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SODALES

SOftware-Defined Access using Low-Energy Subsystems

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Standardization Report

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Abstract

This deliverable D5.5 “Standardization” Report presents on the standardization efforts that have been developed within the SODALES project. These standardization activities have mainly been driven by Ethernity Networks, PTI, HHI and i2CAT.

Ethernity’s standardization activities have been focused on MPLS-TP RFCs.

PTI is an active member of the FSAN, Broadband Forum, MEF and ITU and has pushed SODALES developments into these standardization bodies.

HHI has been active in optical wireless access, and is a member of IEEE 802.15.7a.

Finally, i2CAT has developed the SODALES control and management plane based on the OpenNaaS framework, that aims to create an open source software project community allowing multiple stakeholders to contribute and benefit from a common Network as a Service software stack.

Document Revision History

Version	Date	Description of change	Authors
1.0	15/12/2015	Final Version	D. Levi, C. Bock, E. Escalona, J. Ferrer Riera, M. Parker, S.D. Walker, V. Jungnickel, V. Marques, A. Brizido, T. Mendes,

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List of Acronyms

ARN	Active Remote Node
C-RAN	Cloud (or Centralized) Radio Access Network
FSAN	Full Service Access Network
FTTH	Fiber-To-The-Home
IEEE	Institute of Electrical and Electronics Engineers
LGPL	Lesser General Public License
MEF	Metro Ethernet Forum
MPLS	MultiProtocol Label Switching
MPLS-TP	MultiProtocol Label Switching - Transport Profile
NG-PON	Next Generation Passive Optical Network
OAM	Operation, Administration and Maintenance
ONU	Optical Network Unit
PMD	Polarization Mode Dispersion
RFC	Request for Comments
SDN	Software-Defined Network
TWDM PON	Time-Wavelength Division Multiplexing Passive Optical Network
VPN	Virtual Private Network
XGPON	Next Generation Passive Optical Network
VPN	Virtual Private Network

1 Introduction

An important objective of the SODALES project has been directed towards the driving of the various standardization bodies towards acceptance of the SODALES approach, as well as defining and implementing standards, and working towards standardization. As such, certain SODALES partners have followed and participated in or sent contributions into meetings organized by institutions such as the IEEE, Broadband Forum, and FSAN. These are some of the main consensus-building forums, which are assuming a very active role within next-generation access technologies.

During the SODALES project time frame, project partners have been involved in the following standards groups:

- FSAN, through the partner PTI, with the main focus on NG-PON2 and TWDM PON, that are both related to the connection between the ARN and the central office;
- IEEE 802.15.7a, through HHI's activity in the optical wireless access, this being a major cornerstone in the SODALES approach;
- Broadband Forum, through Ethernity, with a major focus on enabling OAM, L2/L3 VPN to ease Open Access operation within the SODALES approach;
- OpenNaaS, through i2CAT that concentrates on the management system for Open Access.

2 SODALES connections with standardization bodies

The following section describes the main standardization topics that are relevant to enhancing the SODALES technology platform.

2.1 NG-PON2 and TWDM at FSAN

PTI is actively participating in FSAN with contributions into the studies for the evolution of new PON technologies, namely, NG-PON2 and XGPON. The Full Service Access Network (FSAN) Group is a forum for the world's leading telecommunications services providers, independent test labs, and equipment suppliers to work towards a common goal of truly broadband fibre access networks.

The Next-Generation PON activities related to SODALES are the definition of the approach of time and wavelength division multiplexing (TWDM) solutions, with optional wavelength division multiplexed (WDM) overlay extensions designed for next-generation passive optical networking. In addition, the NG-PON2 technology that is the next iteration of PON technology, is designed to meet a broad range of projected communications needs, such as business and mobile backhaul applications, as well as residential access, to increase capacity, support higher light-to-port ratios, improve interoperability, and enhance services.

Furthermore PTI has been involved in the Broadband Forum on aspects related to plug fests and SDN management for XGPON and G.fast.

In continuing PTI's efforts for leading the fibre access standard evolution, PTI is also involved in the FTTH Council in chairing the development & operations committee.

2.2 MPLS for Mobile Backhaul and Carrier Ethernet at the Broadband Forum

The Broadband Forum is an industry association for the development of multi-service broadband packet networking specifications addressing interoperability, architecture and management.

To implement the needed network segmentation and control, to enable multiple operators and service providers operating under the same SODALES platform, it was agreed that the SODALES platform should support MPLS-TP and advanced Carrier Ethernet networking scenarios such as E-Tree, E-LAN, and others as detailed in our previous deliveries. In that respect, the main Broadband Forum technical requirement standard that is relevant to SODALES was TR-224, which provides technical architecture and equipment requirements implementing the specified Ethernet services with an MPLS network, and TR-221 that focuses on MPLS for mobile backhaul, and which was updated on several occasions during the period of the SODALES project.

The TR-224 standard defines a reference architecture for Carrier Ethernet Services using Layer 2 VPN mechanisms that are the main focus of SODALES to achieve support for an Open Access converged platform:

- Ethernet point-to-point (E-Line) and multi-point to multi-point (E-LAN);
- A subset of point-to-multipoint;
- Control, OAM, QoS, reliability and scalability for the MPLS network.

2.3 IEEE 802.15.7a - Optical wireless

HHI has been working on optical wireless in the SODALES project, and it is also the German representative in the COST 1101 research network OPTICWISE [1] in which researchers across Europe meet regularly to exchange results and to coordinate their activities. At the 7th MGMT/WG Meeting of COST 1101 in Madeira, 19th September 2014, a session was organized starting with an invited speech from Tuncer Baykas about IEEE 802 standardization opportunities, as a possible exploitation path for the COST action results. During the meeting, it was decided after a controversial discussion that the action chair, Prof. Murat Uysal, contacts IEEE 802.15.7a task group on Optical Camera Communications with the objective to widen its scope and to extend it to optical wireless communications. Prof. Uysal attended the next task group meeting and the proposal was welcomed, as he was appointed as Vice Technical Editor [2]. From OPTICWISE, the Fraunhofer Institute decided to contribute, and the British company PureLiFi also became active in this field.

SODALES has helped define the optical wireless approach, as it is short distance wireless connection, and the approach has created a lot of interesting results. This has contributed to the situation where this technology can now be promoted again and pushed forward, out of the many previous niche applications, towards more promising large-volume applications in future mobile networks, both as an access technology over short distances (which is particularly interesting for the Internet of Things), and as a low-cost backhaul technology for many small cells, which is part of the 5G definitions and will increase the density of access points and in this way the overall capacity in the same unit area.

It is hoped that the fast progress of standardization in this area will lead to an accelerated understanding of 5G concepts, such as the C-RAN, and the efficient provisioning of backhaul and front-haul, and that it may also contribute towards maturing these new and unusual concepts “in the sandbox” long before the standardization for wide-area radio-based 5G technologies will be started.

2.4 OpenNaaS

I2CAT has implemented the OpenNaaS platform to develop the SODALES Control and Management Plane.

OpenNaaS was born with the aim of creating an open source software project community that allows several stakeholders to contribute and benefit from a common NaaS software stack. OpenNaaS offers a versatile toolset for the deployment of NaaS oriented services. The software

is released with a dual L-GPL/ASF licensing schema that ensures that the platform will remain open and consistent, while commercial derivatives can be built on top. This open schema allows trust to be built on the platform, as NRENs and commercial network operators can rely on the continuity, transparency and adaptability of the platform.

In that sense, each network domain should be able to use their own OpenNaaS instances, in order to:

- Get resources from the network infrastructure: routers, switches, links or provisioning systems.
- Abstract them to service resources, independently of vendor and model details.
- Embed instantiation of virtualized resources in the regular BSS workflows.
- Delegate management permissions over the infrastructure resources they own so that "Infrastructure integrators" can control them during a period of time.

With an eye on versatility and smooth integration, OpenNaaS offers a powerful remote command line, as well as web-service interfaces. This web-service interface offers the possibility to both build a GUI and integrate it with existing middleware applications already deployed in the virtual research organisations.

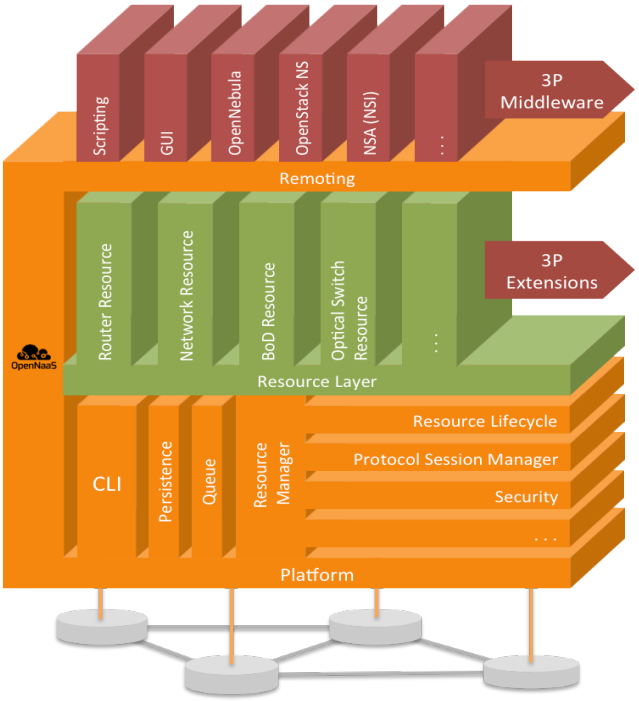

Figure 1: OpenNaaS layers

3 SODALES standardization activities

This section describes the standardization activities that have been performed by the SODALES consortium.

3.1 Ethernity standardization activities

During 2014, Ethernity handled, designed and implemented the RFCs itemized below, that currently form part of the MPLS-TP, or will eventually be part of the definition of the next MPLS-TP standards.

The following Table 1 specifies the normative and informative RFCs for the network backhaul requirements:

RFC	Title
3032	MPLS Label Stack Encoding
6372	MPLS Transport Profile (MPLS-TP) Survivability Framework
6974	Applicability of MPLS Transport Profile for Ring Topologies
4026	Provider Provisioned Virtual Private Network (VPN) Terminology
3809	Generic Requirements for Provider Provisioned Virtual Private Networks (PPVPN)
4664	Framework for Layer 2 VPNs
4665	Service Requirements for Layer 2 Provider-Provisioned Virtual Private Networks
4762	Virtual Private LAN Service (VPLS) Using Label Distribution Protocol (LDP)
4364	BGP/MPLS IP Virtual Private Networks (VPN)
3916	Requirements for Pseudowire Emulation Edge-to-Edge (PWE3)
3985	Pseudowire Emulation Edge-to-Edge (PWE3) Architecture
4385	Pseudowire Emulation Edge-to-Edge (PWE3) Control Word for Use over an MPLS PSN
5885	Bidirectional Forwarding Detection (BFD) for the Pseudowire Virtual Circuit Connectivity Verification (VCCV)
5085	Pseudowire Virtual Circuit Connectivity Verification (VCCV): A Control Channel for Pseudowires
5586	MPLS Generic Associated Channel
6423	Using the Generic Associated Channel Label for Pseudowire in the MPLS Transport Profile (MPLS-TP)
6718	Pseudowire Redundancy
6310	Pseudowire (PW) Operations, Administration, and Maintenance (OAM) Message Mapping
7023	MPLS and Ethernet Operations, Administration, and Maintenance (OAM) Interworking
6073	Segmented Pseudowire
5254	Requirements for Multi-Segment Pseudowire Emulation Edge-to-Edge (PWE3)
5659	An Architecture for Multi-Segment Pseudowire Emulation Edge-to-Edge
6870	Pseudowire Preferential Forwarding Status Bit
6478	Pseudowire Status for Static Pseudowires
5994	Application of Ethernet Pseudowires to MPLS Transport Networks
7189	Virtual Circuit Connectivity Verification (VCCV) Capability Advertisement for MPLS

	Transport Profile (MPLS-TP)
4448	Encapsulation Methods for Transport of Ethernet over MPLS Networks
7267	Dynamic Placement of Multi-Segment Pseudowires
4447	Pseudowire Setup and Maintenance Using the Label Distribution Protocol (LDP)
6723	Update of the Pseudowire Control-Word Negotiation Mechanism

Table 1: List of RFCs for MPLS-TP that were implemented and integrated by Ethernity into the SODALES software and hardware implementation.

Ethernity has worked closely with its customers including RAD Data Communication and Juniper to promote the L2/L3 VPN and OAM aspect into the TR-224.

3.2 PTI standardization activities

The following Table 2 depicts PTI's standardization activities:

ENTITY	Activity Level
BROADBAND FORUM	Active Member - Participation in IOT activities, plug fests and SDN management for XGPON and G.fast.
METRO ETHERNET FORUM	Collect technical information, certify our products (we were one of the first CE 2.0 certified company) and foresee technical evolution and market trends. Keep up to date on the technological evolution. Assess the competition and the market and participate in the polls for ratifying specific drafts.
FTTH COUNCIL	Active Member - Chair of Deployment & Operations Committee, co-writers of the FTTH-CE Handbook and several White Papers.
WI FI ALLIANCE	Collect technical information and product certification (need to be WI-FI Alliance members in order to guarantee IOT and use brand / logo.)
FSAN	Active Member – contribution to the studies for the evolution of new PON technologies, namely, NG-PON2 and XGS-PON.
ITU	Active Member - Keep up to date on the technological evolution. Assess the competition and the market and participate in the polls for ratifying specific drafts.

Table 2: PTI standardization activities summary

In particular, PTI's contributions over the duration of the SODALES project are listed below:

2014-02: San Jose:

- Drivers and Motivations for NG-PON2

2014-05: Stuttgart:

- Operator views on MEFs mid-haul approach

- Operator view for front-haul applications
- NG-PON2 compliance tests. Test Cases for NG-PON2

2014-09:Santa Clara:

- NG-PON2 TWDM Performance Monitoring

2014-10:San Antonio:

- NG-PON2 PMD, ONU type A & B links
- FTTH by Portugal Telecom

3.3 HHI standardization activities

Dr. Volker Jungnickel from HHI took the role to coordinate the standardization activities in OPTICWISE. The first action was to prepare a joint contribution to the tutorial [3] at the 802 plenary meeting in Berlin, Germany, which usually is given when a task group has obtained the mandate to make a new standard. A short version was presented in the Midterm Wireless Meeting, accompanied by a demo prepared by HHI which both together attracted significant interest from the attendees. At the Berlin Meeting, the response to the Call for Applications was somewhat disputed. Fraunhofer submitted such a response [4] in which among others, the backhaul of small radio cells, investigated within SODALES, was mentioned as a promising use case for the high-rate mode in 802.15.7r1.

Within HHI, initially there was a controversial discussion whether to follow up on this or not. For this reason, the Interim Meeting in Vancouver was skipped, where the minutes indicated a critical situation in the early days within the new task group. However, before the Kona Meeting, HHI decided to contribute continuously to the standard, as a new way to push the exploitation of patents owned by HHI and to get in closer contact with the relevant industry.

At the Kona meeting, the Technical Considerations Document [5] was finished, in which all the requirements for the new standard were listed, and also whether the key components of the system are regarded as mandatory or optional. Fraunhofer has actively contributed to it, and the content of the section related to High-rate PD communication is entirely based on the contributions collected from OPTICWISE. The decision about what is mandatory and what is optional included a discussion with the company PureLiFi, leading to the compromise that, on the one hand, the exploitation of existing technology by start-up companies is not hindered, and on the other hand, the path to integrate advanced functionality also remains open. Notice that the backhaul scenario considered in SODALES has been fully included in the TCD. It is responsible for the requirement that the system must support at least one PHY mode up to 10 Gb/s. This enables a high scalability of the standard and opens the door to reach 5G performance targets.

At the Bangkok meeting, two major items were finished: The Channel Modeling Document (CMD), which is based on ray tracing results for the mobile scenarios. At the meeting, Fudan University made a proposal suddenly, after most channel modeling work has been already completed, to also include a model for the backhaul scenario. As the Call for Proposals (CfP) should be published after that meeting, which needs a finalized CMD, and the proposed model was not mature, the discussion on that point was postponed to the next meeting where inputs

from HHI are also expected. These were delivered by HHI in [6] and discussed at the Dallas meeting. The final goal of the Bangkok meeting was to finalize the CfP, which was reached in this way so that delay with respect to the schedule was avoided. TG7r1 moves rather quickly, compared to other task groups. The reason is that companies are already developing products for image-sensor-based communications and there might be companies setting a de-facto standard with proprietary technologies quicker than when the IEEE standard might be finalized. Up to now, this has been respected by the entire group.

Following the Bangkok meeting, 16 entities submitted Intent for Proposal documents, 9 of which were related to high-rate PD Communications, including two submissions from companies (Huawei, PureLiFi) and 7 from academia; a ratio that is similar also for other advanced topics.

In the same way as for other topics, it was agreed that individual proposals should be submitted for high-rate PD communication to get an overview, first of what contributions can be expected from which entity, and then to build a consensus afterwards. It has to be noted that there is a parallel standardization activity at ITU-T lead by Huawei, and the relationship between both activities is not yet fully clear at the moment. Accordingly, the chair has scheduled a timeslot at the Dallas meeting to discuss this with the representative from Huawei.

Fraunhofer has submitted the Intent for Proposal form and has prepared a technical document in which it is explained in principle how all (i.e. mandatory and optional) features in the TCD can be fulfilled in an advanced system design that can be applied to all four application scenarios. The core of the proposal is to adopt the C-RAN architecture, which is discussed for the implementation of 5G mobile radio networks on distances of up to 20 km, also locally for optical wireless communications, e.g. in the home or industry scenario, and to place all coordination of the multiple optical wireless links required in these scenarios into a central controller inside the local cloud. The hope is that a red line is created in this way, which is sustainable and can be adopted by other entities in TG7r1 so that the discussion can be focused quickly onto technical details that can be gone through step-by-step, rather than having a confusing debate among more or less incomplete proposals.

Moreover, a paper was published at the CSCN conference in Tokyo related to this standardization activity, in which the view of the European research network OPTICWISE was summarized in preparation for the next standard. Dr. Volker Jungnickel (HHI) was appointed as main Editor of this joint paper, and Fraunhofer HHI also organized a demo alongside the presentation [7]. This paper is co-authored by the best-known researchers in this field from Europe and it has already attracted a high interest after its pre-publication in ResearchGate.

3.4 I2CAT standardization activities

OpenNaaS (Open Network-as-a-Service) is an open source platform for provisioning network resources. It allows the deployment and automated configuration of dynamic network infrastructures and defines a vendor-independent interface to access services provided by these resources. In detail, OpenNaaS is currently being developed by an open community under the LGPLv3 license. It is based on a lightweight, abstracted, operational model, which is decoupled from actual vendors' specific details, and is flexible enough to accommodate different designs and orientations. In fact, the OpenNaaS framework provides tools to implement the logic of an SDN-like control and management plane on top of the lightweight abstracted model.

The architecture is built around the resource and services concept. There are different reusable building blocks, which are common to all the extensions and abstractions. In essence, a resource represents a manageable unit inside the NaaS concept. Each resource holds a list of capabilities, which are the list of different actions that can be performed into each resource. OpenNaaS allows the creation of a software resource (e.g. Devices, Networks, Network Functions) and manages the offered services.

In fact, as described in previous SODALES deliverables, the software-based management platform has been built over the OpenNaaS platform. It is not a standard platform, but SODALES has contributed to some of the generic services of the platform, which have been included in the official releases available in the web site.

The most significant contribution to the platform has been the specification and implementation of the slicing service (or reservation service), which is utilized in SODALES for the Open Access model implementation.

4 References

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[7] V. Jungnickel, M. Uysal, N. Serafimovski, T. Baykas, D. O'Brien, E. Ciaramella, Z. Ghassemlooy,R. Green, H. Haas, P. A. Haigh, V. P. Gil Jimenez, F. Miramirkhani, M. Wolf, S. Zvánovec, "A European View on the Next Generation Optical Wireless Communication Standard," IEEE Conference on Standards for Communications and Networking (CSCN), Tokyo, Japan, 28-30.Oct. 2015.