Grant Agreement No.: 318600

SODALES

SOftware-Defined Access using Low-Energy Subsystems

Funding Scheme: ***Small or medium-scale focused research project STREP - CP-FP-INFSO***
Activity: **ICT-8-1.1 - Future Networks**

D6.12 Quarterly Report - 11

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Project Manager: Carlos Bock | i2CAT
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Dissemination Level		
PU	Public	✓
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Abstract

This eleventh quarterly report (M33) describes the evolution of the SODALES project during the period commencing month 31 through to the end of month 33 of the project.

As far as the technical objectives are concerned, Deliverable D4.2 was submitted, so allowing the unblocking of the deliverable D4.3, which will be done during August 2015. Due to integration issues, the prototype implementation (D4.2) suffered a delay which affected D4.3.

The risk mitigation plan activated during the last reporting period has allowed the project to fulfil MS52 in M32. Also, the delivery of the remainder of the deliverables and activities will not be affected.

During this reporting period of the SODALES project, there have been a number of publications made at the ITG Symposium Photonic Networks (Leipzig, May 2015), ICTON (Budapest, July 2015) and NOC (London, July 2015) conferences.

Also, one SODALES paper has been accepted for presentation at the ECOC'15 conference, which will take place in Valencia, Spain, September 2015.

At present, WP4 and WP5 are active, together with the project management work package (WP6).

Document Revision History

Version	Date	Description of change	Authors
1.0	31/07/2015	First release	Carlos Bock (i2CAT)

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Figure Summary

1 List of beneficiaries

Participant no.	Participant organization name	Part. short name	Country
1 (Coordinator)	**Fundació i2CAT, Internet i Innovació a Catalunya**	**I2CAT**	**Spain**
2	Portugal Telecom Inovação	PTI	Portugal
3	Ethernity Networks	ETHERNITY	Israel
4	University of Essex	UESSEX	United Kingdom
5	Fraunhofer Gesellschaft e.V.	HHI	Germany

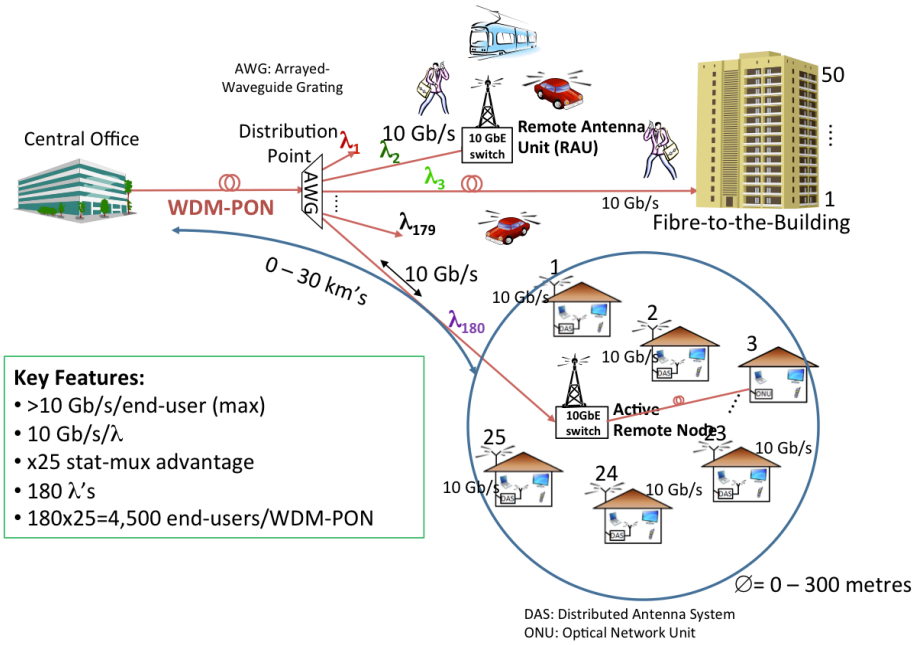
2 Project objectives for the reporting period

2.1 Overall project objectives

The SODALES project proposes a novel, converged next generation access network that combines optical and wireless access solutions to offer ubiquitous wireless / wired layer-2 access in a ground-breaking network architecture for both open access as well as traditional vertical operators.

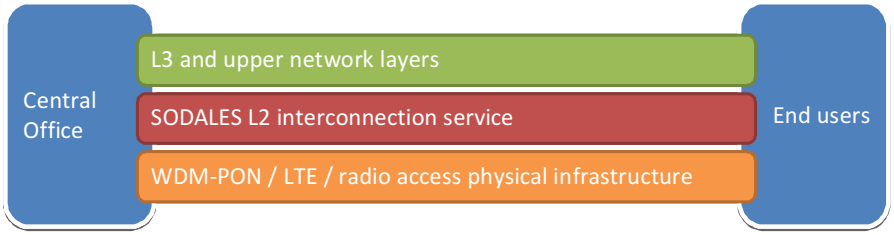
2.1.1 SODALES Mission and Vision

The SODALES (SOftware-Defined Access using Low-Energy Subsystems) project aims to converge Layer-2 Ethernet 2 and wireless technologies (LTE, 60-GHz and beyond) over a unique statistical multiplexer over WDM-PON that offers interconnection to fixed and mobile subscribers in a green, simplified, optimized and easy-to-manage access infrastructure.



SODALES interconnection service across a set of heterogeneous access infrastructures

The SODALES interconnection service integrates a heterogeneous set of different access infrastructures and proposes an innovative layer-1/2 interconnection service that interfaces with the physical substrate for fixed subscribers offering a novel ultra-high bandwidth wavelength-division-multiplexed passive-optical-network (WDM-PON) architecture combined with fixed-radio access, and also offers a standardized interface for long-term evolution (LTE) and beyond mobile users.



SODALES interconnection service layer definition

SODALES takes advantage of the fact that mobile remote base stations (RBSs) require electrical powering in order to incorporate a device called the Active Remote Node (ARN) that will perform advanced multiplexing functionalities. This allows advanced statistical multiplexing and very high network optimization, while simplifying network equipment at the customer premises.

The rationale behind this service from the business point of view is the following:

- It has been widely accepted that fibre-to-the-home (FTTH) is the only passive access infrastructure platform (backhaul, mobile- and fixed final-drop) that will be able to support present and future applications;
- To meet the fast increasing data services, mobile operators need to upgrade their network frequently and operate a multiple-standard network, including GSM, WCDMA/TD-SCDMA; however this results in causing operators to have more complex and costly plans for network expansion and upgrading;
- In order to achieve a viable business model, transversal infrastructure sharing is key;
- Mobility is an essential functional application, as is convergence of fixed and mobile services;
- Services are ubiquitous and need to be delivered independently of the physical substrate and final-drop segment;
- Centralized signal processing greatly reduces the number of sites for equipment room needed to cover the same areas, which will enable handling the support for many cellular technologies in a more central location;
- To reduce operational expenditure (OPEX) and capital expenditure (CAPEX), integration of wired and wireless services is essential.

Turning to future technical expectations, we are adopting the following hypotheses:

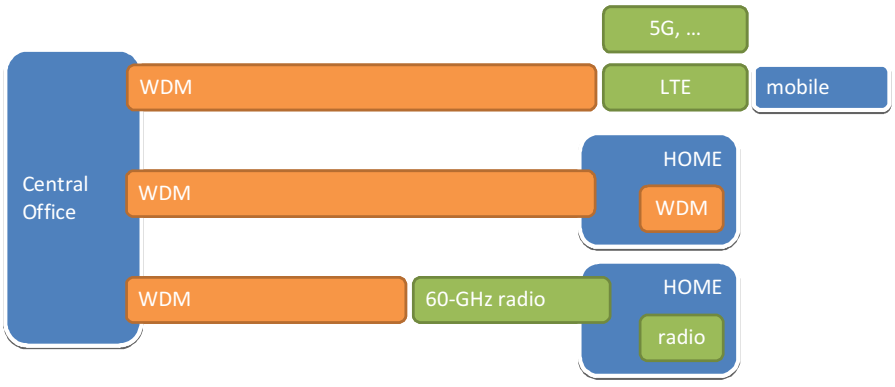
- WDM-PONs are the most-likely evolutionary next-step in deployed FTTH next-generation optical access (NGOA), that are best able to offer 10 Gb/s and beyond to end-users;
- 60-GHz radio access is emerging as the key alternative technology solution for fixed access in locations where fibre is difficult (economically, logistically, topologically etc.) to deploy as the final-drop segment;
- 4G (LTE) and beyond mobile radio services will require fibre mobile backhaul infrastructure;
- To offer high data-rates in a mobile environment, the size of the coverage cells (femto/pico/micro) needs to be small, with the concomitant requirement for higher numbers of remote base stations (RBSs) or active remote nodes (ARNs);
- ARNs, RBSs and antennas will require remote powering – such that the existence of small active routing elements in remote field locations is not an issue; it is even

advantageous, since remote control & management (C&M) functionalities and operations are becoming more practically possible;
- Low power consumption and energy-efficiency at all of the end-user sides, head-end and ARNs/RBSs are essential to keep ICT power consumption low and maintain a minimized carbon footprint.

In addition, the other following requirements are also becoming increasingly critical:

- Although fibre is the preferred choice when deploying new infrastructure, in brownfield sites this can often be a non-viable technical solution, so that an alternative bonding technology needs to be developed;
- Infrastructure sharing technology solutions and other associated novel business models need to be developed in order to successfully (i.e. economically sustainably) offer the massively wide-spread and ultra broadband services that European citizens are increasingly anticipating. At present, the development and deployment of such infrastructures is taking a significantly longer time than is desirable from a societal point of view, and this is also affecting European global competitiveness and productivity;
- Simplification of the provisioning and management in next-generation access (NGA), especially with the evolution towards open access networking, is key to the massively widespread deployment of ultra broadband networks and the stimulation of a dynamic and competitive environment to promote sustained technology and Internet service innovation.

Taking into account all the points listed above, SODALES aims to develop an advanced interconnection service using WDM-PON, legacy cellular technologies (GSM, WCDMA...) and 60-GHz radio for fixed users and LTE and beyond for mobile users, offering a standard L2 Ethernet-based interface to enable a multiplicity of network providers to supply services and applications across a unified access platform that will support transmission of multiple cellular wireless technologies, 60 GHz radio, and data services over an economical aggregation platform.



SODALES global overview of its unified, massively widespread and ultra broadband access platform

2.1.2 SODALES summary of objectives

The fundamental SODALES objective is to develop and assess a NGOA network to offer a scalable FTTH and mobile mass market access solution, minimising TCO, supporting new business models and allowing co-operations among different stake holders, by developing compatibility and standard interfacing for fixed and mobile radio access.

The following measurable and verifiable objectives are listed, including the expected date to be achieved

Technical objectives

- ~~MS 51 Establish the conditions of the ARN physical layer and design the ARN to fulfil compatibility with fibre and mobile access networks (Month 12)~~
- ~~MS 31 Design the interfaces to offer advanced OAM at the ARN, CPE and CO to allow easy provision, control of management of bit stream access in open-access multi-operator networks (Month 12)~~
- ~~MS 41 Develop a low-cost 10 Gb/s demarcation CPE that can be used for fibre and 60-GHz radio access (Month 24)~~
- ~~MS 32 Include backbone network features into access systems (Month 22)~~
- ~~MS 33 Offer a unified C&M plane that offers standard northbound interfaces for service provision, OAM and fault management for both, fixed and mobile services (Month 24)~~

Technical challenges

- ~~MS 12 Define physical and logical interfaces and to specify their functionalities (Month 6)~~
- ~~MS 51 Apply statistical multiplexing adaptation to pure point-to-point standard interfaces (Month 12)~~
- ~~MS 21 Solve packet-to-TDM synchronization and management issues to allow real fixed-mobile convergence (Month 12)~~
- ~~MS 51 Integrate with off-the-shelf components and modules (Month 12)~~
- ~~MS 14 Determine the optimum network architecture for up- and down-stream transmission capacity (Month 18)~~
- ~~MS 42 Define, design and construct an overall prototype concept (Month 28)~~

Demonstration and validation challenges

- ~~MS 41 Implement the proposed solutions in an experimental prototype for evaluating the performance of the solutions as a whole (Month 24)~~
- ~~MS 41 Verify operation within lab network (Month 24)~~
- **MS52 Start of the SODALES field validation (Month 30)**
- MS 43 Test the stable prototype in a live field environment. Key factors to look at besides functional testing are ease and cost of deployment and maintenance (Month 32)
- MS 65 Provide an open specification and driving information exchange with other European operators and EU projects and contribute to Standardization bodies (Month 36)

2.2 Project objectives for the reporting period

During this reporting period D4.2 Prototype lab verification report was delivered, and MS52 Start of the SODALES field validation was achieved in M32.

MS43 Test the stable prototype in a live field environment, initially scheduled for M32 has been moved to M34, due to the delay of MS52. This will not impact the finish date of the project as more resources will be added to the project to finish all the activities on time.

This was part of the contingency plan, which also implied a face-to-face meeting in Centelles, Spain on 8th July 2015 to prepare for the final few months of the SODALES project.

In summary, during this reporting period, the following deliverable has been submitted:

- D4.2 Prototype lab verification report

The following milestone has been achieved:

- MS52 Start of the SODALES field validation

On the other hand, the following reschedules have been done:

- D4.3 Report on installation parameters for the field service validation is expected in August 2015 (M34)
- MS43 Test the stable prototype in a live field environment, which will be achieved by the end of August 2015 (M34)

Delays in the prototype integration (D4.2) have, however, caused hold-ups, which have impacted on D4.3 and also on the achievement of MS52.

At present, the SODALES project has three active WPs, concentrating all the activities on the field trial validation and on the dissemination of the results generated by the previous WPs.

Thus, active WPs are: WP4: Prototypes and Validation and WP5: Dissemination, Standardisation & Techno-Economics), further to the project management work package (WP6).

3 Work progress and achievements during the period

3.1 Project structure

The SODALES work plan is structured around six major activities in order to match the project objectives:

- WP1: Analysis and technical definition of the SODALES network architecture
- WP2: Study and specification of the subsystems and the physical and switching layer
- WP3: Study and design of the SODALES control and network management plane
- WP4: Prototyping and Validation of the SODALES interconnection service in the lab and in a real environment
- WP5: Dissemination, standardization and techno-economics activities
- WP6: Coordination and project management

During this reporting period (M31-M33), the active WPs were:

- WP4: Prototypes and Validation
- WP5: Dissemination, Standardisation & Techno-Economics

Together with WP6: project management.

		MM	11/14	12/14	01/15	02/15	03/15	04/15	05/15	06/15	07/15	08/15	09/15	10/15
		#	25	26	27	28	29	30	31	32	33	34	35	36
WP1: Network and Hardware Architecture	UESSEX	62												
T1.1 General SODALES architecture	UESSEX	23												
T1.2 ARN modeling and roadblocks	UESSEX	15												
T1.3 OAM and control plane building blocks	ETHERNITY	11												
T1.4 Simulations and validations	i2CAT	13												
WP2: Subsystems and Physical Layer Definition	HHI	62												
T2.1 ARN switching fabric design and interfacing	UESSEX	15												
T2.2 WDM/radio CPE demarcation unit	ETHERNITY	15												
T2.3 Headend L2 interface	ETHERNITY	23												
T2.4 L2 interface design for LTE and legacy services	HHI	9												
WP3: Control Plane and Network Management	i2CAT	47												
T3.1 Control Plane service requirements	PTI	7												
T3.2 OAM parameters	ETHERNITY	9												
T3.3 Control Plane Design	i2CAT	9												
T3.4 Control Plane implementation and validation	i2CAT	22												
WP4: Prototypes and Validation	PTI	60					M4.2			M4.3				
T4.1 Prototype concept	HHI	16												
T4.2 Prototype implementation and lab validation	UESSEX	16				D4.2								
T4.3 Lab and Field service validation	PTI	28					D4.3							D4.4
WP5: Dissemination, Standardisation & TechnoEconomics	ETHERNITY	32					M5.2			M5.3				
T5.1 Dissemination	UESSEX	8												D5.4
T5.2 Standardization	ETHERNITY	11												D5.5
T5.2 Technoeconomics	PTI	13												D5.6
WP6: project management	I2CAT	18		M6.3					M6.4					M6.5
T6.1: Establishing the project management procedures	I2CAT	0,5												
T6.2: Performing the project management duties	I2CAT	17,5			D6.10			D6.11			D6.12			D6.13

SODALES progress in M33

3.2 Effective manpower allocated during the reporting period

Each institution has allocated the following manpower to the development of the SODALES project:

- Fundació i2CAT, Internet i Innovació a Catalunya 5.1PM
- Portugal Telecom Inovação 5.0PM
- Ethernity Networks 2.07PM
- University of Essex 3.8PM
- Fraunhofer Gesellschaft e.V. 2.0PM

This effort has been allocated in the different active WPs as described in the following sections.

3.3 WP4: Prototypes and Validation

WP4 has the following objectives:

- Define an overall prototype concept
- Implement experimental prototype from WP2
- Deploy the control and management plane in a real network
- Integrate with off-the-shelf components and modules
- Verify operation within lab and real network

In this work package the prototype will be defined, implemented and verified.

- The overall goal will be to demonstrate the innovative parts of the whole SODALES system, such as the ARN and demarcation points from WP2 and the Control and Management plane from WP3.
- For the rest of the system a pragmatic approach will guide in achieving a working prototype of a complete network by combining new and existing parts.
- In the definition phase a target configuration will be defined, which will also contain lists of possible solutions for any open issues.
- In the implementation phase, the components will be included step-by-step for a first working prototype. It will be a small network including terminals as well as test and analysis equipment.
- In the verification phase, the lab network will be verified for full and stable operation. Field trials should not start until the complete prototype is fully verified and running stable in the lab.

WP4 is divided into three tasks, matching the objectives presented above:

Task T4.1: Prototype concept

The first task of this work package aims at defining the whole prototype. It consists of a combination of newly implemented parts combined with existing modules and off-the-shelf components and data source/sink devices, which could be end-user equipment and test generators / analysers.

All partners will decide on the system configuration concept based on previous experience and SODALES system requirements from WP1 and WP2. This work will need feasibility studies, simulation and extrapolation.

Fed by: WP2; Feeds: T4.2
Task leader: HHI
Contributing partners: TRANSMODE, ETHERNITY, I2CAT and UESSEX
Success criteria: acceptance of concept within consortium.

Task 4.1 is completed

Task T4.2: Prototype implementation and lab validation

This is the main implementation work on the selected platforms. It consists of several steps:

- Provision of ARN switching
- Implementation of the ARN interfaces by PTI
- Implementation of the CPE demarcation points by ETHERNITY
- Deployment of the optical wireless link by HHI
- The Control and Management Plane developed in WP3 will be provided and maintained by i2CAT.

Fed by: WP2, WP3, WP4 (Task 4.1); Feeds: WP4 (Task 4.3)
Task leader: UESSEX
Contributing partners: PTI, HHI, ETHERNITY, I2CAT
Success criteria: devices working satisfactorily

Task 4.2 is completed

Task T4.3: Lab and Field Service Validation

This task includes the verification of the whole prototype configuration in a lab environment to test the correct performance of the entire SODALES network. It will be lead by PTI with support from the platform providers. Once the services have been demonstrated in the lab, the SODALES service will be validated on a real access infrastructure provided by PTI in the Delta Demonstrator that PTI has located in Aveiro, Portugal.

Fed by: WP4 (Task 4.2); Feeds: -
Task leader: PTI
Contributing partners: i2CAT, HHI, ETHERNITY, UESSEX
Success criteria: The successful outcome of this task will be the stable working of the SODALES service.

Task 4.3 is active

3.3.1 Overall WP4 achievements

During this reporting period, T4.2 was finished and the D4.2 Prototype lab verification report submitted.

Also, the delivery of D4.2 set the starting point of the SODALES field trial, and so fulfilled milestone MS53 Start of the SODALES field validation.

The late delivery of D4.2 has affected the D4.3 Report on installation parameters for the field service validation, which will be delivered in M34. The document is now under final review, but all the technical content is already finished.

The contingency plan that was activated to mitigate the delays caused by D4.2 comprised a face-to-face meeting in Centelles, Catalonia, which was held on 8th July 2015.

This meeting helped to prepare for the last few months of the project and consisted of:

- Planning of the rest of the project deliverables (due M36)
- Preparation of the SODALES workshop (MS53 and due in M32)
- Preparation of the Project Final Review, which will also consist of a visit to the Centelles commercial trial.

3.4 WP5: Dissemination, Standardization & Techno-Economics

WP5 has the following objectives:

- Disseminate the research developed in the SODALES framework
- Contribute to Standardization bodies
- Analyse the techno-economics of SODALES. Key factors to look at, besides functional testing, is ease and cost of deployment and maintenance.

WP5 is divided in three tasks, matching the objectives presented above:

Task T5.1: Dissemination

Dissemination of the work is key to give visibility to the SODALES concept. UESSEX is the leader of this task. Relevant conferences and journals are targeted to have the maximum impact in this field.

Mainly the academic partners, with small contributions from PTI, are developing this task.
Task leader: UESSEX
Contributing partners: PTI, i2CAT and HHI

Task 5.1 is active

Task T5.2: Standardization

Due to the industrial vision of the consortium, Standardization is one of the key objectives of the SODALES initiative. This task, coordinated by ETHERNITY, contributes to Standardization bodies with the developments carried on during the research stages.

Standardization bodies and organizations like the Metro Ethernet Forum (MEF) are targeted in this task.
Task leader: ETHERNITY
Contributing partners: PTI and I2CAT

Task 5.2 is active

Task T5.3: Techno-economics

This task analyses the SODALES concept from the economic point of view. Mainly industry driven, it analyses the SODALES component parts to find a viable business model for the commercial exploitation of the SODALES network.

Task leader: PTI
Contributing partners: ETHERNITY, I2CAT, USSEX, HHI

Task 5.3 is active

3.4.1 Overall WP5 achievements

During the Q11 of the SODALES project, there have been a number of publications made at the ITG Symposium Photonic Networks (Leipzig, May 2015), ICTON (Budapest, July 2015), and NOC (London, July 2015) conferences. These papers include:

- D. Schulz, C. Alexakis, M. Schlosser, J. Hilt, R. Freund, V. Jungnickel, "Initial Outdoor Trials with Optical Wireless Links for Small-Cell Backhauling," *16. ITG Symposium Photonic Networks,* 7-8 May 2015, Leipzig, Germany
- K. Habel, L. Fernandez del Rosal, S. Weide, J. Hilt, V. Jungnickel, R. Elschner, C. Schubert, F. Frey, J. K. Fischer, R. Freund, "5 Gbit/s Real-Time Processing Using π/4-shift DQPSK for Bidirectional Radio-Over-Fibre System," *ICTON*, 5.-9.7.2015, Budapest (invited), July 2015
- M.C. Parker, G. Koczian, T. Quinlan, S.D. Walker, "High Capacity Communications at 24 GHz and and 60 GHz for Converged 5G Networking (invited)", *NOC'15*, London, July 2015

In addition, one SODALES paper has been accepted for presentation at the ECOC'15 conference, which will take place in Valencia, Spain, September 2015:

- V. Jungnickel, D. Schulz, J. Hilt, C. Alexakis, M. Schlosser, L. Grobe, A. Paraskevopoulos, R. Freund, B. Siessegger, G. Kleinpeter, "Optical Wireless Communication for Backhaul and Access (invited)", *European Conference on Optical Communication (ECOC)*, Valencia, Spain. September 2015

Unfortunately, our paper "Software-Defined Open Access for Flexible and Service-Oriented 5G Deployment" submitted to the IEEE Communications Magazine special issue on "Software Defined 5G Networks for Anything as a Service") was rejected after the 2nd round of review. We are now deciding where to submit the paper as an alternative journal publication.

Representing a continuation (and enlargement) of the SODALES project (technologies and partners) into the 5G service space, the SODALES coordinator Dr. Carlos Bock attended the 5G-PPP meeting in Brussels on 27th May 2015, on behalf of the forthcoming H2020 CHARISMA project.

Dr. Eduard Escalona (i2CAT) also attended the EuCNC conference, in Paris, 30th June 2015, representing both the SODALES and CHARISMA projects.

As part of the milestone MS53 SODALES workshop, it has been decided to have a booth at the Broadband World Forum (BWF) that will take place in London in 20th - 22nd October 2015, as a means to provide a wider dissemination outlet for the SODALES results.

3.5 WP6: Project management

WP6 Project management comprises 2 tasks, both led by i2CAT:

Task T6.1: Establishing the project management procedures

Task 6.1 is finished

Task T6.2: Performing the project management duties

WP6 provides the internal project management and the overall co-ordination of activities, financial- and technical- planning and control. It ensures that the project objectives are met and represents the contact point of the project to the Commission, the FP7 and H2020 communities, and the external world. It provides guidance for the process of registering IPR, especially in cases where joint ownership is involved. It also addresses any issues concerning access rights, including cases where partners join or leave the project during its duration. It is assisted in its tasks by other bodies established as part of the management structure.

Task 6.2 is active

3.5.1 Overall WP6 achievements

The usual coordination activities have been carried out during this reporting period.

Additionally, a contingency plan to mitigate risks on the late delivery of D4.2 was implemented and coordinated. This has comprised the organization of a face-to-face meeting to accelerate the integration process and a re-scheduling of the deliveries of D4.2 and D4.3.

Also, MS52 has been impacted, and the MS43 “Running the field validation over a period of 3 months” will be rescheduled to M34.

As a result of the contingency plan, D4.2 has already been submitted and MS52 has also been achieved (detailed description of the fulfilment of this deliverable can be seen in section 3.3.1 of this document).

During the face-to-face meeting in Centelles, the consortium agreed not to arrange any other face-to-face meeting unless a contingency plan needs to be activated.

The last three months of the project will be very active, so the consortium agreed to arrange weekly follow-up calls to check on the progress of the different activities starting in September. Communication during end July – August will be difficult due to summer holidays, so calls will be substituted by follow-up emails during this period of 6 weeks.

All the collaboration and file sharing repositories are being kept active, and i2CAT is maintaining the infrastructure to support these systems.

Additionally, weekly calls are being organized in order to monitor the progress of the Project. GoToMeeting is the platform that is used for those meetings, which offers good interaction, video conferencing and collaboration features.

As i2CAT is the sole participant in WP6, all activities below are referred to i2CAT:

- Maintenance of the SODALES webpage (http://www.fp7-sodales.eu)
- Maintenance of the SODALES mailing list (sodales@i2cat.net)
- Maintenance of the SODALES weekly meetings platform, using GoToMeeting
- Organization and preparation of the meeting minutes of the weekly calls, which are organized to monitor the project evolution.

4 Deliverables and milestones

During this reporting period, one deliverable was submitted:

- D4.2 Prototype lab verification report

and one milestone achieved:

- MS52 Start of the SODALES field validation

As already indicated in the WP4 progress section, a delay in D4.2 due to integration issues has propagated through to D4.3, causing delays to this activity. Thus, D4.3 Report on installation parameters for the field service validation will be delivered in M34.

Also, the late achievement of MS52 will impact on MS43 “Running the field validation over a period of 3 months”, which will be subsequently delayed to M34.