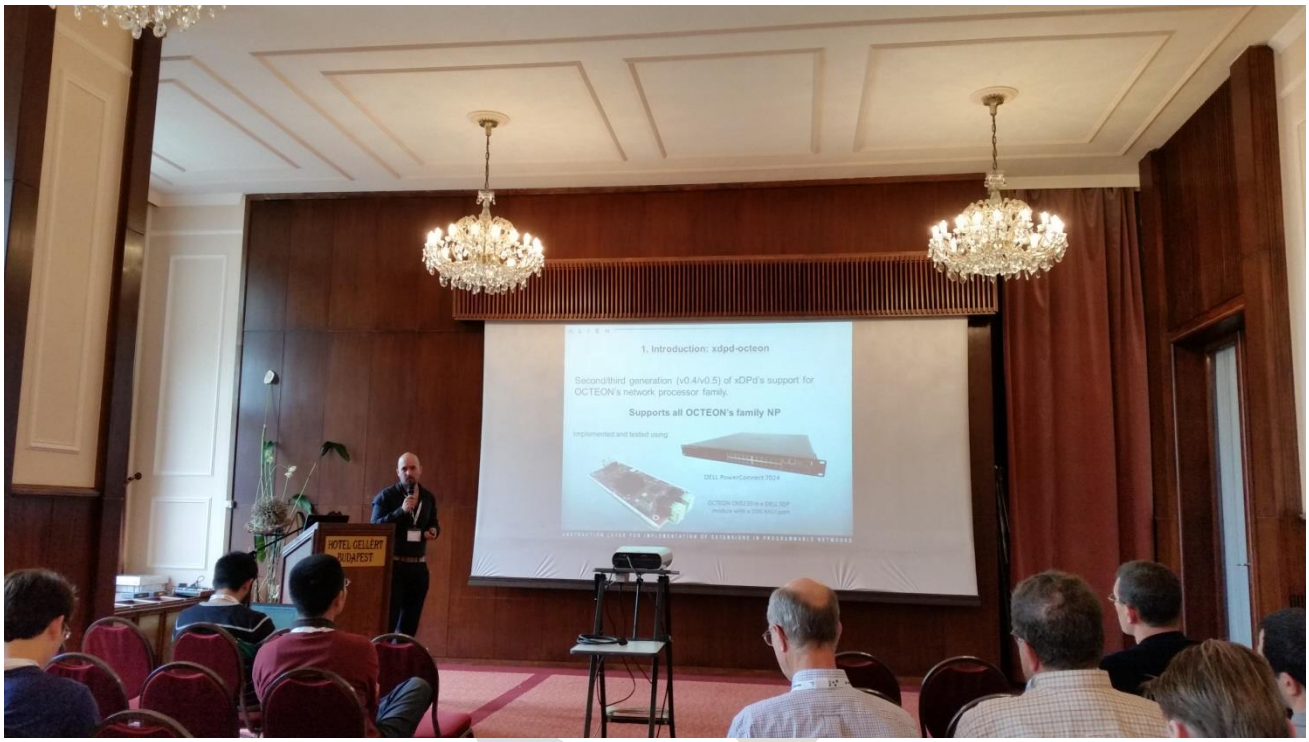

Figure 2.30 "Octeon" presentation during EWSDN 2014 workshop (Budapest, Hungary)

Figure 2.31 "EZappliance" presentation during EWSDN 2014 workshop (Budapest, Hungary)

Figure 2.32 "DOCSIS" presentation during EWSDN 2014 workshop (Budapest, Hungary)

Figure 2.33 "Designing and orchestrating experiments on ALIEN devices" presentation during EWSDN 2014 workshop (Budapest, Hungary)

Figure 2.34 "Experimentation experience and results" presentation during EWSDN 2014 workshop (Budapest, Hungary)

Figure 2.35 "Summary & Conclusions" presentation during EWSDN 2014 workshop (Budapest, Hungary)

The set of presentations covering different aspects of the project's activities was also done during the technical sessions. The following papers were presented during different sessions:

1. **Technical Session 1: Data Paths**

    1) B. Belter, A. Binczewski, K. Dombek, A. Juszczyk, Ł. Ogrodowczyk, D. Parniewicz, M. Stroiński, I. Olszewski, „Programmable Abstraction of Datapath"

    2) R. Doriguzzi-Corin, E. Salvadori, M. Gerola, M. Suñé, H. Woesner , „A Datapath-Centric Virtualization Mechanism for OpenFlow Networks"

2. **Technical Session 2: Technologies**

    1) R. G. Clegg, J. Spencer, R. Landa, M. Thakur, J. Mitchell, M. Rio, "Pushing Software Defined Networking to the Access"

    2) V. Fuentes, J. Matias, A. Mendiola, M. Uharte, J. Unzilla, E. Jacob, "Integrating Complex Legacy Systems under OpenFlow Control: The DOCSIS Use Case"

3. **Technical Session 5: Security**

    1) U. Toseef, A. Zaalouk, T. Rothe, M. Broadbent, K. Pentikousis, "C-BAS: Certificate-Based AAA for SDN Experimental Facilities"

4. **Poster Papers**

    1) B. Belter, D. Parniewicz, Ł. Ogrodowczyk, A. Binczewski, M. Stroiński, V. Fuentes, J. Matias, M. Huarte, E. Jacob, "Hardware Abstraction Layer as an SDN-enabler for Non-OpenFlow Network Equipment"

    2) M. Santuari, R. Doriguzzi-Corin, M. Gerola, E. Salvadori, U. Toseef, A. Zaalouk, K. Dombek, D. Parniewicz, A. Hammad, M. Rashidi-Fard, E. Jacob, J. Matias, "Leading the OFELIA Facility Beyond OpenFlow 1.0 Experimentations"

    3) M. Suñé, V. Alvarez, T. Jungel, U. Toseef, K. Pentikousis, "An OpenFlow Implementation for Network Processors"

5. **Demonstration Papers**

    1) D. Depaoli, R. Doriguzzi-Corin, M. Gerola, E. Salvadori, "Demonstrating a Distributed and Version-Agnostic OpenFlow Slicing Mechanism"

The session participants were interested in presented issues and many fruitful discussions between ALIEN representatives and the session participant were provoked. In this way, valuable feedback was received on ALIEN's activities.

2.5.2 NetFPGA Workshop 2014

In January 2014 PUT organized a local version of NetFPGA workshop. It was hands on tutorial. Due to local character of this event, all attendees were PUT's students, mostly from last year of the MsC course.

The first part of this workshop was realized as a lecture with demonstrations. The second part consisted on practical experiments with prepared structure of code and laboratory network. All lectures and laboratories were realized at PUT's rooms and laboratories. The workshop lasted about total several hours divided into two days. These labs were treated as an element of standard educational process in course: "Networking Operating Systems".

There was also presentation of the ALIEN project and its achievements, including other hardware platforms used in the ALIEN project. Based on experience from this and mainly from previous edition of the NetFPGA camp [26] (described in details in deliverable D6.3 [8]) organized by PUT on May 2013, PUT is planning to realize analogical course for the next group of students. It is very interesting and valuable element of education, which shows actual state of the art and features of modern equipment.

Students were very interested in this workshop. One of the master thesis was prepared using NetFPGA cards. This work will be continued in future. The additional functionality to already achieved results will be added. This gives new a solution. It will be the main part of the topic of the PhD student's research during his PhD studies and will be a part of his PhD thesis.

All ALIEN targets and KPIs planned for NetFPGA workshop 2014 were achieved (see Table 15).

Table 15 KPI for the NetFPGA workshop

Key Performance Indicator (KPI)	ALIEN target	Status
Number of participant	To have more than 20 participants.	**Achieved**
Number of prepared projects	Each group of participant will prepare and run its own project as a confirmation of acquired knowledge and experience.	**Achieved**

2.5.3 CNN Workshop 2013

This workshop was organized by Technical University of Hamburg in December 2013, Hamburg, Germany. EICT as the ALIEN project partner presented the standardization activities in ICN research group (ICNRG) and SDN research group (SDNRG). The main focus was on ICN Baseline Scenarios and Evaluation Methodology as detailed in Section 2.4.

2.5.4 FFV Workshop 2014

FFV workshops are arranged biannually where experts from academia and industry participate. EICT participated in this workshop in March 2014 to disseminate the ALIEN project activities. For this purpose, ALIEN flyers prepared for FIA 2014 were distributed among the participants and a summary of work was presented.

2.5.5 2nd EU-China FIRE European Workshop 2014

In the 2nd EU-China FIRE European workshop 2014, the interest of the work done in the ALIEN project, mostly in the DOCSIS platform, was clearly stated by attendants from the Communication University of China as it can be seen in Figure 2.36.

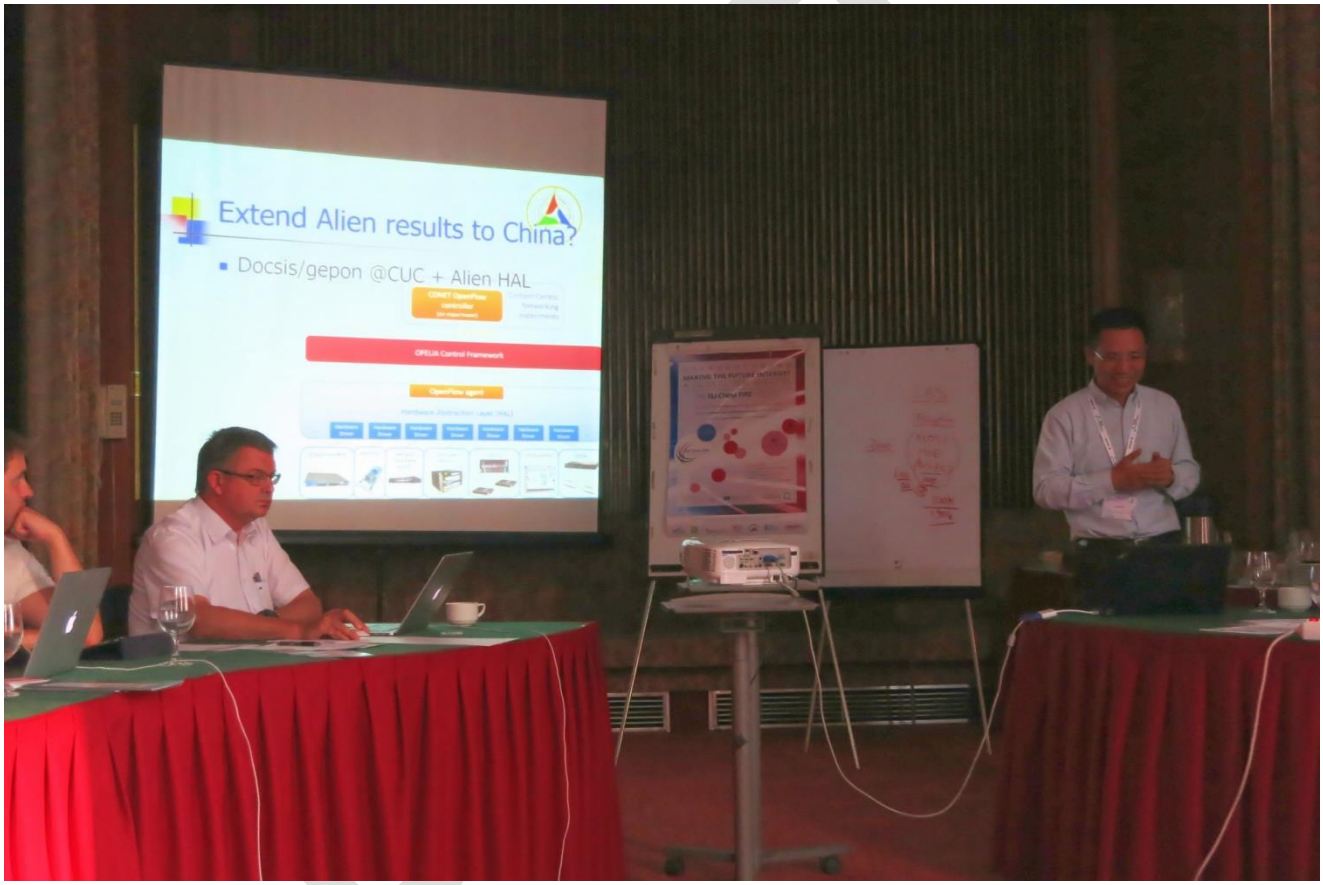

Figure 2.36 ALIEN presentation during 2nd EU-China FIRE European workshop 2014

3 Live Demonstrations

The live demonstration for academic and industrial people, and potential customers has several advantages – it shows a practical solution running just before visitors. It is sometimes more spectacular when the real platforms can be visible in action. The visitors can then see what is needed to connect different platforms (for example EZappliance and CAROS devices) between each other. It gathered simply more attention of attendees. What is more, we have then these devices in our range and in an emergency situation the physical restart of such platforms, if needed, can be done. And the most important – it can be seen that our solution works in reality. Considering the HAL as a new idea for using non-OpenFlow devices in OpenFlow networks, live demonstrations are treated as a proof of concept. The live demonstrations were carried out on carefully chosen and well-attended events.

One of the ALIEN mile stone was MS21 “ALIEN Workshop”. According to the DoW: “This mile stone represents workshop for external European industry partners. During this workshop others are allowed to access the ALIEN testbed”. The workshop was organized in close coordination with the European Workshop on Software Defined Networks 2014. We decided to prepare a special live demonstration where people from industry could see closer our concepts and solutions. Such demos were done during the Future Internet Assembly 2014 and European Workshop on Software Defined Networks 2014 where a lot of industry partners were present.

It took a lot of effort, however, after few meetings at PUT laboratory “Video on Demand in OpenFlow Network” was prepared for live demonstration and as a proof of HAL concept. To this demonstration three network processors devices (platforms) were used. It allowed to set up a small network with: three nodes (EZappliance network processors were used to this), one server (which storage some video materials required in demonstration by the end user), and one end user computer (we used to this a laptop with Internet browser). Additionally we added also one CAROS device. Network used to this live demonstration as well as separation of www and video traffic is shown in Figure 3.1. Very similar live demonstration was also shown during the TNC 2014 conference.

The ALIEN project prepared also demonstration “Integration of legacy DOCSIS access network under OpenFlow control” with DOCSIS platform. This platform was controlled remotely by the OpenFlow Controller. To communicate between this controller and DOCSIS device the OpenFlow protocol was used. This demonstration was shown during the FIA 2014 meeting. A little modified demonstration was also prepared: “DOCSIS platform integration in OFELIA”. This time the OFELIA environment was used to connect few devices between each other. This second live demonstration was shown during the TNC 2014 conference.

During the FIA 2014 event the third live demonstration concerning mostly virtualization was also shown: “Distributed and Version-agnostic OpenFlow slicing mechanism”. This was in some part remotely demonstration due to physical dimensions,

weights, and problem with transport of platforms used to is. These devices were connected to the network using OFELIA infrastructure and were controlled remotely from a laptop available at the ALIEN booth (see Figure 3.2).

The last live demonstration was prepared especially for the EWSDN 2014 workshop: "Demonstrating a Distributed and Version-agnostic OpenFlow Slicing Mechanism". This demonstration learns from experience gathered during the FIA 2014 demos.

3.1 FIA 2014 in Athens

The ALIEN project presented three live demonstrations on the FIRE booth (Figure 3.2) during the Future Internet Assembly (FIA) in Athens, Greece (18-20 March 2014) to show main project achievements:

- **Demo 1 – Video on Demand in OpenFlow Network**

  This demonstration showed the first successful deployment of the ALIEN's Hardware Abstraction Layer (HAL) for EZchip NP-3 and Intel platforms with DPDK processors. In this demo end users' applications were running in the OpenFlow-controlled network environment empowered by the latest HAL release for non-OpenFlow network equipment.

  Demonstration infrastructure used in this demo is depicted in Figure 3.1. Functional testing was performed using EZappliance devices (EZapplaince-1, -2 and -3 are shown in Figure 3.1) is demonstrating how HAL can be used to create a flexible streaming on demand service in OpenFlow networks with HAL-enabled network devices. Although these devices are programmable, they do not natively support the OpenFlow protocol. Thanks to implementation of HAL they are able right now to communicate with the OpenFlow Controller, and appear as any protocol compatible switch. As a practical example, after the request for a video by an end user, the Controller generates OpenFlow flow modifications (called flowmods) to redirect web and video streaming requests from the client to the media server. Finally, the video stream traffic from the media server is directed in the OpenFlow reactive manner, back to the client over the HAL-enabled network [27]. During the live demonstration CAROS.io with Intel DPDK libraries and xDPd framework [14] was used, as well (it is shown also in Figure 3.1).

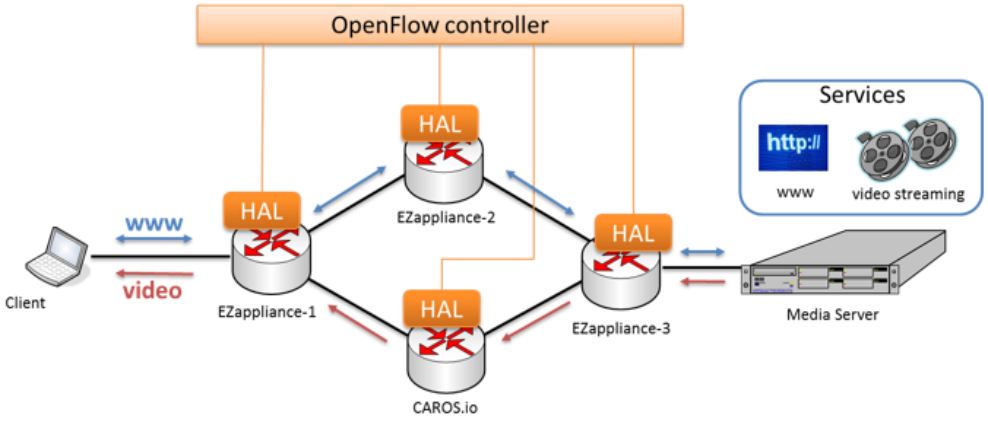

Figure 3.1 ALIEN demonstration topology during FIA 2014 conference (Demo 1 – VoD in OpenFlow network)

Figure 3.2 ALIEN live demonstrations booth during FIA 2014 conference (Athens, Greece)

The general demonstration workflow is as follows:

1) Proactive web-access

    i. OpenFlow entries installed proactively in EZappliance for web-access transport service (ARP, ICMP, HTTP protocols).

2) User can view and navigate on web server page

3) User request a movie stream (click Play button)

    i. OpenFlow Controller ignores RTSP request in *packet_in* event (network not configured yet).

4) User requests a network configuration (click Connect button)

    i. OpenFlow entries installed proactively in EZappliance (RTSP protocol).

5) User requests a movie stream (click Play button again)

    i. Basing on RTSP session, video streaming server starts sending RTP messages carrying video content. First network node generates packet-in with RTP packet.

6) Video stream is sent

   i. OpenFlow entries installed reactively in EZappliance (RTP protocol).

7) User stops video (generates RTSP request)

   i. RTSP message is forwarded from Client to Media Server through OpenFlow network

8) User clears network (click Deconfigure network)

   i. OpenFlow Controller uninstall flow entries for RTSP and RTP.

   ii. Back to Step 1).

Demonstration workflow was also reused as a functional test of the HAL for EZappliance in the OFELIA between PSNC and UNIVBRIS islands and it was described in details in deliverable D5.2 [27].

Screenshot from the live demonstration application can be seen in Figure 3.3. In turn, in Figure 3.4 there can be seen the ALIEN devices used for this demonstration.

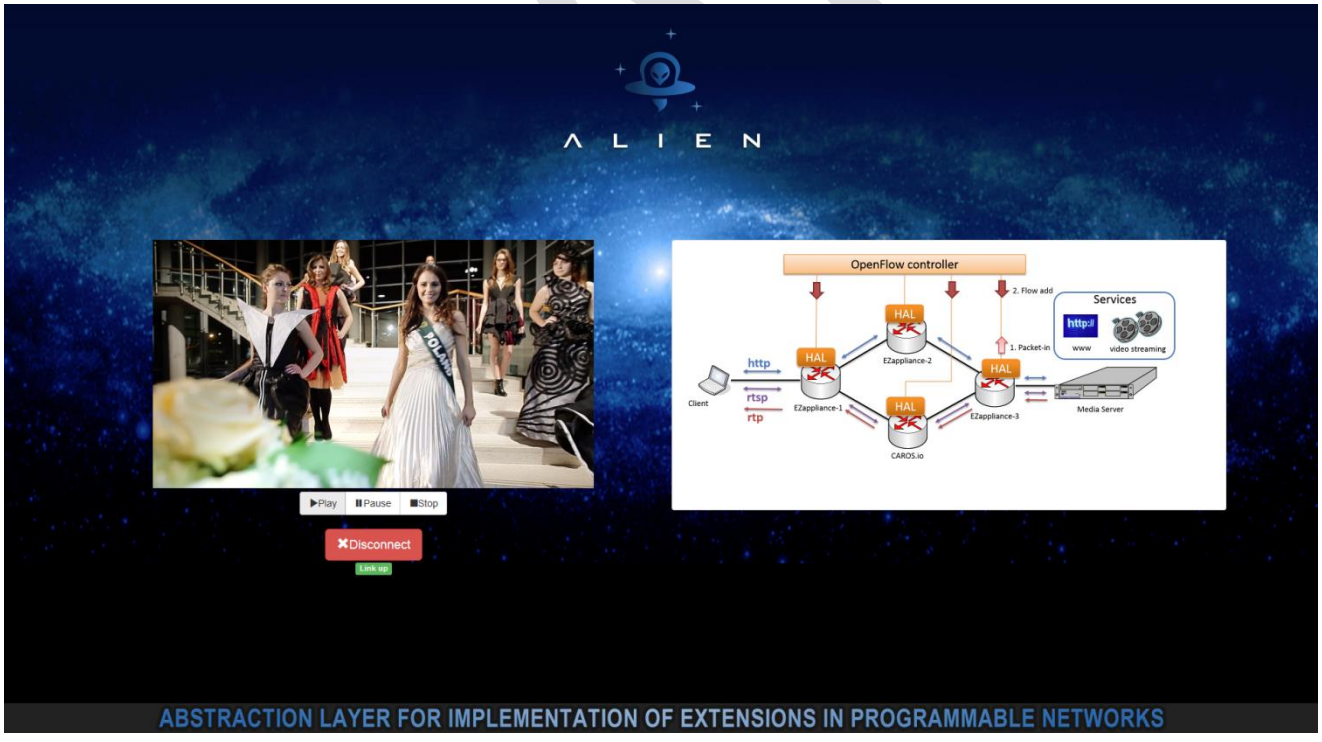

Figure 3.3 Screenshot from the live demonstation (VoD over OF network)

Figure 3.4 ALIEN live demonstrations during FIA 2014 conference (Athens, Greece)

- **Demo 2 – Distributed and Version-agnostic OpenFlow slicing mechanism**

  In this demonstration a preliminary results obtained by deploying and using a novel OpenFlow-based network virtualization mechanism were presented. The mechanism is based on the ALIEN's Hardware Abstraction Layer (HAL) and is able to run on multi-version OpenFlow scenarios. The main goal of the demonstration was to show how the proposed network virtualization approach, which relies on the HAL's plugin called Virtualization Agent (VA), allows for:

  - multiple versions of the OpenFlow protocol to be used at the same time to control the same physical infrastructure,
  - IPv6 and IPv4 multicast streaming experiments to be performed on different virtual networks without interfering each other,
  - virtual networks to operate even in case of failure of one of the VA instances.

- **Demo 3 – Integration of legacy DOCSIS access network under OpenFlow control**

  This demonstration showed how OpenFlow can be deployed over a legacy DOCSIS access network, exposing a unique OpenFlow interface and behaving as OpenFlow-enabled switch, hiding DOCSIS required configuration details. The HAL used in this proxy and the Orchestrator module were able to translate OpenFlow messages incoming from a NOX controller, using OpenFlow 1.0 into required actions over the different devices of the network involved. This implies generating CMTS commands to enable L2VPN for the cablemodems, autoassigment of the VLANs inside the DOCSIS network, and configuring and installing rules specifically for each element of the network.

  An OpenFlow 1.0 NOX controller was used running an application connected to an AAA VNF. Once authentication traffic is detected and the client is authenticated, rules for granted service (like video or SSH) are deployed by the controller and applied by the proxy to the network elements (see Figure 3.5).

  The general demonstration workflow is as follows:

  2) A new cablemodem tries to get its configuration from the provisioning system. As soon as this event is detected, traffic to the provisioning system is enabled for it and a VLAN is assigned to the cablemodem.
  3) Once cablemodem is configured, client side OF helper connects proxy and then it is also configured. Client port is ready but only authentication traffic can progress to the access control application.
  4) Client authentication is based on an IEEE 802.1x modified schema and it grants access per each service (like SSH, video streaming), which has an OpenFlow ruleset associated with it and it is installed by the controller once the access control VNF sends the profile to the controller to be installed.
  5) When the client is authenticated, it can access to the service.

These three demonstrations were also described shortly on poster (see Figure 2.14) which was placed on the ALIEN's booth (Figure 3.2). This poster helped us a lot to explain of our project ideas to visitors (see Figure 3.6).

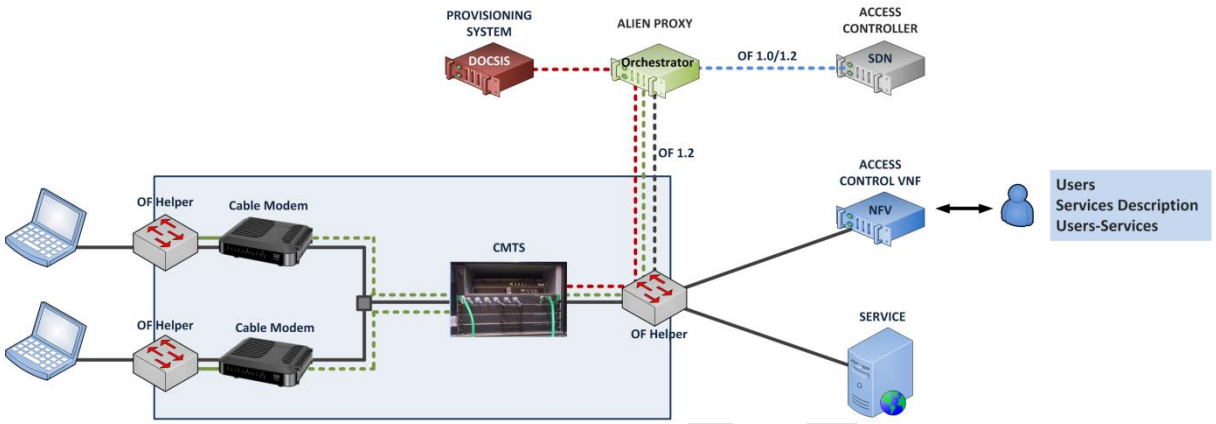

Figure 3.5 OpenFlow enabled DOCSIS access network enhanced with access control VNF schema

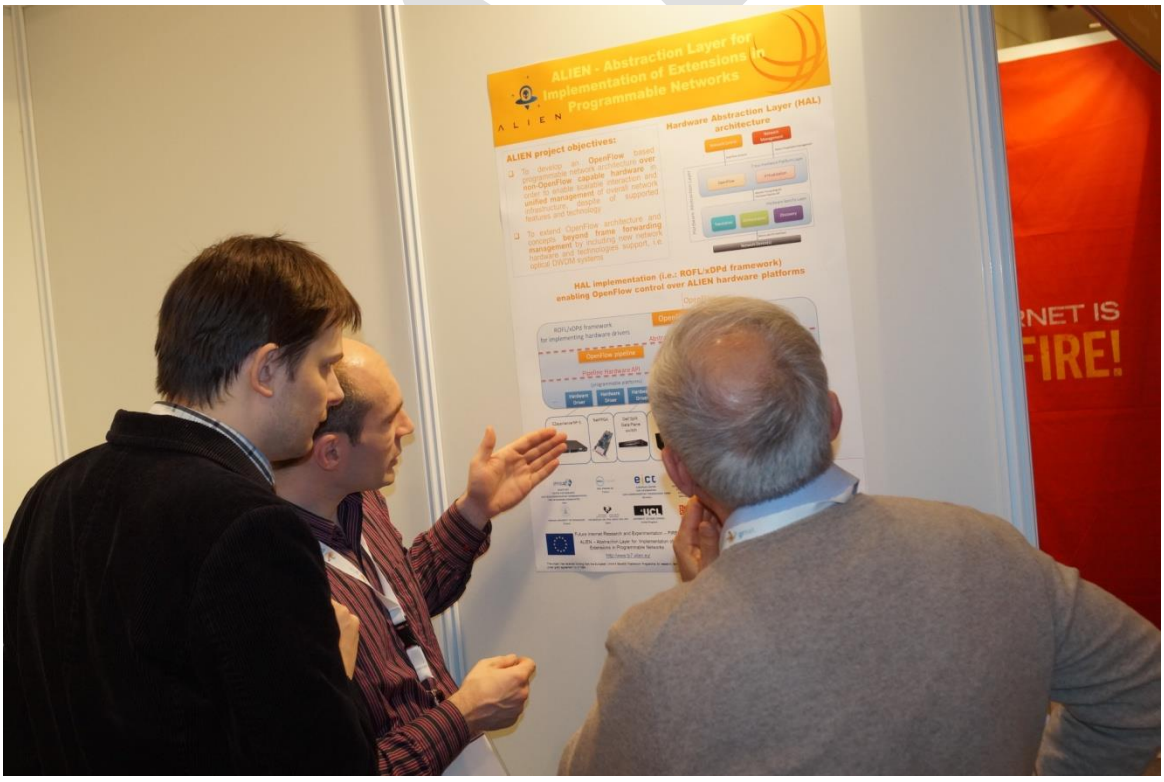

Figure 3.6 Discussion about ALIEN's HAL concept during FIA 2014 conference (Athens, Greece)

3.2 TNC 2014 in Dublin

The ALIEN project presented two live demonstrations on the PIONIER booth (Figure 3.7) during the TERENA Network Conference (TNC) in Dublin, Ireland (19-22 V 2014) to show main project achievements:

- **Demo 1 – Streaming on demand in OpenFlow networks**

  During this live demonstration it was presented:

  - HAL hardware drivers for EZchip NP-3 and Intel with DPDK,
  - end users applications' running on HAL-enabled hardware.

  Demo 1 is a repetition of Demo 1 from FIA 2014 conference (see Section 3.1).

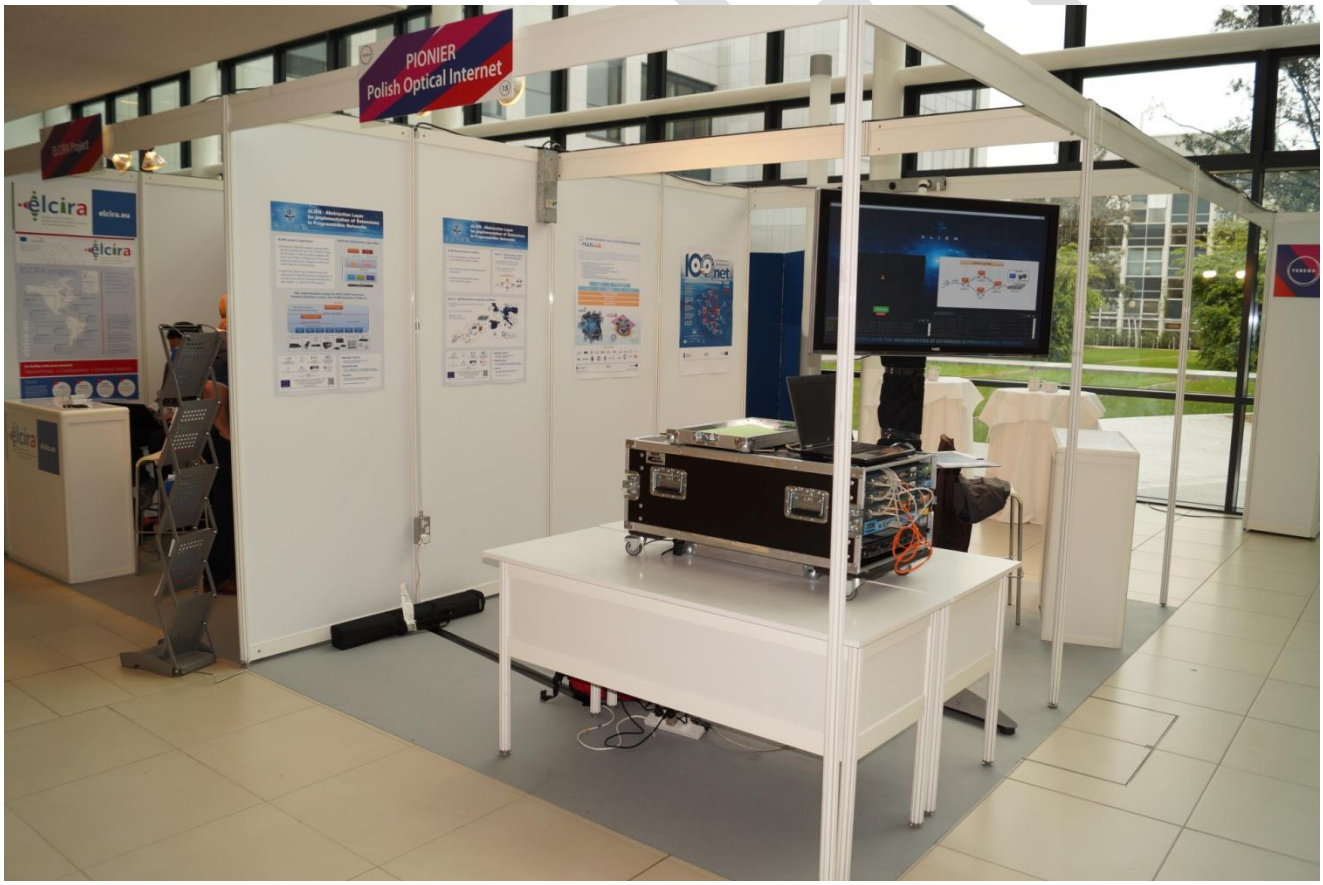

Figure 3.7 ALIEN live demonstrations booth during TNC 2014 conference (Dublin, Ireland)

- **Demo 2 – DOCSIS platform integration in OFELIA**

  This was a remote demonstration. During it was presented:

  - DOCSIS Access network available as an OpenFlow resource in OFELIA,
  - application running over OFELIA framework.

The UPV/EHU OFELIA was created and connected (both control plane and data plane) to I2CAT OFELIA island through a L2 connection provided by RedIris.

A controller and a server were deployed as virtual machines at i2CAT OFELIA island, and the ALIEN DOCSIS and some OF switches were connected to the POX controller, as it is shown in Figure 3.8. A PC was placed at the client side of the DOCSIS access network, which could connect to the server over OFELIA facility, after flow rules were deployed by the controller. The flow rules deployed at the ALIEN DOCSIS were processed by the HAL-based Proxy and converted into several actions for each device (OF helpers and CMTS equipment), resulting in an abstract OpenFlow enabled switch (i.e. Big Switch abstraction model).

In Figure 3.9 there can be seen also leaflets on the right side of the ALIEN devices used during live demonstrations. The ALIEN posters used at the booth during the TNC 2014 conference are visible very well in Figure 3.7.

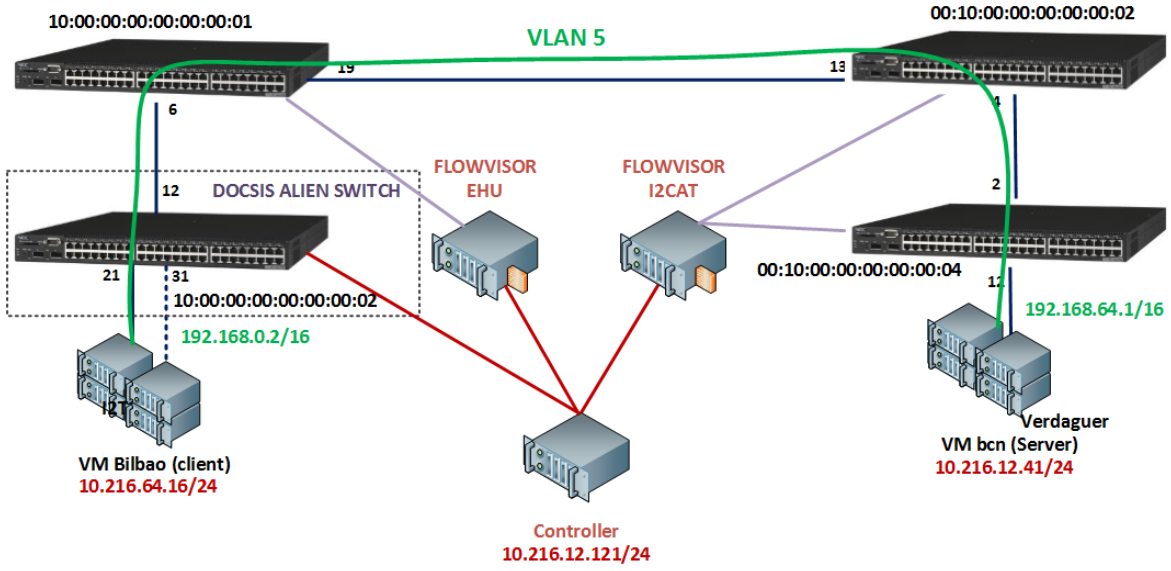

Figure 3.8 ALIEN DOCSIS integration over OFELIA facility

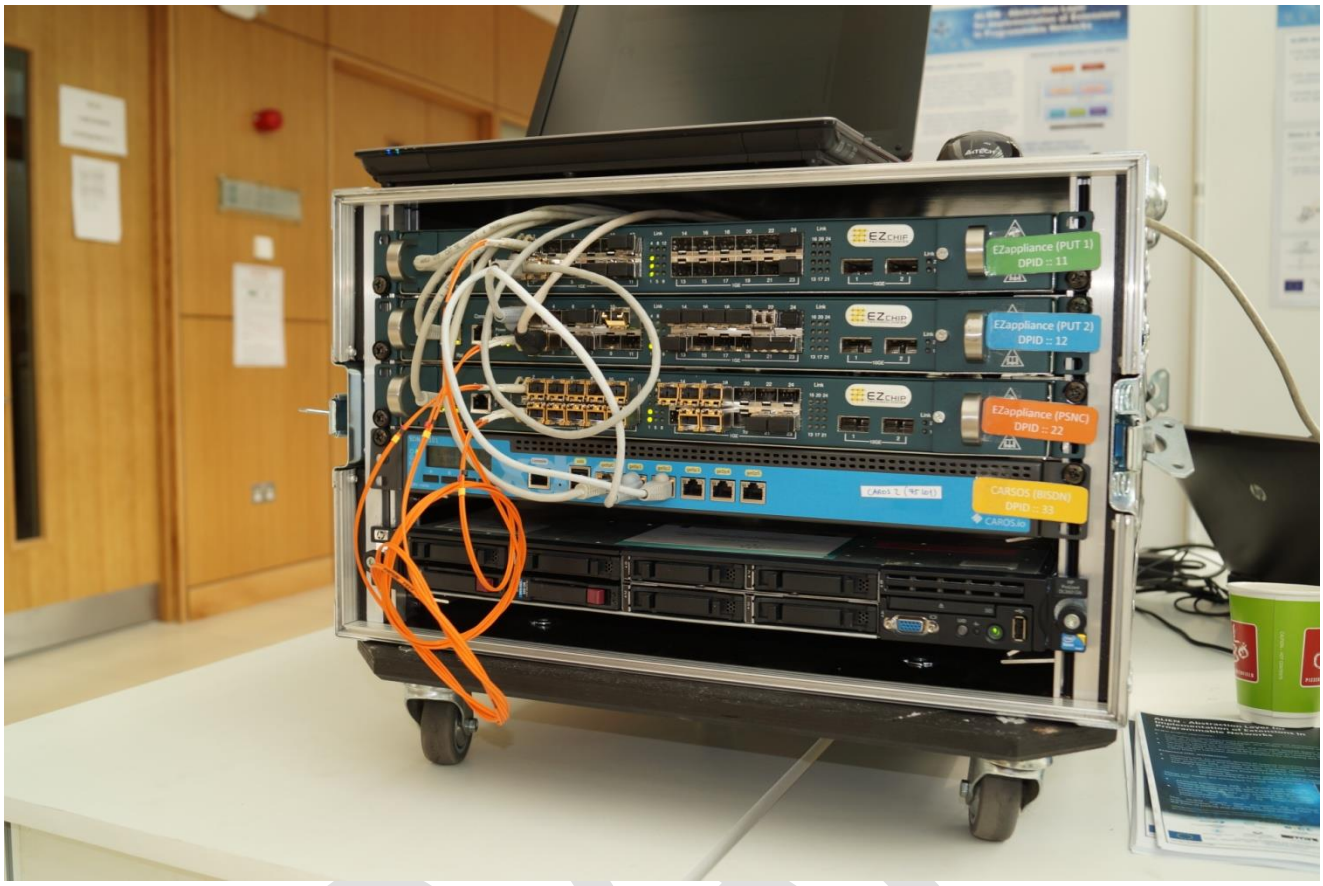

Figure 3.9 ALIEN live demonstrations equipment during TNC 2014 conference (Dublin, Ireland)

3.3 EWSDN 2014 in Budapest

The main goal of the demonstrations was to show a preliminary prototype of the novel virtualization mechanism presented in the paper "A Datapath-centric Virtualization Mechanism for OpenFlow Networks". This paper was also accepted to EWSDN 2014 (see Section 2.3). This demonstration was realized as a graphical console for remote laboratory network accessible via Internet.

As shown in Figure 3.10, the demonstration focused on the two main aspects that differentiate the proposed approach from FlowVisor [25] (the current reference virtualization architecture in OpenFlow networks):

- **Multiple versions of the OpenFlow protocol can be used simultaneously** to control the same physical infrastructure. In particular, OpenFlow v1.0 and v1.2 were used on different slices (or experiments) to control multimedia traffic based respectively on IPv4 and IPv6 addresses.

- **No Single Points of Failure** are introduced by the virtualization mechanism. In case of failure of one of the VA instances, only the virtual networks including the failing node can be affected by traffic disruption. However, if the failure is restricted to a single node, the controller can apply the necessary countermeasures.

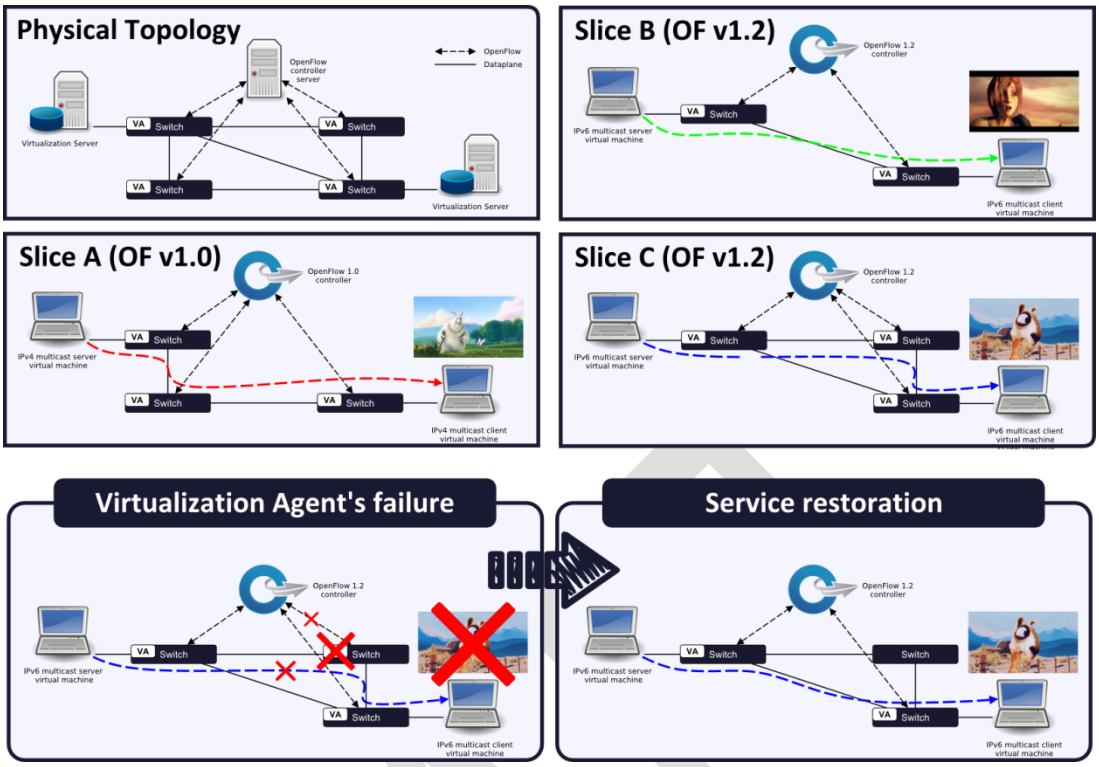

Figure 3.10 ALIEN demo during the EWSDN 2014 conference (Budapest, Hungary)

All interested participant from EWSDN 2014 audience were able to generate a failure in the presented network topology and could then observe a reaction of the live network.

3.4 ONS 2014

The University of the Basque Country's team attended the Open Networking Conference in Santa Clara (California) March 3-5, 2014, to present a demonstration done around the NFV concept. This involved setting up a booth (see Figure 3.11). Between demos some of the research works undertaken by the research group was presented using separate slides sets on a monitor. The ALIEN work on DOCSIS was presented. This brought the attention of Cablelabs who invited the team to participate and monitor OpenDaylight DOCSIS based on PCMM solution. It can be seen at OpenDayllight website in https://wiki.opendaylight.org/view/Project_Proposals:PacketCablePCMM. The research group has participated also in some meetings and presented during them the ALIEN work and ideas.

Figure 3.11 ALIEN demo during the ONS 2014 conference (Santa Clara, California, USA)

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4 Key Performance Indicators

To measure the progress of dissemination activities in the ALIEN project, a set of Key Performance Indicators (KPIs) have been identified per each event, providing a clear indicator of the impact assessment of the activity. All events planned for dissemination activities in deliverable D6.4 [20] are listed below in Table 16. In this table there can be found information which KPIs were achieved, which were not achieved, and which were partially achieved in the second year of the ALIEN project. The exact description of all events related KPIs is included in Sections 2.3, 2.4, and 2.5. Explanation why some of Key Performance Indicators were not achieved is included as well it the appropriate part of Sections 2.3, 2.4, and 2.5.

It should be also mentioned that some of planned KPIs were achieved at different conferences than it was earlier planned in deliverable D6.4 [20]. However, the impact factor of substituted conferences was comparable with original one mentioned in plans for Y2, therefore we decided to check the proper KPIs as achieved. What is more, all planned conferences (ONDM 2014 and INFOCOM 2015) are mentioned and described with a relevant explanation in Section 2.3. The additional conferences (NOMS 2014 and SIGCOMM 2014) are described as well in Section 2.3. We added also additional events not planned earlier in report D6.4 “Report on dissemination plan for the second year of the project” [20]. We allocated to this event theirs ALIEN targets and KPIs.

One KPI (number of audience) was not fully achieved. We planned this target for INFOCOM 2014 conference. However, we replaced it by SIGCOMM 2014 conference which is a little bit smaller conference. We planned that there will be “about 1000 people from researchers and scientists”. It was in fact less number of people than 1000, however, there was about 100 people. That is why this KPI is denoted (orange color in Table 16) as partially achieved.

All Key Performance Indicators for the Y2 can be seen in Table 16. Red color denotes which KPIs were not achieved. Green color denotes which KPIs were achieved. In turn, blue color denotes additionally achieved KPI which was not planned in D6.4 report [20].

We planned in the deliverable D6.4 [20] total 30 KPIs for the second year of the ALIEN project. We achieved 28 KPIs, 1 KPI was achieved partially (number of audience from INFOCOM 2015/SIGCOMM 2014 conference), 1 KPI was not achieved (publication in the IET journal), and we achieved 5 additional KPIs (publication in the FIRE Magazine, MONAMI conference, and SDNRG meeting). It should be also mentioned that in Y1 we planned 16 KPIs and we achieved 15 of them. Hence, in total it was defined 46 different ALIEN targets and we achieved 49 such targets (including 1 KPI achieved partially and 5 KPIs achieved additionally). We hope that it could be recognized as a quite good result at the end of the ALIEN project.

Table 16 KPIs for the second year of the ALIEN project

No.	Event	Key Performance Indicator (KPI)	ALIEN target	Status
1.	European Workshop on Software Defined Networks 2013 (EWSDN 2013), 10-11 October 2013 – Berlin, Germany	ALIEN poster	During the workshop the poster was available in the most visible manner, thus allowing attendees to be informed about the latest developments in the project. A minimum of 10 individuals asked about ALIEN progress and development plans.	Achieved
2.		xDPd presentation	The open-source datapath element software xDPd, which is used extensively in ALIEN was presented to a full house as part of the Industry Session I. Several questions were asked after the presentation, and we perceive this as a clear indication of the interest in this line of software development line of work in ALIEN. Approximately 100 people attended EWSND 2013.	Achieved
3.	Supercomputing Conference 2013 (SC 2013), 17-20 November 2013 – Denver, USA	Number of visitors at the booth	A minimum of 10 unique visitors (company representatives) are expected at the booth, interested in project outcomes.	Achieved
4.	Future Internet Assembly 2014 (FIA 2014), 18-20 March 2014 – Athens, Greece	The public demonstration of the ALIEN prototypes	During the workshop the public demonstration of the ALIEN software prototypes to the FIRE community was provided.	Achieved
5.		Number of visitors at the booth	A minimum of 10 unique visitors (company representatives) interested in project outcomes visited the project booth.	Achieved
6.		Software Demonstrations	The main ALIEN concept (the implementation of the HAL on few chosen ALIEN platforms) was demonstrated with usage of available software prototypes functionalities. A simple use-case demonstration was performed.	Achieved

7.	IEEE/IFIP Network Operations and Management Symposium (NOMS 2014), 5-9 May 2014 – Krakow, Poland	Number of submitted papers	A minimum of 1 paper presenting work done in the ALIEN project.	Achieved
8.		Number of audience	More than 100 person from industry and 50 researchers and scientists.	Achieved
9.	TERENA Networking Conference 2014 (TNC 2014), 19-22 May 2014 – Dublin, Ireland	The publication of ALIEN paper at the conference	It is planned to answer for TNC'14 paper call.	Achieved
10.		Number of submitted papers	A minimum of 1 unique paper presenting work done in ALIEN project.	Achieved
11.	IEICE Information and Communication Technology Forum (ICTF 2014), 28-20 May 2014 – Poznan, Poland	ALIEN posters	PUT will prepare a poster to disseminate ALIEN results.	Achieved
12.		Number of audience	About 50 people from industry, researchers and scientists.	Achieved
13.	IEEE 15th International Conference on High Performance Switching and Routing (HPSR 2014), 1-4 July 2014 – Vancouver, Canada	Number of submitted papers	A minimum 1 paper presenting work done in the ALIEN project.	Achieved
14.		Number of audience	About 200 people from researchers and scientists.	Achieved
15.	ACM Special Interest Group on Data Communication (SIGCOMM 2014), 17-22 August 2014 – Chicago, USA	Publication of the ALIEN experiments results	Publicize results from the ALIEN experiments in WP5 at a top international venue.	Achieved
16.		Number of audience	About 1000 people from researchers and scientists.	Partially achieved.
17.	European Workshop on Software Defined Networks (EWSDN 2014), 1-3 September 2014 – Budapest, Hungary	Number of visitors to the ALIEN presentation booth at EWSDN	A minimum of 30 unique visitors (company representatives) are expected at the booth, interested in project outcomes.	Achieved
18.		ALIEN Poster(s)	The consortium will prepare 1-2 posters to disseminate its final results. This will be part of the overall participation of ALIEN in EWSDN as a supporting-sponsoring project.	Achieved
19.		Academic paper(s) and/or Industry Track presentations	We envisage that at least one paper describing the overall achievements in ALIEN (architecture to implementation) will be submitted, and we expect that one or more	Achieved

			solution-specific papers will be submitted as well.	
20.		Software Demonstrations	All ALIEN results (i.e.: HAL implementation for all ALIEN hardware, OCF integration, CCN usage) will be presented in form of one or many parallel software prototypes demonstrations. The ALIEN project will demonstrate more advanced use cases.	**Achieved**
21.			In addition to the overall ALIEN demonstrations, EICT aims to demo in more detail the Member and Project Authority, which is compliant with GENI Federation API, and is currently under development within the framework of ALIEN will be demonstrated. As part of the presentation the capabilities of the Aggregate Manager Framework AMsoil will also be illustrated. Since this is an enabling technology for the overall demonstration, this demo will focus on the work that goes on under the hood in order to facilitate a better understanding, which may not be attained when all the pieces of the ALIEN demonstration are presented.	**Achieved**
22.	30 National Symposium on Telecommunications and Teleinformatics (KSTiT 2014), 3-5 September 2014 – Poznan, Poland	ALIEN posters	The ALIEN consortium will prepare few posters to disseminate its final results.	**Achieved**
23.		Number of participant	A minimum 6 ALIEN participants.	**Achieved**
24.		Number of submitted papers	A minimum 3 papers presenting work done in the ALIEN project.	**Achieved**
25.		Number of audience	About 50 people from industry and 100 researchers and scientists.	**Achieved**
26.	IET journal	Number of submitted papers	A paper presenting work done in the ALIEN project.	**Not achieved**
27.	Standardization	Internet Draft submission and presentation	ALIEN aims to continue the work already initiated in SDNRG and submit further revisions of the Internet Draft mentioned above. We also plan to keep the topic in the agenda and aim for SDNRG adoption within	**Achieved**

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			2014. This is a difficult task, but it is worthwhile. As the work progresses further aspects can be added and/or expanded upon in separate Internet Drafts.	
28.	NetFPGA Workshop	Number of participant	We plan to have more than 20 participants.	**Achieved**
29.		Number of prepared projects	Each group of participant will prepare and run its own project as a confirmation of acquired knowledge and experience.	**Achieved**
30.	TUHH CCN Workshop	Presentation on ALIEN project, and its relationship with ICN, as well as the use of OpenFlow/xDPd - based virtualization	Increased awareness of the ALIEN testbed – related work in the academic community (16 experts from 4 institutions attended).	**Achieved**
31.	IRTF SDNRG meeting at IETF 90, 20-25 July 2014 – Toronto, Canada	Presentation of ALIEN ideas	A minimum 1 presentation demonstrating ideas suggested and done in the ALIEN project.	**Achieved**
32.		Number of audience	About 200 people from industry, researchers and scientists.	**Achieved**
33.	FIRE Magazine	Number of submitted papers	A paper presenting work done in the ALIEN project.	**Achieved**
34.	6 International Conference on Mobile Networks and Management (MONAMI 2014), 22-24 September 2014 – Wuerzburg, Germany	Number of submitted papers	A paper presenting work done in the ALIEN project.	**Achieved**
35.		Number of audience	About 50 people from industry, researchers and scientists.	**Achieved**

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5 Impact Assessment of Dissemination Activities

During the European Workshop on Software Defined Networks (EWSDN), 10-11 October, 2013, EICT placed the ALIEN project poster in the most visible manner which allowed attendees to be informed about the last developments in the project. There were several questions about ALIEN, HAL concept and future steps of the project. Also during this event M. Suñé from BISDN presented the open-source datapath software xDPd [14] as a part of the Industry Session. There were about 100 attendees.

PSNC attended the Supercomputing Conference (SC13), 17-20 November 2013, where a special booth dedicated to ALIEN project was prepared. At this booth leaflets and poster were available. There were several general questions about the ALIEN project, however, more precisely questions appears too. It was very big conference – few thousand attendees. Our booth visited approximately about 150 visitors from industry and scientist environment.

PSNC, PUT, CREATE-NET, and EHU/UPV were at the Future Internet Assembly (FIA), 18-20 March, 2014. We prepared a special posters and leaflets to this event which were distributed among the visitors. This was also the first time when a live demonstration of the ALIEN project was showed to attendees. There were three demos: “Video on Demand in OpenFlow networks”, “Distributed and Version-agnostic OpenFlow slicing mechanism”, and “Integration of legacy DOCSIS access network under OpenFlow control”. Our booth visited about 100 visitors from industry and researchers. Several of them discussed about details we presented.

UCL attended the IEEE/IFIP Network Operations and Management Symposium (NOMS), 5-9 May, 2014. R. Clegg presented article “Software-defined network support for transport resilience”. There was about 100 industry audience and about 50 researchers during that event. UCL tried to answer and explain all questions gave by attendees.

PSNC attended the TERENA Networking Conference (TNC), 19-22 May, 2014. The ALIEN project had part of the PIONIER booth place. Two new project’s posters were prepared and leaflets were available for visitors. There was prepared second live demonstration divided into two parts: “Streaming on demand in OpenFlow networks”, and “DOCSIS platform integration in OFELIA”. At the booth 95-100 people watched our live experiments and asked us about implementation and usage of the ALIEN solution. It was very promising discussion especially with industry attendees. During this conference Ł. Ogrodowczyk (PSNC) presented project’s article: “Hardware Abstraction Layer for non-OpenFlow capable devices”. There was about 100 people in the audience at this session.

PUT prepared a special session dedicated to European projects during the IEICE Information and Communication Technology Forum (ICTF), 28-30 May, 2014. The project leaflets and posters were prepared and putted in visible places. PUT and PSNC attended the conference session and presented three ALIEN project articles: “ALIEN Project – Abstraction

Layer for Implementation of Extensions in programmable Networks", "Hardware Abstraction Layer on EZchip NP-3", and "Adding Support for NetFPGA10G Cards in xDPd". These presentations were done by: Ł. Ogrodowczyk, D. Parniewicz and T. Sielach, respectively. In total it was about 50 attendees in the session room. It was also coffee break where we spend time explaining other participants ideas of the ALIEN project and our point of view.

PUT attended the IEEE 15th International Conference on High Performance Switching and Routing (HPSR) conference, 1-4 July, 2014. There was about 200 people, mostly researchers and scientists, however, from industry too. M. Michalski presented "The System for Delay Measurement in Ethernet Networks on NetFPGA Cards" dedicated to the NetFPGA cards used in the ALIEN project. This topic showed potential usage of some part of this measurement in the performance tests prepared later by the ALIEN consortium.

PSNC, PUT, EICT, BISDN, CREATE-NET, and EHU/UPV attended the European Workshop on Software Defined Networks (EWSDN), 1-3 September, 2014. This workshop was co-organized by the ALIEN consortium due to a special tutorial "ALIEN tutorial on advanced technologies in OpenFlow networks" and software demonstration "Demonstrating a Distributed and Version-agnostic OpenFlow Slicing Mechanism". For this live demonstration a special booth was used. We prepared four new posters. Additionally, three poster papers were prepared: "Leading the OFELIA Facility Beyond OpenFlow 1.0 Experimentations", "Hardware Abstraction Layer as an SDN-enabler for non-OpenFlow network equipment", and "An OpenFlow Implementation for Network Processors". The ALIEN consortium submitted and presented five papers: "Programmable Abstraction of Datapath", "C-BAS: Certificate-based AAA for SDN Experimental Facilities", "A Datapath-centric Virtualization Mechanism for OpenFlow Networks", "Integrating complex legacy systems under OpenFlow control: The DOCSIS use case", and "Pushing Software Defined Networking to the access". Totally there were more than 150 people mostly from industry, however, from university community too.

PSNC was at the ACM Special Interest Group on Data Communication (SIGCOMM) conference, 17-22 August, 2014. We submitted two papers: "Design and Implementation of an OpenFlow Hardware Abstraction Layer", "Advanced Programmability of Heterogeneous Datapath Elements through Hardware Abstraction", however, the second one was rejected. The audience counted about 100 people from scientist and industry community.

PUT and PSNC attended the 30th National Symposium on Telecommunications and Teleinformatics (KSTiT), 3-5 September, 2014. PUT prepared a special session dedicated to European projects. Three ALIEN articles (in polish): "ALIEN – warstwa abstrakcji dla urządzeń niezgodnych z OpenFlow w sieciach SDN", "Implementacja modłu kart NetFPGA 1G I NetFPGA 10G w xDPd", "Karty NetFPGA jako podstawa sprzętowego pomiaru czasu transmisji ramek Ethernetowych w przełącznikach OpenFlow" were presented by: Ł. Ogrodowczyk, T. Sielach, and M. Michalski, respectively. There were also available a special poster and the ALIEN project leaflets. It was about 50 people during special session and coffee break interested in the ALIEN solutions.

The ALIEN project has been mentioned recently as a part of the SDN history document [1]. Solution proposed by the ALIEN consortium is described as one of the possible one for the SDN in article "Software-Defined Networking: A Comprehensive Survey". This paper has more than 60-pages. That is why this article is also called "the SDN encyclopedia". This article is still under construction, however, it is available on-line (direct link is available in [1]). There are several citations of our latest paper and it still grows (ALIEN project' newest articles from last conferences and workshops appear in references).

An overview of the conferences and posters is provided in Table 17. As it can be seen presentations of the ALIEN project reached more or less about 1600 people. It is almost triple times greater value than it was in the Y1. It reflects mostly that in Y2 we achieved some results and our solution was in more advanced stage than in Y1. At the end of Y2 period we finished our implementation process and the final solution was then ready to show others researchers and scientists.

Table 17 Impact assessment of the ALIEN project conference presentations and posters

Conference	Countries Addressed	Size of Audience
European Workshop on Software Defined Networks (EWSDN 2013), 10-11 October 2013	European	120
Supercomputing Conference (SC 2013), 17-20 November 2013	Worldwide	140
Future Internet Assembly (FIA 2014), 18-20 March 2014	Worldwide	120
IEEE/IFIP Network Operations and Management Symposium (NOMS 2014), 5-9 May 2014	Worldwide	150
TERENA Networking Conference (TNC 2014), 19-22 May 2014	European	200
IEICE Information and Communication Technology Forum (ICTF 2014), 28-30 May 2014	Worldwide	80
IEEE 15th International Conference on High Performance Switching and Routing (HPSR 2014), 1-4 July 2014	Worldwide	200
IRTF SDNRG meeting at IETF 90, 20-25 July 2014	Worldwide	200
ACM Special Interest Group on Data Communication (SIGCOMM 2014), 17-22 August 2014	Worldwide	70
European Workshop on Software Defined Networks (EWSDN 2014), 1-3 September 2014	European	150
30th National Symposium on Telecommunications and Teleinformatics (KSTiT 2014), 3-5 September 2014	Poland (national)	110
6th International Conference on Mobile Networks and Management (MONAMI 2014), 22-24 September 2014	European	60

Table 18 presents the impact assessment of the ALINE project achieved during workshops organized in the second year of the ALIEN project. As it can be seen, the ALIEN project achievements were presented to about 180 people. It is almost triple times greater value than it was in the Y1. It reflects mostly that in Y2 we achieved some results and our solution was in the more advanced stage than in Y1. At the end of Y2 period we finished our implementation process and the final solution was ready to show other researchers and scientists.

Table 18 Impact assessment of the ALIEN project workshops

Workshop	Countries Addressed	Size of Audience
EWSDN 2014 Workshop	European	45
NetFPGA Workshop 2014	Poland (PUT's students)	26
CNN 2013 Workshop	European	36
FFV 2014 Workshop	European	41
2nd EU-China FIRE European Workshop 2014	Worldwide	35

In turn, in Table 19 it can be seen impact assessment of the ALIEN project during seven live demonstrations done at three meetings. The number of visitors reached more than 210 people from industry and scientific community.

Table 19 Impact assessment of the ALIEN project live demonstrations

Live demonstration	Countries Addressed	Size of Audience
Video on Demand in OpenFlow networks – during FIA 2014, May 2014	Worldwide	45
Distributed and Version-agnostic OpenFlow slicing mechanism – during FIA 2014, May 2014	Worldwide	
Integration of legacy DOCSIS access network under OpenFlow control – during FIA 2014, May 2014	Worldwide	
Streaming on demand in OpenFlow networks – TNC 2014, May 2014	European	50
DOCSIS platform integration in OFELIA – TNC 2014, May 2014	European	
Demonstrating a Distributed and Version-agnostic OpenFlow Slicing Mechanism – during EWSDN 2014, September 2014	European	65
Extended ALIEN results to China? – during ONS 2014, March 2014	Worldwide	50

6 Impact of ALIEN Work

6.1 New Ofelia Islands

In the ALIEN project we used OFELIA facility to connect our devices between each other. However, not all partners had before access to the OFELIA resources. Therefore, we decided to add new islands to extend the OFELIA facility, especially for our purposes. It allowed us to test a few different configurations and test behavior of different devices.

Three new Ofelia islands were set up by UPV/EHU, PSNC and PUT to validate the developments done under the ALIEN project. The UPV/EHU is connected to OFELIA through i2Cat, and the PSNC and PUT are connected through the UNIVBRIS island. These islands are as follows:

1) **The first OFELIA island**. The UPV/EHU decided to create an OFELIA island and to link it to OFELIA through a dedicated 1Gbps layer 2 link provided by Spanish NREN RedIRIS to the i2Cat OFELIA Island. The UPV/EHU OFELIA island comprises computational and OpenFlow-enabled datapath resources, which are exposed to OFELIA experimenters through the appropriate Aggregate Managers configured in the UPV/EHU's. The UPV/EHU island resources are as follows:

    - DOCSIS ALIEN device exposed as OF1.0 switch (ALIEN OpenFlow datapath);
    - NEC IP8800 OF1.0 switch (OpenFlow datapath);
    - Servers for deploying Virtual Machines (computation resources).

2) **The second OFELIA island**. The PSNC OFELIA island connect EZappliance device to the old OFELIA UNIVBRIS island through the GEANT layer2 link. This island comprises four devices (2 server machines and 2 network devices):

    - HP Proliant DL360 G7 – used for deploying all management and control software required by OFELIA environment (OCF components, OpenVPN and QUAGGA);
    - IBM System x3550 M3 – server with XEN installed, controlled by OCF Virtualization Aggregation Manager and participating in data plane as endpoint;

- EZappliance – the ALIEN platform with HAL installed (xDPd-for-EZappliance) exposing OpenFlow protocol, dynamically configuring data plane connections;

- Juniper EX4200 – manually configured switch, providing static data plane connectivity through GEANT and PIONIER networks to other islands.

This island is connected with UNIVBRIS island and with PUT island using VLANs.

3) **The third OFELIA island**. The PUT island is connected to the OFELIA facilities through the PSNC island. The direct fiber from PUT to PSNC island is used to connect a hardware. PUT OFELIA island is composed of many different networking devices therefore configuration is flexible and can be extended and adopted to required conditions. The island comprises:

   - 2x Juniper EX3200 – L2/L3 switches providing L2 data connectivity between interfaces of hosts and virtual machines in the same VLANs and L3 routing to different IP networks of OFELIA Control and PUT local laboratory VPNs. Their (mostly manual) configuration allows to create a dynamic configuration of L2 connections between interfaces of laboratory hosts as datapath and IP routing for management interfaces;

   - HP Proliant DL360 G7 – 1U rack mounted servers for virtual machines used for deploying all management and control software required by OFELIA environment (OCF components, OpenVPN and QUAGGA);

   - 3x hosts with NetFPGA cards – the ALIEN platform with HAL prototype exposed as OpenFlow switch to OFELIA. PUT can increase number of NetFPGA nodes (PUT has 12 NetFPGA cards with interfaces 4x1G and 5 NetFPGA cards with interfaces 4x10G).

In Figure 6.1 it could be seen list of all OFELIA islands. The three new islands (PSNC, PUT and EHU/UPV) are denoted by the purple rectangle.

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Name	IslID	IP Range Ctrl	IP Range Mgmt	Mac Range	dpid Prefix	OSPF Area
Ctrl VPN	0	Primary: 10.216.0.0/23	-	-	-	0
		backup: 10.216.2.0/23				
iMinds	1	Ofelia: 10.216.4.0/22	10.216.132.0/22	02:01:xx:xx:xx:xx	01:xx:xx:xx:xx:xx:xx:xx	1
		VWall: 10.0.0.0/16		physical mac		
		Wilab: 10.11.0.0/20		physical mac		
ETHZ	2	10.216.8.0/22	10.216.136.0/22	02:02:xx:xx:xx:xx	02:xx:xx:xx:xx:xx:xx:xx	2
i2CAT	3	10.216.12.0/22	10.216.140.0/22	02:03:xx:xx:xx:xx	03:xx:xx:xx:xx:xx:xx:xx	3
TUB	4	10.216.16.0/22	10.216.144.0/22	02:04:xx:xx:xx:xx	04:xx:xx:xx:xx:xx:xx:xx	4
UnivBristol	5	10.216.20.0/22	10.216.148.0/22	02:05:xx:xx:xx:xx	05:xx:xx:xx:xx:xx:xx:xx	5
EICT	6	10.216.24.0/22	10.216.152.0/22	02:06:xx:xx:xx:xx	06:xx:xx:xx:xx:xx:xx:xx	6
NEC	7	10.216.28.0/22	10.216.156.0/22	02:07:xx:xx:xx:xx	07:xx:xx:xx:xx:xx:xx:xx	7
CNET	8	10.216.32.0/22	10.216.160.0/22	02:08:xx:xx:xx:xx	08:xx:xx:xx:xx:xx:xx:xx	8
CNIT-RM	9	10.216.36.0/22	10.216.164.0/22	02:09:xx:xx:xx:xx	09:xx:xx:xx:xx:xx:xx:xx	9
CNIT-CT	10	10.216.40.0/22	10.216.168.0/22	02:0A:xx:xx:xx:xx	0A:xx:xx:xx:xx:xx:xx:xx	10
NICT	11	10.216.44.0/22	10.216.172.0/22	02:0B:xx:xx:xx:xx	0B:xx:xx:xx:xx:xx:xx:xx	11
CNIT-PI	12	10.216.48.0/22	10.216.176.0/22	02:0C:xx:xx:xx:xx	0C:xx:xx:xx:xx:xx:xx:xx	12
CTTC	13	10.216.52.0/22	10.216.180.0/22	02:0D:xx:xx:xx:xx	0D:xx:xx:xx:xx:xx:xx:xx	13
DELL-F10	14	10.216.56.0/22	10.216.184.0/22	02:0E:xx:xx:xx:xx	0E:xx:xx:xx:xx:xx:xx:xx	14
UFU	15	10.216.60.0/22	10.216.188.0/22	02:0F:xx:xx:xx:xx	0F:xx:xx:xx:xx:xx:xx:xx	15
/24 subnets						
EHU	16	10.216.64.0/24	10.216.192.0/24	02:10:xx:xx:xx:xx	10:xx:xx:xx:xx:xx:xx:xx	16
PSNC	17	10.216.65.0/24	10.216.193.0/24	02:11:xx:xx:xx:xx	11:xx:xx:xx:xx:xx:xx:xx	17
PUT	18	10.216.66.0/24	10.216.194.0/24	02:12:xx:xx:xx:xx	12:xx:xx:xx:xx:xx:xx:xx	18
ARGELA	19	10.216.67.0/24	10.216.195.0/24	02:13:xx:xx:xx:xx	13:xx:xx:xx:xx:xx:xx:xx	19
User VPN	31	upd&certs: 10.216.124.0/24	-	-	-	31
		tcp&certs: 10.216.125.0/24				
		udp&pwd: 10.216.126.0/24				
		tcp&pwd: 10.216.127.0/24				

Figure 6.1 List of the OFELIA islands

6.2 Exploitation

To guarantee the transfer of the ALIEN project results beyond its life the official project's website [9] will be available for a few next years. It is possible, because this website is maintained and stored by PSNC on its servers. We also used the GitHub repository website to allow other groups of researchers and scientists to download and use our code and use ALIEN project's ideas in future solutions [2], [3], [4], [5], [6], and [7].

The initial strategy was defined and carried out in a close relation with the dissemination activities. The final exploitation report (the public report D5.3 [28] is almost finished in time when this report is creating) will incorporate all results and recommendations based on our experience achieved during the ALIEN project evaluation time. Deliverable D5.3 [28] will be available at the official ALIEN website [9] soon (the right link should be available on November 2014). At this website also previous public reports are still available for wide range of community interested in this topic.

Till end of the ALIEN project ALIEN Consortium is going to publish "ALIEN HAL cookbook" which will provide detailed guideline for developers how to adopt the ALIEN HAL based on xDPd/ROFL into a new non-OF platforms. We think it could be very handy for future usage by people who will want to use our solution. We believe that it for sure allows even for a quicker adoption of our solutions to new devices.

As part of the exploitation activities, project partners (PUT and EHU/UPV) will use knowledge from this project to educate students. PUT is still continuing the NetFPGA workshops 2014 and the 2013 NetFPGA camp [26] legacy constitutes a very good background to teach new groups of potentially interested students. Few of these students are now continuing their NetFPGA workshop 2014 projects and results from them will constitute their PhD research and PhD thesis.

In the last months of the ALIEN project, live demonstrations during European and worldwide events were organized to disseminate project's results and ideas. These demos based on tools still available on-line for a future use. Mostly all code is in an open-source and can be downloaded from ALIEN project's GitHub repositories [2], [3], [4], [5], [6], and [7]. Exceptions are some devices due to their license, however, it is possible to contact us to get help (contact information to the ALIEN project partners are available at the official project' website [9]).

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7 Conclusions

This deliverable summarizes the dissemination activities employed within the ALIEN project during the second year of execution. This period of time was devoted first of all to: implementation of HAL concept on selected platforms, integration of non OpenFlow devices under the OFELIA Control Framework, and testing proposed solutions. Moreover, all partners were involved in dissemination activities of the project using different kind of media: project website, leaflets, posters and hands-out, technical papers, and live demonstrations. The members of ALIEN consortium took part in conferences, workshops, and organized tutorials. All dissemination activities were selected carefully to maximize the efficiency and the scope of influence on the research and technical world.

After the second year of dissemination the ALIEN project is recognizable, many visitors from different countries visited ALIEN project website (about 9420 visits in period of the Y2). The visitors were interested not only in a project description, but also in project reports. During the second year of the project the HAL concept, its implementation and other related issues were published in 21 conference papers, on 13 posters, and in 12 standardization Internet Drafts. The most significant events were the following:

- European Workshop on Software Defined Networking (EWSDN), 1-3 September, 2014 – Budapest, Hungary,
- TERENA Networking Conference (TNC), 19-22 May, 2014 – Dublin, Ireland,
- Future Internet Assembly (FIA), 18-20 March, 2014 – Athens, Greece,
- IEICE Information and Communication Technology Forum (ICTF), 28-30 May, 2014 – Poznan, Poland
- ACM Special Interest Group on Data Communication (SIGCOMM), 17-22 August, 2014 – Chicago, USA.

The participants of EWSDN 2014 workshop took part also in a special tutorial titled: “ALIEN tutorial on advanced technologies in OpenFlow networks”, prepared by the ALIEN community members. Many interesting questions concerning HAL concept were asked during this tutorial. ALIEN specialists answered to all questions explained consequently the details of HAL concept and its implementation on “alien” devices.

The proof of HAL concept was done during live demonstrations. Many fruitful discussions with visitors, asked questions, and different remarks constituted valuable feedback on the project’s activities. In total, six demos were shown during FIA 2014 in Athens, TNC 2014 in Dublin, and EWSDN 2014 in Budapest.

The ALIEN project, under the leadership of EICT, was also active in standardization bodies. The contribution was made to the document: „SDN Layers and Architecture Terminology". We expect that this document will become an RFC in the near future. The results obtained by the ALIEN project in the area of ICN (Information-Centric Networking) will be introduced in the draft of document "Information-centric Networking: Evaluation Methodology" prepared under the umbrella of ICNRG.

The achievements of the ALIEN project were noticed by the authors (mostly IEEE members) of "Software-Defined Networking: A Comprehensive Survey". They have mentioned about the HAL concept, PAD concept, virtualization, and C-BAS, and referred to six papers published by the ALIEN consortium members.

The ready-to-use software enabling selected non-OpenFlow devices to communicate with OpenFlow controller within OFELIA infrastructure is the main practical achievement of the ALIEN project. As a result, non-OpenFlow devices are connected to OFELIA infrastructure (OpenFlow network) creating unique heterogeneous environment for testing protocols as well as control and management mechanisms. In such environment consisted of non-OpenFlow and OpenFlow equipment it is possible to do a research on SDN network control and management issues, traffic control, scalability, security etc.

The impact of the ALIEN project achievements to commercial world lies mainly in specification of the HAL concept and application of its functionalities on selected non-OpenFlow devices. This shows that it is possible to extend OpenFlow functionality on different kind of programmable devices, and transition to the SDN network does not mean that all network equipment has to be new and SDN-native. The software produced by the ALIEN project may be used to connect selected devices to the OpenFlow network.

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9 Acronyms

AAA Authentication, Authorization and Accounting
C-BAS Certificate-based AAA for SDN
CGBP Carrier-Grade Base Platform
DCC Distributed Cloud Computing
HAL Hardware Abstraction Layer
HPC High Performance Computing
HSP Hardware Specific Part
ICN Information-Centric Networking
ICNRG Information-Centric Networking Research Group
KPI Key Performance Indicator
NEP Network Equipment Provider
NREN National Research and Education Network
OF OpenFlow
OFELIA OpenFlow in Europe: Linking Infrastructure and Applications
OCF OFELIA Control Framework
ROFL Revised OpenFlow Libraries
SDN Software Defined Networks
SDNRG Software Defined Networking Research Group
VA Virtualization Agent
xDPd eXtensible Data Path Daemon

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Appendix A List of ALIEN Publications

In Section 2.3 it is described in details each event we participated in. There are also relevant information about all papers presented by us. In this appendix there are only putted lists of all publications we achieved in Y2 (period time from October 2013 till September 2014) of the ALIEN project.

List of articles published in conference materials

Below is a list of the ALIEN project publications which were accepted and published in the Y2 and are in printed version in conference materials:

1. J. Araujo, R. Landa, R. Clegg, R. Landa, "Software-defined network support for transport resilience", NOMS 2014, Krakow, Poland, May 2014.

2. Ł. Ogrodowczyk, B. Belter, A. Binczewski, K. Dombek, A. Juszczyk, I. Olszewski, D. Parniewicz, R. Doriguzzi Corin, M. Gerola, E. Salvadori, K. Pentikousis, U. Toseef, H. Woesner, M. Rashidi Fard, M. Huarte, E. Jacob, J. Matias, V. Fuentes, M. Michalski, R. Rajewski, “Hardware Abstraction Layer for non-OpenFlow capable devices”, Proc. TERENA 2014, ISBN 978-90-77559-24-6, Dublin, Ireland, May 2014.

3. B. Belter, A. Binczewski, K. Dombek, A. Juszczyk, J. Kleban, M. Michalski, Ł. Ogrodowczyk, I. Olszewski, D. Parniewicz, R. Rajewski, M. Stroiński, “ALIEN Project – Abstraction Layer for Implementation of Extensions in programmable Networks”, Proc. IEICE ICTF 2014, Poznan, Poland, May 2014.

4. B. Belter, A. Binczewski, A. Juszczyk, K. Dombek, Ł. Ogrodowczyk, I. Olszewski, D. Parniewicz, “Hardware Abstraction Layer on EZchip NP-3” , Proc. IEICE ICTF 2014, Poznan, Poland, May 2014.

5. M. Michalski, T. Sielach, “Adding Support for NetFPGA10G Cards in xDPd”, Proc. IEICE ICTF 2014, Poznan, Poland, May 2014.

6. M. Michalski, “The System for Delay Measurement in Ethernet Networks on NetFPGA Cards”, IEEE 15th HPSR 2014, Vancouver, Canada, July 2014.

7. D. Parniewicz, R. Doriguzzi Corin, L. Ogrodowczyk, M. Rashidi Fard, J. Matias, M. Gerola, V. Fuentes, U. Toseef, A. Zaalouk, B. Belter, E. Jacob, K. Pentikousis, "Design and Implementation of an OpenFlow Hardware Abstraction Layer", Proc. SIGCOMM DCC 2014, Chicago, USA, August 2014.

8. B. Belter, A. Binczewski, A. Juszczyk, K. Dombek, Ł. Ogrodowczyk, I. Olszewski, D. Parniewicz, M. Stroiński, "Programmable Abstraction of Datapath", Proc. EWSDN 2014, Budapest, Hungary, September 2014.

9. U. Toseef, A. Zaalouk, T. Rothe, M. Broadbent, K. Pentikousis, "C-BAS: Certificate-based AAA for SDN Experimental Facilities", Proc. EWSDN 2014, Budapest, Hungary, September 2014.

10. R. Doriguzzi Corin, E. Salvadori, M. Gerola, M. Suñé, H. Woesner, "A Datapath-centric Virtualization Mechanism for OpenFlow Networks", Proc. EWSDN 2014, Budapest, Hungary, September 2014.

11. V. Fuentes, J. Matias, A. Mendiola, M. Huarte, J. Unzilla, E. Jacob, "Integrating complex legacy systems under OpenFlow control: The DOCSIS use case", Proc. EWSDN 2014, Budapest, Hungary, September 2014.

12. R. G. Clegg, M. Thakur, J. Spencer, J. Mitchell, M. Rio, R. Landa, "Pushing Software Defined Networking to the access", Proc. EWSDN 2014, Budapest, Hungary, September 2014.

13. A. Zaalouk, K. Pentikousis, “Network Configuration in OpenFlow Networks”, Proc. MONAMI 2014, Wuerzburg, Germany, September 2014.

List of articles published in journals

Below is a list of the ALIEN project publications which were accepted and published in the Y2 and are in were printed in journals:

1. “Empowering SDN: Hardware Abstraction Layer for non-OpenFlow equipment”, FIRE Magazine, February 2014.

2. G. Danilewicz, M. Dziuba, J. Kleban, M. Michalski, R. Rajewski, M. Żal, B. Belter, A. Binczewski, Ł. Ogrodowczyk, D. Parniewicz, M. Stroiński, "ALIEN – warstwa abstrakcji dla urządzeń niezgodnych z OpenFlow w sieciach SDN" (polish title), Przegląd Telekomunikacyjny, no. 8-9, pp. 1297-1304, September 2014.

3. M. Michalski, T. Sielach, “Implementacja modłu kart NetFPGA 1G I NetFPGA 10G w xDPd” (polish title), Przegląd Telekomunikacyjny, no. 8-9, pp. 1305-1312, September 2014.

4. M. Michalski, “Karty NetFPGA jako podstawa sprzętowego pomiaru czasu transpisji ramek Ethernetowych w przełącznikach OpenFlow” (polish title), Przegląd Telekomunikacyjny, no. 8-9, pp. 1313-1320, September 2014.

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List of articles published as poster papers

Below is a list of the ALIEN project publications which were published as a poster articles:

1. M. Santuari, R. Doriguzzi Corin, M. Gerola, E. Salvadori, U. Toseef, A. Zaalouk, K. Dombek, D. Parniewicz, A. Hammad, M. Rashidi-Fard, E. Jacob, J. Matias, “Leading the OFELIA Facility Beyond OpenFlow 1.0 Experimentations”, EWSDN 2014 – poster paper, Budapest, Hungary. September 2014.

2. B. Belter, D. Parniewicz, Ł. Ogrodowczyk, A. Binczewski, M. Stroiński, V. Fuentes, J. Matias, M. Huarte, E. Jacob, “Hardware Abstraction Layer as an SDN-enabler for non-OpenFlow network equipment”, EWSDN 2014 – poster paper, Budapest, Hungary. September 2014.

3. M. Suñe, V. Alvarez, T. Jungel, U. Toseef, K. Pentikousis, “An OpenFlow Implementation for Network Processors”, EWSDN 2014 – poster paper, Budapest, Hungary. September 2014.

4. D. Depaoli, R. Doriguzzi Corin, M. Gerola, E. Salvadori, “Demonstrating a Distributed and Version-agnostic OpenFlow Slicing Mechanism”, EWSDN 2014 – demo paper, Budapest, Hungary, September 2014.

List of rejected articles

Below is a list of the ALIEN project publications which were submitted to conferences, however, they were unfortunately rejected in Y2:

1. D. Parniewicz, R. Doriguzzi Corin, L. Ogrodowczyk, J. Matias, M. Gerola, U. Toseef, A. Zaalouk, B. Belter, E. Jacob, K. Pentikousis, "The ALIEN Hardware Abstraction Layer In Practice", EUCNC 2014, Bologna, Italy.

2. T. Rothe, A. Vico–Oton, V. Kotronis, M. Suñé, R. Riggio, E. Salvadori, K. Pentikousis, "An Open–Source Orchestration Framework for OpenFlow Experimental Facilities", EUCNC 2014, Bologna, Italy.

3. B. Belter, A. Juszczyk, K. Dombek, Ł. Ogrodowczyk, I. Olszewski, D. Parniewicz, "Advanced Programmability of Heterogeneous Datapath Elements through Hardware Abstraction", SIGCOMM HotSDN 2014.

List of standardization contribution

In turn, below is a list of publications covering the ALIEN project standardization activity:

1. E. Haleplidis, S. Denazis, K. Pentikousis, J. Hadi Salim, O. Koufopavlou, “SDN Layers and Architecture Terminology”, Internet Draft, draft-haleplidis-sdnrg-layer-terminology-01 (work in progress), Presented in SDNRG meeting at IETF 88, Vancouver, Canada, September 2013.

2. E. Haleplidis, S. Denazis, K. Pentikousis, J. Hadi Salim, O. Koufopavlou, “SDN Layers and Architecture Terminology”, Internet Draft, draft-haleplidis-sdnrg-layer-terminology-02 (work in progress), Presented in SDNRG meeting at IETF 88, Vancouver, Canada, November 2013.

3. E. Haleplidis, S. Denazis, K. Pentikousis, J. Hadi Salim, D. Meyer, O. Koufopavlou, “SDN Layers and Architecture Terminology”, Internet Draft, draft-haleplidis-sdnrg-layer-terminology-03 (work in progress), Presented in SDNRG meeting at IETF 89, London, UK, December 2013.

4. E. Haleplidis, S. Denazis, K. Pentikousis, J. Hadi Salim, D. Meyer, O. Koufopavlou, “SDN Layers and Architecture Terminology”, Internet Draft, draft-haleplidis-sdnrg-layer-terminology-04 (work in progress), Presented in SDNRG meeting at IETF 90, London, UK, March 2014.

5. E. Haleplidis, S. Denazis, K. Pentikousis, J. Hadi Salim, D. Meyer, O. Koufopavlou, “SDN Layers and Architecture Terminology”, Internet Draft, draft-haleplidis-sdnrg-layer-terminology-05 (work in progress), Presented in SDNRG meeting at IETF 90, Toronto, Canada, July 2014.

6. E. Haleplidis, S. Denazis, K. Pentikousis, J. Hadi Salim, D. Meyer, O. Koufopavlou, “SDN Layers and Architecture Terminology”, Internet Draft, draft-haleplidis-sdnrg-layer-terminology-06 (work in progress), Presented in SDNRG meeting at IETF 90, Toronto, Canada, July 2014.

7. E. Haleplidis, S. Denazis, K. Pentikousis, J. Hadi Salim, D. Meyer, O. Koufopavlou, “SDN Layers and Architecture Terminology”, Internet Draft, draft-haleplidis-sdnrg-layer-terminology-07 (work in progress), August 2014.

8. E. Haleplidis (Ed.), K. Pentikousis (Ed.), S. Denazis, J. Hadi Salim, D. Meyer, O. Koufopavlou, “SDN Layers and Architecture Terminology”, Internet Draft, draft-irtf-sdnrg-layer-terminology-00 (work in progress), August 2014.

9. E. Haleplidis (Ed.), K. Pentikousis (Ed.), S. Denazis, J. Hadi Salim, D. Meyer, O. Koufopavlou, “SDN Layers and Architecture Terminology”, Internet Draft, draft-irtf-sdnrg-layer-terminology-01 (work in progress), September 2014.

10. E. Haleplidis (Ed.), K. Pentikousis (Ed.), S. Denazis, J. Hadi Salim, D. Meyer, O. Koufopavlou, “SDN Layers and Architecture Terminology”, Internet Draft, draft-irtf-sdnrg-layer-terminology-02 (work in progress), October 2014.

11. E. Haleplidis (Ed.), K. Pentikousis (Ed.), S. Denazis, J. Hadi Salim, D. Meyer, O. Koufopavlou, “SDN Layers and Architecture Terminology”, Internet Draft, draft-irtf-sdnrg-layer-terminology-03 (work in progress), October 2014.

12. K. Pentikousis (ed.), et al., “Information-centric Networking: Evaluation Methodology”, Internet Draft, draft-irtf-icnrg- evaluation-methodology-01 (work in progress), July 2014.

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Appendix A List of ALIEN Live Demonstrations

During the Y2 (period time from October 2013 till September 2014) the ALIEN project prepared six live demonstrations. The exact description of these demonstrations could be found in Section 3.

Below is a list of live demonstrations which the ALIEN project prepared and showed in the Y2:

1. Video on Demand in OpenFlow networks – during FIA 2014, May 2014
2. Distributed and Version-agnostic OpenFlow slicing mechanism – during FIA 2014, May 2014
3. Integration of legacy DOCSIS access network under OpenFlow control – during FIA 2014, May 2014
4. Streaming on demand in OpenFlow networks – TNC 2014, May 2014
5. DOCSIS platform integration in OFELIA – TNC 2014, May 2014
6. Demonstrating a Distributed and Version-agnostic OpenFlow Slicing Mechanism – during EWSDN 2014, September 2014.
7. Extend ALIEN results to China? – during ONS 2014, March 2014.

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