Data Centres Optimization for Energy-Efficient and EnvironmentalLy Friendly INternet

Funding scheme: Specific Targeted Research Projects – STREP

Co-funded by the European Commission within the Seventh Framework Programme

Project no. 609140

Strategic objective: FP7-SMARTCITIES-2013 (ICT-2013.6.2)

Start date of project: October 1st, 2013 (36 months duration)

Final dissemination and standardization results

Due date: 30/09/2016

Submission date: 17/10/2016

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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)

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Amendment History

Version	Date	Partners	Description/Comments
0.1	20/07/2016	UCL	ToC
1.0	23/09/2016	UCL	Full Draft Version V1.0
1.1	26/09/2016	UCL	Small revision
1.2	29/09/2016	ITR, SYN, SIE, PSNC	Additional contributions
2.0	30/09/2016	UCL	Final Version & Submission to EU

Abstract

This deliverable presents the final results and activities performed for dissemination and standardisation of the DOLFIN consortium.

We listed the dissemination channels, results and activities that consortium has carried during the life of the project and we presented a list of the main dissemination activities performed where we presented DOLFIN consortium's point of view. During the lifetime of the consortium members have published: 4 white papers, 1 transaction paper, 1 Journal /magazine paper, 15 conference papers. We presented our standardization results and activities performed. During the life time of the project the consortium members have: (i) monitored the work progress in 19 relevant defacto / dejure SDOs Standard Organisations (SDOs) and open source projects; (ii) actively participate in the activities of 4 relevant defacto / dejure SDOs; (iii) contributed to 5 relevant published standard documents.

Table of Contents

Figures Summary

Tables Summary

Abbreviations

AAPM	Application-Aware Power Management
BEMPs	Best environmental management practices
CAPEX	CAPital EXpenditure
DC	Data Centre
DCIM	Data Centre Infrastructure Management
Git	A version control system that is used for software development
ITU-T	ITU Telecommunication Standardization Sector
IEEE	Institute of Electrical and Electronics Engineers
IT	Information Technology
JTC	Joint Technical Committee
ESOs	European Standards Organisations
ETSI	European Telecommunications Standards Institute.
EDUCA	European Data Centres Association
EMAS	EU Eco-Management and Audit Scheme
MEC	Mobile Edge Computing
NFV	Network Function Virtualisation
OPEX	OPerative EXpenditure
SDO	Standard Organization
SDN	Software Defined Network
VM	Virtual Machine
5G	5th Generation Infrastructure

Executive Summary

The objective of DOLFIN is to improve energy efficiency in Data Centres (DCs) through coordinated energy management functions and active interaction with the smart grid network. A fundamental aspect of the project is the creation of awareness around the innovative approaches designed to reduce and optimize the DCs energy consumption, together with their benefits in terms of operative costs and improved automation.

DOLFIN consortium is focused on guaranteeing a strong impact of the project achievements in the most relevant research and industrial communities, spanning across several categories of stakeholders in the cloud, DCs and network areas, but also involving the Smart Grids disciplines. WP6 is responsible to coordinate this effort, through a wide range of activities that include:

- establishing suitable internal and external dissemination channels, to facilitate collaboration and promote the DOLFIN solution in academic and industrial communities;
- monitoring the progress and contributing to the standardization activities in the DOLFIN technical areas to guarantee the alignment of the project results with the latest standards and identifying potential contributions to target standardization bodies;
- monitoring the evolution of the market trends and defining impact measure.

This deliverable presents the final results and activities performed for dissemination and standardisation of the DOLFIN consortium.

In the first chapter of the document we listed the dissemination channels, results and activities that consortium has carried during the life of the project and we presented a list of the main dissemination activities performed where we presented DOLFIN consortium's point of view. During the lifetime of the consortium members have published:

- 4 white papers
- 1 transaction paper
- 1 Journal /magazine papers
- 15 conference papers

In the 2nd chapter we presented our standardization results and activities performed. During the life time of the project the consortium members have:

- monitored the work progress in 19 relevant defacto / dejure SDOs Standard Organisations (SDOs) and open source projects
- actively participate in the activities of 4 relevant defacto / dejure SDOs
- contributed to 5 relevant published standard documents

1. Dissemination Results and Activities Preferment in Dolfin

Current and future data centres comprise diverse cloud management and autonomic functions. The envisaged solutions accommodate the need for effective energy management with a view to:

- Improve capital and operational effectiveness for DC operators through the use of a common organization, automation, and operation of all energy functions across the different domains
- Migrate from an ecosystem of separate energy management functions towards a related coordinated arrangement as represented in the following figure.

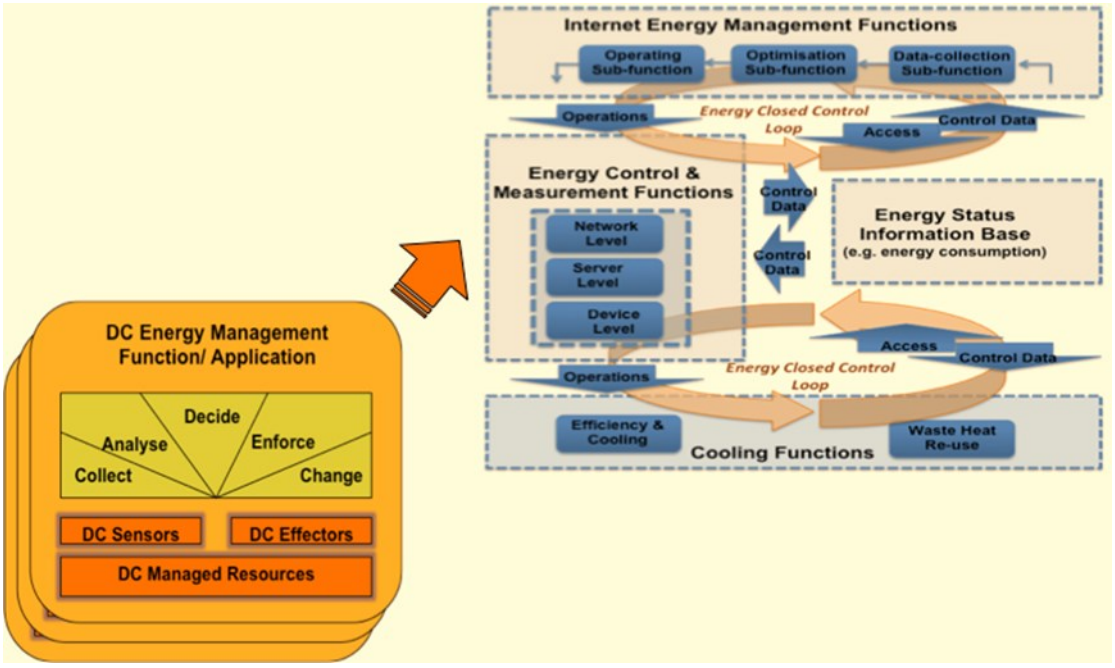

Figure 1 - Migration from separate energy control loops to a coordinated arrangement of multiple DC energy control loops

DOLFIN considers dissemination as of prime importance, since we believe that "going green" is not only a matter of cost effectiveness and competitiveness, but also a matter of attitude and quality of life. This attitude has to permeate to all involved stakeholders, to IT system designers and developers and to managers making strategic decisions.

The primary objective of dissemination is to promote the DOLFIN activities to external audience, in this sense the main target are focused on industrial and academic community in Europe and the world that spans across individual researchers, developers, providers and stakeholders involved or interested not only in what concerning the green Data Centre (DC) aspects, but also the innovation that are identified, developed and documented in DOLFIN, with the aims to introduce new models and functionalities in a DC environment.

The main actors in green DCs who can be targeted by dissemination actions by DOLFIN can be classified in:

- Industry
- Public organizations and regulators
- The scientific community at large (academia and research centres)
- Funding agencies
- Media contacts

With regards to industry, the group primarily includes DC operators, network and cloud operators (in most cases, these are also the service providers), and system vendors. For this large community, a structured list of dissemination events and standardization groups apply, with the need to use the appropriate dissemination means to maximise the impact.

The project team has defined and set up a set of different means used for external dissemination, which are detailed in the following sections. This extends from website, social networking, newsletters, press and whitepapers, technical publications on specialized books or journals, participation to events, workshops and international conferences promoted from the EU, etc.

1.1. Dissemination channels

Each subsection of this paragraph shows the main initiatives undertaken or planned for the specific dissemination subject. Given the multi-year duration of the project, this document will be subject to changes over time, that will aim to keep updated and tracks the information contained herein, during the life cycle of the project.

1.1.1. Public Web Site

The public Web-site has been published on January 2013 and it represents the main entry point for project's communication and dissemination activities. Besides the "Overview" and "Project" sections that provide information about the project's description and scope, the website includes other two sections, namely "Dissemination" and "News and Event", which are periodically updated with relevant information on communication and dissemination activities as soon as they are made available.

In the last period the "Dissemination" section has been updated by publishing and uploading the final versions of all the different public Deliverables.

Also the "News and Event" section has been updated with information about the events where project's partners took part, like, among others, the "DREAMCloud 2016" event held in Prague, and

the IEEE International Workshop on"Green Standardization and Industry Issues for ICT and Relevant Technologies" workshop at Globecom 2015" held in San Diego, California. The related publications presented during these events have been reported in the "Publication" sub-section of the website.

On August 2015 the website has been provided with a useful Word Press plugin which enables the analytic reports on the website. With the data gathered from the tool, the project's partners can keep track and monitor all the website's visits in order to have a complete and accurate overview on the project divulgation, and a real-time acknowledgement on our communication strategy and activities.

In the following snapshot of September 2016, taken from the Word Press Statistics plugin, is reported the overall number of visits.

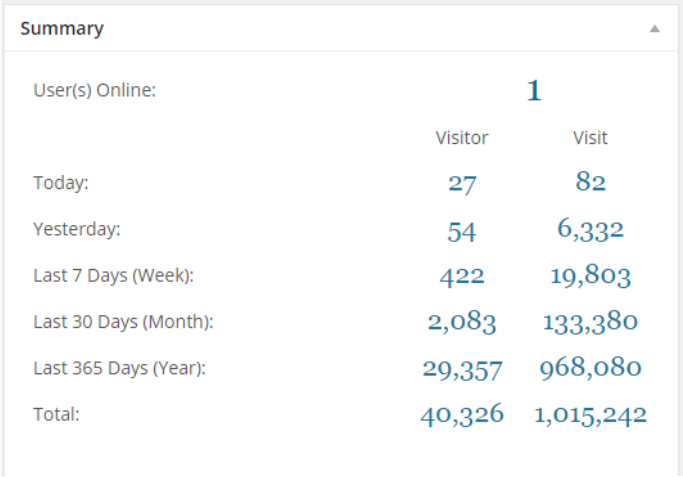

Figure 2- Visits summary

In order to have an overview on the number of visitors during the last year (period from 16/Sep/2015 to 27/Sept/2016), below is reported the "Hits Statistic" chart:

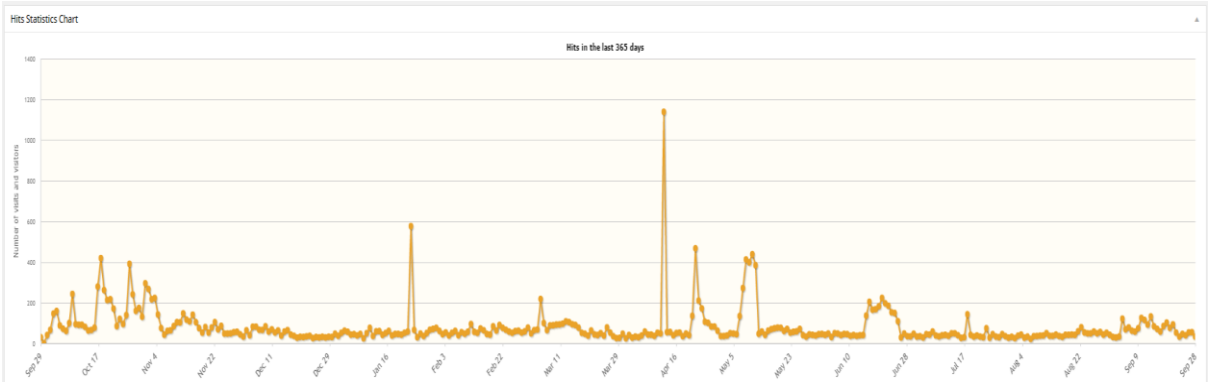

Figure 3- Number of visitors in the last year

Another useful information regarding the online presence footprint is provided by the "Top Countries" reports. Following are listed the top 15 countries from which the DOLFIN website has been visited:

Rank	Flag	Country	Visitor Count
1		China	5,934
2		Ukraine	4,107
3		United States	3,363
4		Russian Federation	1,611
5		India	829
6		France	764
7		Greece	691
8		Germany	610
9		Netherlands	604
10		Brazil	579
11		Philippines	541
12		United Kingdom	531
13		Italy	466
14		Romania	463
15		Canada	316

Figure 4- Visitors per country table

These statistics demonstrate a global presence of DOLFIN and interest in tackled research areas spread across different countries.

1.1.2. Whitepapers

Whitepapers have the main purpose to provide a short overview of the DOLFIN impact in the real world of DC industry and green telecommunication services. The whitepapers are excellent means to describe the DOLFIN project and promote the concepts and results beyond the DOLFIN ecosystem, bringing these concepts within a real market and business scenarios.

In the more common form, the whitepapers are used as a marketing tool, so the information contained are often accompanied by use cases that allow to represent, through logical and well-structured arguments, the potential of the system (and related technologies) as a solution to concrete business problems.

In the specific case of DOLFIN, whitepapers will have as target industries, scientific communities and other entities that have interests in the areas directly or indirectly affected by the project, such as:

Green IT and Green DCs, SmartGrids, Cloud Computing and Virtualization systems, Building Management Systems, etc.

The DOLFIN participants have contribute to 4white papers:

- **5GPPP White Paper: 'Views on 5G Architecture"** - 5G PPP Association - July 2016; Contributions and Editorialship of: Overall 5G Architecture, Logical & Functional Architecture, Software Networks Technologies A. Galis (editor & contributor), - Global 5G event – Beijing 1 June 2016 and EUCNC 2016 – Athens 27-30 June 2016.
- **NetWorld 2020 White Paper: "Vision Document for Beyond 5G Research"**- R.L. Aguiar, J. S. Bedo, A G Armada, B. Evans, A. Galis, H. Karl – NetWorld2020 30th November 2015 - http://networld2020.eu/sria-and-whitepapers**/**
- **IEEE SDN Initiative White Paper: "Software-Defined Networks for Future Networks and Services - Main Technical Challenges and Business Implications"** - Antonio Manzalini, Telecom Italia, Italy Roberto Saracco, EIT ICT Labs, Italy Cagatay Buyukkoc, AT&T Labs, USA Prosper Chemouil, Orange, France Sławomir Kukliński, Orange Polska, Poland Andreas Gladisch, Deutsche Telekom, Germany Masaki Fukui, Wenyu Shen, NTT, Japan Eliezer Dekel, IBM, Israel, Walter Cerroni, Franco Callegati, University of Bologna, Italy, Giovanni Schembra, Vincenzo Riccobene, University of Catania, Italy, Carmen Mas Machuca, Technische Universität München, Germany, Alex Galis, University College London, U.K. Julius Mueller, FhG FOKUS, Germany, David Soldani, Huawei, Germany Mehmet Ulema, Manhattan College, USA – 29th January 2014, http://sites.ieee.org/sdn4fns/files/2014/02/White-Paper-IEEE-SDN4FNS-2014_02_05.pdf
- **IEEE SDN Initiative White Paper: "Towards 5G Software-Defined Ecosystems - Technical Challenges, Business Sustainability and Policy Issues"** - Antonio Manzalini, Telecom Italia Mobile, Italy, Cagatay Buyukkoc, AT&T Labs, USA, Prosper Chemouil, Sławomir Kuklinski Orange, France Franco Callegati, University of Bologna, Italy, Alex Galis, University College London, UK Marie-Paule Odini, HP, France, Chih-Lin I, Jinri Huang, China Mobile, China Mike Bursell, Intel, UK, Noel Crespi, Telecom Sud Paris, France Eileen Healy, pdv Wireless, USA Stuart Sharrock, Telemates, UK - July 2016 http://sdn.ieee.org/images/files/pdf/towards-5g-software-defined-ecosystems.pdf

1.1.3. EC Conferences & Cluster Meetings

1.1.3.1. *DC-CLUSTER COLLABORATION*

The DC Cluster Collaboration initiative [1] constitutes an attempt of the EC to coordinate a group of eight (8) FP7 projects related to energy efficient, Green DC operation and DC-Smart Cities interaction. The goal of the DC Cluster Collaboration is to establish sets of well-defined metrics to render the quantification, evaluation and comparison of the projects' results feasible, from a combined technical and financial perspective. Apart from the identification of well-established DC energy efficiency metrics, the DC Cluster activities include the determination of new ones, to address the increasing need for applying effective ways to assess the efficiency of DC operation not only in terms of energy, but also of flexibility, cooperation with other DCs, CO2 savings and reduced energy expenses. In addition to identifying and theoretically establishing these new metrics, the DC Cluster aims at also coming up with concrete methodologies for measuring these metrics in real-field trials and verifying the results in an unambiguous way. The DC Cluster-defined metrics and the respective

[1] DC Cluster Collaboration, http://projects.dc4cities.eu/projects/smart-cities-cluster

methodologies developed will be evaluated and validated during the projects trials and proper actions will be taken in order to standardise (some of) the Collaboration results.

DOLFIN actively participates in the DC Cluster activities. Specifically, DOLFIN was involved in Task 1, assisting in the identifying of the already existing metrics and methodologies. DOLFIN also participated in analysing the energy metrics and methodologies and determining their limitations. Notably, DOLFIN (UCL) acted as one of main coordinator of this task 1 – an additional deliverable to the DoW contract was produced as common DC Cluster collaboration activity- and participated in Tasks 2 and 3 of the DC Cluster. DOLFIN acted as both coordinator (SYN) and developing project (SYN, UCL, I2CAT) in Task 4 of the DC Cluster, being responsible for the determination of the measurement and verification plans of the metrics. DOLFIN is currently active (with NXW as main representative partner) in establishing the complete dissemination plan of the DC Cluster which is part of Task 5 activities. Last, as soon as integration is over and the first project results are gathered, all DOLFIN developing partners are going to provide feedback with respect to the measurement and verification processes already established within the context of Task 4, actively contributing in DC Cluster Task 6.

1.1.3.2. *European Conference on Networks and Communications (EUCNC)*

EuCNC is 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 programmes on R&D and projects co-financed by European programmes, as well as presenting the latest developments in this area. EuCNC is structured to permit open interactions and cross-fertilization across technical domains. It works towards a) Vision, challenges, scenarios and roadmaps for Future Internet (FI) research and b) the development of prenormative principles, concepts, design, architectures, recommendations and functional specifications of key FI system components and their interfaces.

DOLFIN will have an active participation in the next EUCNC in 2016, presenting final results on energy efficiency optimization solutions in Data Centres, to the European research community.

1.1.4. Publications

Publications are one of main instruments, through which DOLFIN approach and results will be promoted to the international scientific and technical community. Publications typically provide a mean to disseminate specific topics, or a specific set of functions and concepts that are integral and essential part of the ecosystem proposed by the project itself.

The publication is a valued tool not only to divulge the overall description of DOLFIN, but also to present solutions and results with the aims of facilitate the dissemination and sharing of knowledge. Three main types of publications means are provided:

- conferences papers
- technical books
- journals papers

1.1.5. Social Networks

DOLFIN also aims to be active within the social networking. Twitter (@DOLFIN_FP7) and Linkedin (DOLFIN-FP7) accounts have been created and are maintained up-to-date with project activities and news. They are also used to promote latest discussions, publications and demonstration events related to energy management inside data centres at a global scale. Although current followers are mainly other European projects and individuals with interests in data centre and cloud realms, the consortium intend to continue pushing for a wider reach to other industry partners.

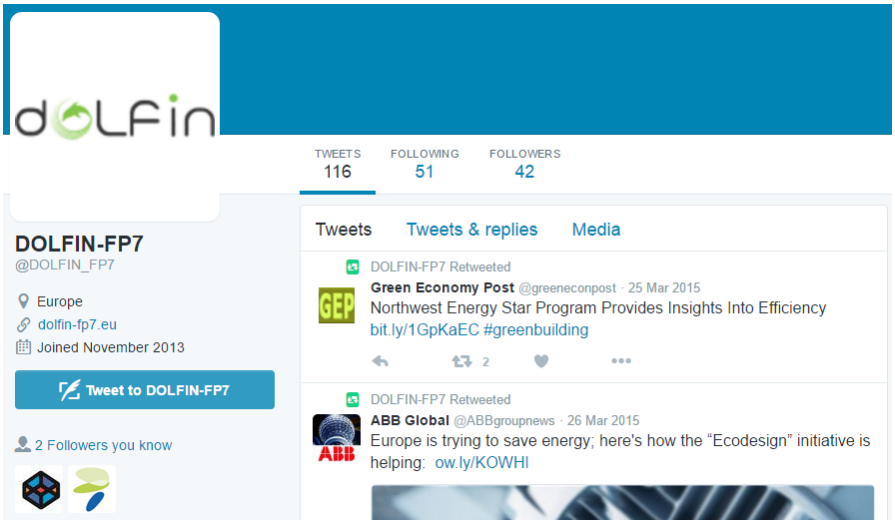

Figure 5- Twitter account

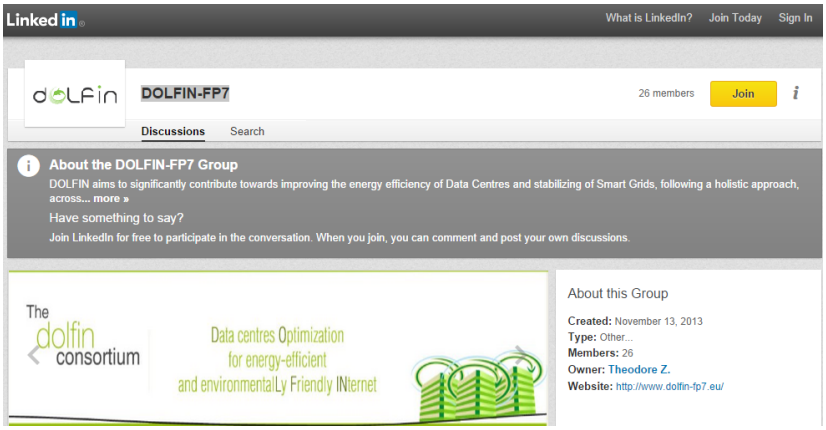

Figure 6- Linkedin account

1.1.6. Projects Liaison Activities

DOLFIN recognizes that Energy Efficiency may be achieved only in a collaborative manner. Therefore, liaison activities with relevant projects have been initiated and are already in progress. These activities go well beyond the DC Cluster Collaboration initiative. In more details:

- **GEYSER project (FP7 ICT-609211).** The GEYSER project aims to design, implement and validate a technological and conceptual framework for green energy-sustainable networked Data Centres acting as Energy Prosumers within a Smart City /Smart Grid integration paradigm.

  The relevance between the GEYSER and the DOLFIN projects is quite obvious and close collaboration will be for the mutual benefit of the projects. Therefore, Synelixis as the technical coordinator of DOLFIN has close communication with Engineering, Coordinator of the GEYSER project, in order to share ideas and technical approaches. Of course, special care has been taken so that no IPR issues rise via this communication.

  Discussions on a potential common architecture between the two projects continued during Year 2, mostly led by the DOLFIN Technical Manager, Dr. Theodore Zahariadis..

- **FINESCE project (FP7 ICT-604677).** FINESCE (Future INtErnet Smart Utility ServiCEs) is the smart energy use case project of the 2nd phase of Future Internet Public Private Partnership (FI-PPP) programme funded by the European Union within FP7. From 2013 until 2015, FINESCE will contribute to the development of an open IT-infrastructure to be used to develop and offer new app-based solutions in all fields of the Future Internet related to the energy sector.

  The project has organized and runs a series of field trials at trial sites in 7 European countries. Among them, the trial site in Terni, Italy performs experiments in Energy grid management in a smart city via an energy marketplace. Though DOLFIN concentrates on the Data Centre site, it also interfaces a smart grid interface, while links with an energy market place would be beneficiary for the project. Thus, Synelixis keeps close links between the two projects in order to maximize information flow.

  Discussions about exchanging information on a common smart grid API also continued during Year 2, led by Synelixis.

- **XiFi project (FP7 ICT-604590)** XIFI is a project of the European Public-Private-Partnership on Future Internet (FI-PPP) programme. XIFI paves the way for the establishment of a common European market for large-scale trials for Future Internet and Smart Cities through the creation of a sustainable pan-European federation of Future Internet test infrastructures. The XIFI open federation leverages existing public investments in advanced infrastructures and support advanced large-scale deployment of FI-PPP early trials across a multiplicity of heterogeneous environments and sector use cases that should be sustained beyond the FI-PPP programme.

  XiFI federates already 18 cloud infrastructures all over Europe. DOLFIN (represented by Synelixis) is following these developments in order to find out if results from the DOLFIN can directly apply on XiFi federation extending the FIWARE Ops[2]

1.1.7. Other dissemination activities

Industrial partners also plan to use their networks of technological partners and customer-related events to publish and make available gathered knowledge and experiences in DOLFIN.

[2] FIWARE Ops is a collection of tools that ease the deployment, setup and operation of FIWARE instances by Platform Providers. It is designed to help expanding the infrastructure associated to a given FIWARE instance by means of federating additional nodes (Data Centres) over time and allowing cooperation of multiple Platform Providers.

In particular, project results are disseminated via the company intranets and in employees' seminars and courses, customers' training and products' offerings, scientific and commercial workshops and exhibitions.

In particular, WIND has organized several meetings throughout the first and second year of the project, aimed at sharing project results and evolution with WIND Information Technology Managers. These managers are in charge of deciding about the internal adoption of the DOLFIN solution and are the most qualified to create the appropriate conditions for a correct evaluation of it. In addition, a first contact with the Marketing Dept. at WIND has been established and the DOLFIN project briefly introduced. It was underlined that SMEs or other enterprises using WIND as Telco operator could benefit from the saved resources and be able to concentrate on other business opportunities. WIND has also involved its Business Strategy group to share the project approach and define a possible endorsement process, initially within the company itself and potentially in other companies of the Vimpelcom Group. As a principal member of Vimpelcom, WIND has a role of promoter to all companies in the group and its experience could provoke interest in various local contexts according to the level of attention to this topic in individual countries. The internal company website is also being kept up-to date with the reports ensuing from project developments.

Interoute has also interacted with their company CTO and top management (CEO and Board of Directors), both established in London, presenting DOLFIN updates in periodic quarterly meetings. Aim of these meetings was to discuss potentials for exploitation of DOLFIN ideas in Interoute data centers. Updates on project activities have been also provided in the Interoute intranet, accessible to all employees across different countries. Finally, Interoute Italy have cited DOLFIN in many company news published on Italian newspapers, thus making DOLFIN part of the promotional campaign used to further consolidate Interoute image and positioning in the Italian TLC market.

1.2. Dissemination Results and Activities Performed in DOLFIN

Overall, during its lifetime, DOLFIN has been well represented and has raised a lot of interest at the different events where it has been presented. The audience of the events has in general showed a lot of interest to the project hence encouraging further DOLFIN participation in the most relevant events during its lifetime.

The table below summarizes the participation of the DOLFIN consortium to events, workshops and conferences during the whole project's lifetime.

Actual Date	**Conference**	**Type of Audience**	**DOLFIN Participation**	**DOLFIN partner responsible / involved**
Year 1				
23-25 Sept. 2013	5th International Conference on Mobile Networks and Management (MONAMI 2013), Cork, Republic of Ireland, http://mon-ami.org/2013/show/home; http://link.springer.com/book/10.1007/978-3-319-04277-0?wt_mc=alerts.TOCseries	Scientific Community	Software Enabled Future Internet – Challenges in Orchestrating the Future Internet	UCL, SYN
11-13 Nov. 2013	IEEE SDN4FNS (Software Defined Networks for Future	Scientific Community	Softwarization of Future Networks and Services -	UCL, SYN

Actual Date	Conference	Type of Audience	DOLFIN Participation	DOLFIN partner responsible / involved
	Networks and Services), Trento, Italy; http://sites.ieee.org/sdn4fns/		Programmable Enabled Networks as Next Generation Software Defined Networks	
20 March 2014	DC Cluster Collaboration Workshop, Barcelona, Spain	Scientific & Development Communities	Contributions and activities of the DC Cluster Collaboration- 1st Cluster report	UCL
28th March 2014	11th IEEE Workshop on Managing Ubiquitous Communications and Services part of PerCom 2014- Budapest; http://ubiquitous-management.org/mucs/2014/program.php	Scientific & Development Communities	Keynote presentation "Software Defined Systems for Management of Ubiquitous Communications and Services - How and What to Virtualize and Programme"	UCL
9 May 2014	1st IEEE / IFIP International Workshop on SDN Management and Orchestration - at IEEE/IFIP NOMS 2014 conference in Krakow 5-9 May 2014	Scientific Community	Organisation & paper	UCL
20 May 2014	10th Smart Grid Stakeholder Group Meeting, Graz, Austria	Industry, Smart Grid Stakeholders	Attended the meeting	SYN
23-26 June 2014	EuCNC'2014 (European Conference on Networks and Communications) http://www.eucnc.eu Venue: Bologna, Italy	Scientific & Development Communities	Analysis & Results - Poster	UCL,IRT,NXW
10 Sept. 2014	DC Cluster Collaboration workshop, Brussels	Scientific & Development Communities	Leading project in the Task 4 activities of the DC Cluster Collaboration	SYN, UCL
24-26 Sept. 2014	Wireless World Research Forum	Scientific & Development Communities	Keynote presentation "Softwarization of 5G Network and Service Infrastructures - Current State, Upcoming Trends and Key Challenges"	UCL
Year 2				
1-3 December 2014	19th IEEE International Workshop on Computer Aided Modelling and Design of Communication Links and Networks (IEEE CAMAD) Athens, Greece http://www.ieee-camad.org	Scientific & Development Communities Conference is sponsored by IEEE Communications Society	Simulation of features of an Energy Efficient Data Centre (including VM migration)	Synelixis
2nd December 2014	Workshop on Cloud and Server Support for Wearable Computing /11th International Conference on Mobile and Ubiquitous Systems. London. 2nd December 2014 - http://www.dcs.bbk.ac.uk/~gr/iot-ecosystems/	Scientific & Development Communities	Keynote presentation "Softwarization of Network. IoT and Service Infrastructures – Current State. Upcoming Trends and Key Challenges"	UCL
13-17 April 2015	IEEE NetSoft 2015 (Software Defined Infrastructures for Networks, Clouds, IoT and Services) 13-17 April 2015 London (4 tutorials, 40 papers, 7 demonstrations, 3 workshops) - 160 participants -	Scientific & Development Communities	Organasing and hosting	UCL

Actual Date	Conference	Type of Audience	DOLFIN Participation	DOLFIN partner responsible / involved
	endorsement and support from the Dolfin project			
10th April 2015	"A Service-Aware Virtualized Software-Defined Infrastructure" - Lefteris Mamatas, Stuart Clayman and Alex Galis- publication in IEEE Communications Magazine in April 2015 (Volume 53, Issue 4), pp 166-174, ISSN 0163-6804; DOI: 10.1109/MCOM.2015.7081091	Scientific & Development Communities	Paper publication	UCL
8th April 2015	DC Cluster meeting in Barcelona	Scientific & Development Communities	Attended workshop	SYN
29 June -2 July 2015	EuCNC 2015 EU commission organised conference - http://www.eucnc.eu	Scientific & Development Communities	Attended conference	UCL
14th July 2015	Datacentre Transformation - Facilities, ICT & Cloud – Manchester UK, http://dtmanchester.com	Scientific & Development Communities	Contribution to a DC – Cluster presentation	SYN, UCL, IR,
21 -23 July 2015	Siemens Digitalization Days 2015	Business drivers, product owners, R&D communities	Attended Conference & present to business drivers projects ideas	SIE
21-23 September 2015	ITU-T Focus Group on 5GNetwork Softwarization – IMT 2020 – Turin (http://www.itu.int/en/ITU-T/focusgroups/imt-2020/Pages/default.aspx)	Standards Communities	Keynote Presentation on 'Challenges in 5G networking softwarization'	UCL
Year 3				
26-27 October 2015	EAI International Conference on Cloud, Networking for IoT, Rome http://cloudniot.org/2015/show/home	Scientific & Development Communities	Invited Dolfin paper	SYN, UCL
28 October 2015	Green Grid EMEA Forum 2014	Industry, Scientific & Development Communities	DOLFIN presentation	SYN
6-10 December 2015	IEEE International Workshop on Green Standardization and Industry Issues for ICT and Relevant Technologies (GSICT) of Globecom 2015	Scientific & Development Communities	Paper Publication	SYN
19th January 2016	2nd International Workshop on Dynamic Resource Allocation and Management in Embedded, High Performance and Cloud Computing DREAMCloud 2016	Scientific & Development Communities	Paper Publication	GRNET
25-29 April 2016	IEEE Network Operations and Management Symposium (NOMS)	Scientific & Development Communities	Paper Publication	UCL
22-25 May 2016	Clima 2016/ 12th REHVA World Congress 2016	Scientific & Development Communities	Paper Publication	NXW, SYN
6-10 June 2016	IEEE Network Softwarization (IEEE NetSoft 2016);	Scientific & Development Communities	Paper Publication	UCL

Actual Date	Conference	Type of Audience	DOLFIN Participation	DOLFIN partner responsible / involved
30th August 2016	International Journal of Network Management	Scientific & Development Communities	Paper Publication	UCL
30th August 2016	IEEE Transactions on Network and Service Management – (IEEE TNSM)	Scientific & Development Communities	Paper Publication	UCL
12th May 2016	Siemens CT Energy Day 2016	Business drivers, product owners, R&D communities	Present and demonstrate a use case incorporating some of Dolfin implemented ideas	SIE
5th March 2016	DC Cluster meeting in Barcelona	Scientific & Development Communities, EC	Attended meeting	PSNC
21st June 2016	Energy Efficient Data Centers 2016 (e-Energy 2016)	Scientific & Development Communities	Paper Presentation	PSNC

Table 1: Events that the DOLFIN consortium has already organized/participated

A detailed list of the papers published or submitted during the three years of the DOLFIN lifetime is given below:

Year 1

1. Galis, A (UCL), Rubio-Loyola, J., Clayman, S. (UCL), Mamatas, L. (UCL), Kukliński, S., Serrat, J., Zahariadis, T. (SYN), "Software Enabled Future Internet – Challenges in Orchestrating the Future Internet, 5th International Conference on Mobile Networks and Management" (MONAMI 2013), Cork, Republic of Ireland, 23-25 Sept 2013, http://mon-ami.org/2013/show/home; http://link.springer.com/book/10.1007/978-3-319-04277-0?wt_mc=alerts.TOCseries

2. Galis, A. (UCL), Rubio-Loyola, J., Clayman, S. (UCL), Mamatas, L. (UCL), Manzalini, A., Kukliński, S., Serrat, J., Zahariadis, T. (SYN), "Softwarization of Future Networks and Services - Programmable Enabled Networks as Next Generation Software Defined Networks", IEEE SDN4FNS (Software Defined Networks for Future Networks and Services), Trento, Italy; 11-13 Nov 2013, http://sites.ieee.org/sdn4fns/

3. A. Manzalini (Telecom Italy –Italy), R. Saracco (TI Italy), C. Buyukkoc, (AT&T Labs USA_, P. Chemouil – (Orange France), S. Kukliński (Orange Polska Poland), A. Gladisch (Deutsche Telekom Germany), M. Fukui (NTT Japan), W. Shen (NTT- Japan), E. Dekel (IBM Israel), D. Soldani (Huawei Germany), M. Ulema (Manhattan College USA), W. Cerroni (University of Bologna Italy), F. Callegati (University of Bologna Italy), G. Schembra (University of Catania – Italy), V. Riccobene (University of Catania Italy), C. Mas Machuca (Technische Universität München Germany), A. Galis (University College London, U.K.), J. Mueller (FhG FOKUS Germany) "Software-Defined Networks for Future Networks and Services - Main Technical Challenges and Business Implications" - IEEE SDN4FNS Whitepaper – open access @ http://sdn.ieee.org/articles-publications.html

4. Clayman S. (UCL), Maini E. (UCL), Galis A. (UCL), Manzalini A. (TI), Mazzocca N. (UF), "The Dynamic Placement of Virtual Network Functions", IEEE/IFIP NOMS 2014 / SDNMO 2014 –

9th May 2014 Krakow; http://noms2014.ieee-noms.org; http://clayfour.ee.ucl.ac.uk/sdnmo2014/

5. Matteo Biancani (IRT), Theodore Zahariadis (SYN), Poster for "DOLFIN - Data Centres Optimization for Energy-Efficient and EnvironmentalLy Friendly INternet", EuCNC 2014

Year 2

6. L. Mamatas, S. Clayman and A. Galis- "Software-Defined Infrastructure" - IEEE Communications Magazine in April 2015 (Volume 53, Issue 4), pp 166-174, ISSN 0163-6804; DOI: 10.1109/MCOM.2015.7081091

7. A. Aravanis, A. Voulkidis, J. Salom, J. Townley, V. Georgiadou, A. Oleksiak, M. Porto, F. Roudet, T. Zahariadis "'Metrics for Assessing Flexibility and Sustainability of Next Generation Data Centers", accepted for publication in IEEE International Workshop on Green Standardization and Industry Issues for ICT and Relevant Technologies (GSICT) in Globecom 2015 ('GC'15 – IEEE GSICT'), will be published in the Proceedings of IEEE GLOBECOM 2015 and IEEE Xplore.

8. A. Aravanis, P. Karkazis, A. Voulkidis, T. Zahariadis, "On the Minimization of the Energy Consumption in Federated Data Centers", invited paper in EAI International Conference on Cloud, Networking for IoT systems (CN4IOT 2015).

Year 3

9. L. Mamatas, S. Clayman, A. Galis - "Experimenting with Management Information Orchestration for Virtual Software-Defined Networks"- International Journal of Network Management - Special Issue on Software-Defined Operations; DOI: 10.1002/nem.1943, Publication date: August 2016 http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1099-1190/earlyview

10. L. Mamatas, S. Clayman, A. Galis -"Information Management as a Service for Network Function Virtualization Environments - IEEE Transactions on Network and Service Management – (IEEE TNSM), DOI: 10.1109/TNSM.2016.2587664, Publication date: August 2016

11. S. Clayman, L. Mamatas, A. Galis - "Efficient Management Solutions for Software Defined Infrastructures"- IEEE Network Operations and Management Symposium (NOMS) – 25-29 April 2016, Istanbul, http://noms2016.ieee-noms.org; DOI: 10.1109/NOMS.2016.7503005, published.

12. S. Clayman, L. Mamatas, A. Galis - "Experimenting with Control Operations in Software-Defined Infrastructures"- - IEEE Network Softwarization (IEEE NetSoft 2016); http://opennetworking.kr/ossn; 6-10 June 2016, Seoul, http://sites.ieee.org/netsoft/; DOI: 10.1109/NETSOFT.2016.7502473,

13. S. Clayman, L. Mamatas, A. Galis "Energy-efficiency Enablers and Operations in Software-Defined Environments" - Management of 5G Networks Workshop at IEEE NOMS 2016, 25-29 April 2016, Istanbul, Turkey - http://noms2016.ieee-noms.org

14. E. Angelou, K. Kaffes, A. Asiki, G. Goumas, N. Koziris - "Improving virtual host efficiency through resource and interference aware scheduling," 2nd International Workshop on Dynamic Resource Allocation and Management in Embedded, High Performance and Cloud Computing DREAMCloud 2016, 19th January 2016 in Prague, Czech Republic.

15. A. Aravanis, A. Voulkidis J. Salom, A. Oleksiak, Th. Zahariadis -"Metrics for Assessing Flexibility and Sustainability of Next Generation Data Centers" 1st IEEE International Workshop on Green Standardizations and Industry Issues for ICT and Relevant Technologies (GSICT), At San Diego, CA, USA in parallel to IEEE Globecom 2015, December 6-10, 2015
Green Grid EMEA Forum 2015, October 2015 -Participation of the project at the event.

16. Aravanis, P. Karkazis, A. Voulkidis, T. Zahariadis -: "On the Minimization of the Energy Consumption in Federated Data Centres," EAI International Conference on Cloud, Networking for IoT systems., (CloudNIoT) OCTOBER 26–27, 2015 | ROMA, ITALY

17. Gino Carrozzo, Tommaso Zini, Gianluca Insolvibile, Theodore Zahariadis and Artemis Voulkidis, "An Energy Consumption Optimization Platform For Green Data Centres", Clima 2016/ 12th REHVA World Congress 2016, Aalborg, Denmark 2016.

18. Ariel Oleksiak, Wojciech Piatek, Konrad Kuczynski, and Franciszek Sidorski. 2016. Reducing energy costs in data centres using renewable energy sources and energy storage. In *Proceedings of the 5th International Workshop on Energy Efficient Data Centres* (E2DC '16). ACM, New York, NY, USA,, Article 5, 8 pages. DOI: http://dx.doi.org/10.1145/2940679.2940684

1.3. Internal communication channels

In order to facilitate the internal communication within the DOLFIN consortium several tools have been implemented including a general mailing list, a code repository, a Dropbox folder and conferencing tools. All these dissemination channels for internal information sharing have been set up according to the initial description in the project DoW (Description of Work).

1.3.1. Mailing list

GRNET hosts the general mailing list that the consortium uses for day to day communication: dolfin@lists.grnet.gr. The list allows the people subscribed to send emails to the list and blocks emails coming from addresses not subscribed, this way, spamming to the list is avoided.

1.3.2. Dropbox folder

It was agreed amongst the partners of DOLFIN consortium that the most appropriate way of sharing and version handling of documents was using the tool Dropbox. Previously, a similar document sharing system by Interoute was used, but since its support was discontinued in April 2015 the consortium decided to move to Dropbox. The screenshot in Figure 7 shows the current home of the

Dropbox folder. In May 2015 the folder in the previous system was migrated to Dropbox successfully and since then, the document and information sharing for DOLFIN is carried out using Dropbox.

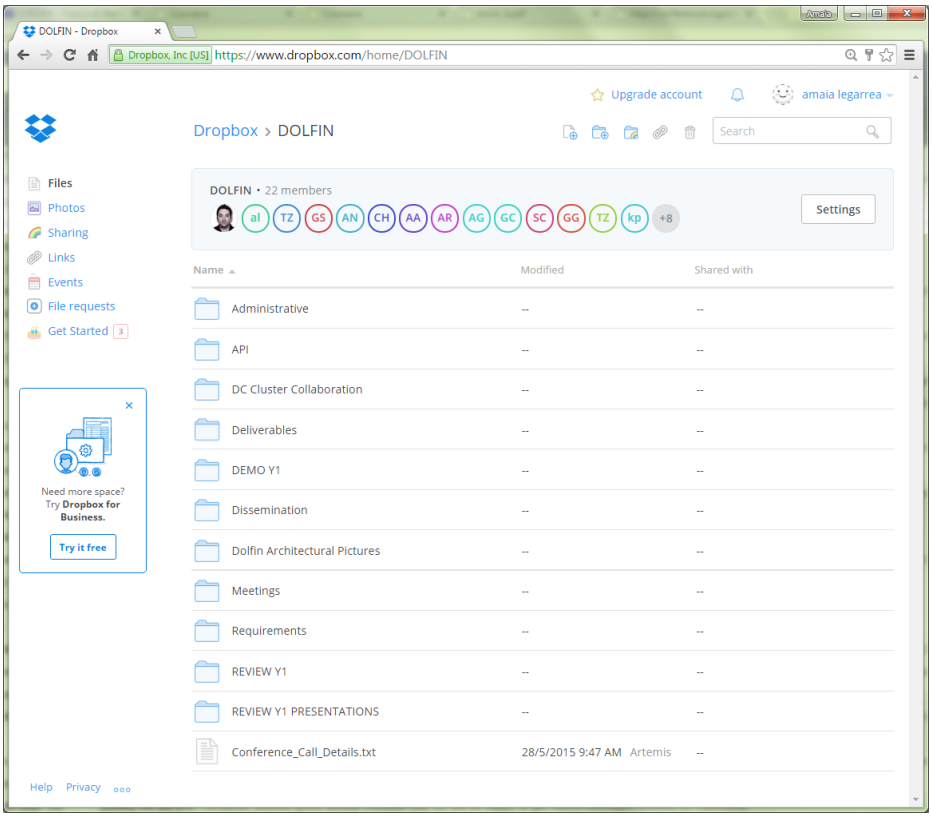

Figure 7- Dropbox Folder screenshot

1.3.3. GIT Repository

A Git repository has been set up for DOLFIN developers to ease the distribution version control of the developed software. The Git repository used by DOLFIN is based in the STASH product, by Atlassian and managed by i2Cat. A screenshot of the home page is provided below.

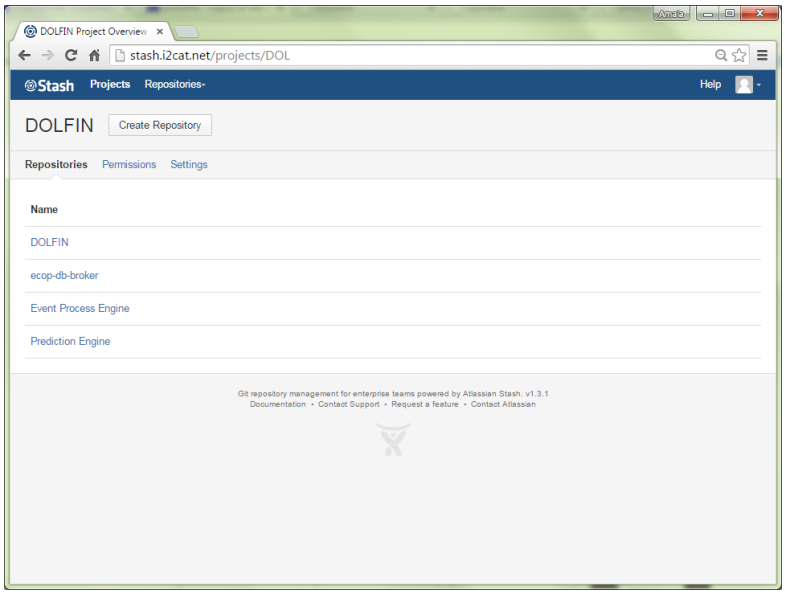

Figure 8 – STASH Git repository screenshot

At the moment, three modules of software have been included in the repository: the eCOP DB Broker, Event Receiver Engine and the Prediction Engine. It is expected that as the project and WP5 progress, more modules are developed and they will be included in new sub repositories.

1.3.4. Conferencing Tools

At the moment DOLFIN consortium meet up weekly in a virtual conferencing tool provided by Cisco (WebEx). This tool allows screen sharing to any of the participants, messaging, video-conferencing and recording the discussion. Figure 9 presents a screenshot of the actual weekly call.

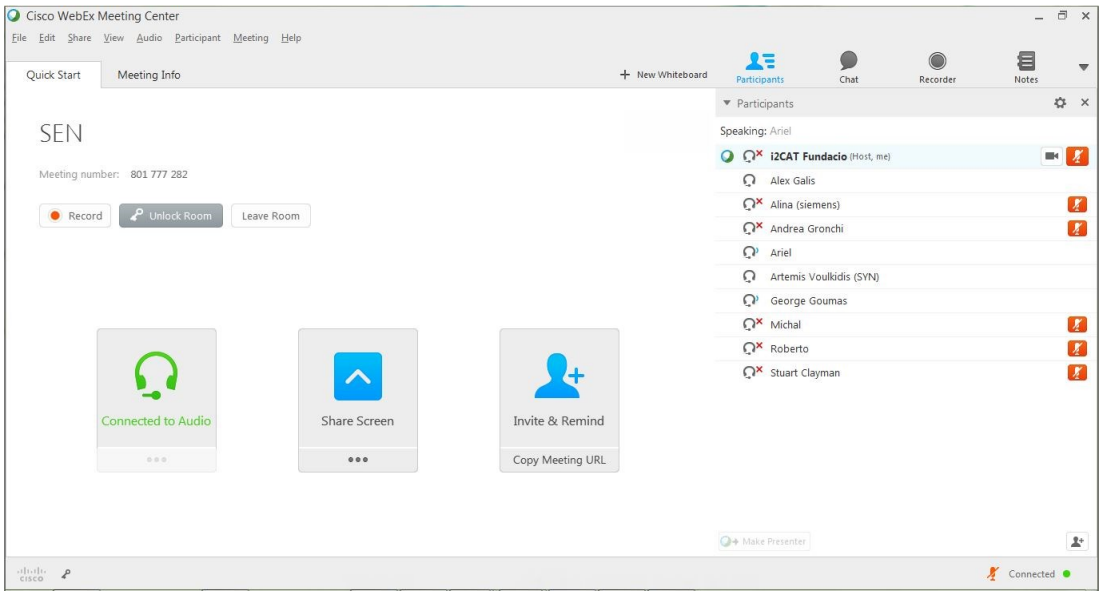

Figure 9– WebEx Conferencing tool screenshot

2. Standardization Results and Activities Performed in DOLFIN

DOLFIN consortium brings together partners that are present in standardisation bodies and it has created significant impact contributing to the relevant work groups. Usually, contributions to standards are submitted by project partners or jointly by a group of partners, which actively participate in the respective bodies. All DOLFIN contributions are based on the actual work plan of the respective standards body, the availability of suitable material to these bodies and the actual interests of the project partners.

2.1. Main Defacto / De Jure Standardization bodies

To realise the vision of green DCs and their integration in Smart Grids for a sustainable Internet growth, which has a very broad scope, the cooperation and coordination among different standardisation bodies is required. This is why the three European Standards Organizations (CEN/CENELEC/ETSI) created a Joint Working Group (JWG), which produced a report that outlines Europe's standardization views in the area of Smart Grids, taking due account of existing global activities. Smart Energy, Smart Grids and their relationship with the Future Internet have motivated a significant number of very significant international and European standardization bodies to address the issues related with standardizing the Smart Grid and Smart Energy Interfaces.

SIEMENS is involved in almost all standardisation bodies related to Smart Grids, telecommunication and information infrastructures and future Internet architectures and has a strong potential to push DOLFIN results in these bodies, as shown in Table 2*. Among them, the most suitable groups will be chosen and DOFIN will focus on them. All partners will assist in preparing contributions of high quality to create the maximum possible impact.*

Standardisation De Jure / Defacto body	**Relevance for DOLFIN**	**DOLFIN partner involved**
CEN/CENELEC/ETSI	Medium	SIEMENS
Green Grid Alliances	Medium	SIEMENS (Contributor member)
ETSI Technical Committee "Environmental Engineering" (TCEE)	Medium	GRNET (partner of the FP7 IP ECONET project)
ETSI Network Function Virtualisation	Medium	UCL
ETSI Mobile Edge Computing	Medium	UCL

Standardisation De Jure / Defacto body	Relevance for DOLFIN	DOLFIN partner involved
ITU-T Future Networked Systems Group	Medium	UCL (is a vice chair of ITU-T FN Group)
ITU-T IMT2020 Focus Group	High	UCL
Open Source Solutions: Open Daylight, Open Stack, Open NFV	High	UCL
Smart Grid Stakeholder Group	Medium	SYN
The Green Grid Forum	Medium	SYN
DC Cluster Collaboration initiative	High	SYN, UCL, i2CAT,
The Smart Grid Stakeholder Group (SGSG)	Medium	SYN
EUDCA - European Data Centres Association	Medium	SYN
CLIMA 2016	Medium	SYN, NXT
EU Eco-Management and Audit Scheme	High	SYN

Table 2: Standardisation focal areas

For each standardization committee identified in the Table 2, will be introduced a detailed section where will be described the activities and the contributions of DOLFN in the specific standardisation body.

2.1.1. CEN/CENELEC/ETSI

The European Commission requested the three European Standards Organisations (ESOs), CEN, CENELEC and ETSI, to develop a framework to enable European Standardisation Organisations to perform continuous standard enhancement and development in the field of Smart Grids, while maintaining transverse consistency and promote continuous innovation.

CEN/CENELEC is relevant for DOLFIN due to the fact that it covers as focus the energy efficiency from both Smart Grid point of view and Green Data Centres one. If for the Smart Grids aspects first established activities of a join work group (CEN/CENELEC, ETSI) in July 2011 leading to the release of first set of consistent standards in the end of 2012, for Green Data Centres the activity is on a level of coordination groups delivering a standardisation landscape. This is the effect of current convergence and maturity for this industry, connected to the wealth of research and developments in Cloud Computing and management, and the advent of Big Data analytics field.

Therefore, based on proposed architecture and further results DOLFIN monitor and consider contributing in both relevant activities tracks: Smart Grids and Green Data Centres.

DOLFIN keeps under observation following specifications for Smart Grids as expressed as technical artefacts around defined SGAM (Smart Grid Architecture Model) as detailed in ftp://ftp.cen.eu/EN/EuropeanStandardization/HotTopics/SmartGrids/First%20Set%20of%20Standards.pdf (section 10.1.1) with a current focus on:

- *EN 13321 series, EN 13757 1- 5- relevant for Metering Interfaces and Demand & Production flexibility*
- *EN 61968 (all parts) – relevant for aggregated market place systems*

Nevertheless standards listed are evaluated for contribution based on DOLFIN implementation progress.

Regarding Data Centres aspects it can be observed that topics related to Energy Management and protections are shared and applicable within peer domains such as telecommunications (e.g. EN 50600-2-4) and building automation (e.g. EN 50600-2-5). Currently CEN/CENELEC refers as relevant standard at European level: ETSI TS 105174-2-2. DOLFIN will observe potential domain related improvements and propose them to be included in relevant standards.

2.1.2. Green Grid Alliances

The Green Grid Association is a non-profit, open industry consortium of end users, policy makers, technology providers, facility architects, and utility companies that works to improve the resource efficiency of information technology and DCs throughout the world.

This body is relevant for DOLFIN regarding its work in agreed metrics area and energy management.

During last years the group has published a number of position papers focused on server energy management. The outcomes are published as recommending. Currently relevant ones for DOLFIN are:

- Recommendations For Measuring and Reporting Overall Data Center Efficiency Version 2 - Measuring PUE for Data Centers (May 2011) - See more at: http://www.thegreengrid.org/en/Global/Content/Regulatory-Activities/RecommendationsForMeasuringandReportingOverallDataCenterEfficiencyVersion2#sthash.n6DGjrtk.dpuf
- ENERGY STAR® for Computer Servers Version 2.0 Data Set Feedback and Recommendations (May 2013)

2.1.3. Joint Technical Committee (JTC) – JTC 1/SC 39

JTC 1/SC 39 is a joint subcommittee established between ISO (International Standard Organisation) and IEC (international Electrotechnical Commission) on “Sustainability for and by Information Technology”. It has developed drafts for metrics assessing energy efficiency of data centres. At the moment PUE (power usage effectiveness) metric standard is being developed.

This body is relevant for DOLFIN regarding its work in agreed metrics area and energy

2.1.4. ETSI Technical Committee “Environmental Engineering” (TCEE)

DOLFIN is targeting to contribute to Working Item (WI) for the standardization of the Green Abstraction Layer (GAL). GAL is an architectural interface/middleware that will give a flexible access to the power management capabilities of the future energy aware telecommunication nodes to effectively exploit the capability of adapting the energy consumption of the network nodes with respect to the load variations. It will provide:

- definitions of the power supply interfaces of all telecommunication equipment, installed in telecommunications centres, access network and in customer premises,
- and definitions of equipment practice for telecommunication equipment installed in telecommunication centres.

DOLFIN results in telecommunication equipment management towards energy efficient operations are very relevant to the objectives of the TCEE. DOLFIN members intend to follow and monitor TCEE activities.

2.1.5. ETSI Network Function Virtualisation

ETSI NFV has produced a number of standard specifications including:

- GS NFV-PER 001 Network Functions Virtualisation (NFV); NFV Performance & Portability Best Practises
- GS NFV 001 Network Functions Virtualisation (NFV); Use Cases
- GS NFV 002 Network Functions Virtualisation (NFV); Architectural Framework
- GS NFV 003 Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV
- GS NFV 004 Network Functions Virtualisation (NFV); Virtualisation Requirements
- GS NFV-PER 002 Network Functions Virtualisation (NFV); Proofs of Concepts; Framework

DOLFIN results in energy management concepts, energy control platform deployment, and interfaces would be provided to the ETSI NFV. UCL is following and monitoring ETSI NFV activities.

2.1.6. ETSI Mobile Edge Computing

ETSI Mobile-Edge Computing (MEC) initiative started at the end of 2014 and it offers application developers and content providers cloud-computing capabilities and an IT service environment at the edge of the mobile network. It has produced so far a white paper on the concept of Mobile-edge Computing and the related key market drivers, and to discuss the business, consumer and technical value/benefits that this technology offers. This white paper [3] discusses the enablers, the requirements and challenges including energy and resource efficiencies for Mobile-edge Computing.

DOLFIN results in energy management concepts, energy control platform deployment, and interfaces would be provided to the ETSI MEC. UCL is following and monitoring ETSI MEC activities.

2.1.7. ITU-T IMT-2020 Focus Group/SG13: Future 5G networking

ITU has established in 2015 a new Focus Group to identify the network standardization requirements for the '5G' development of International Mobile Telecommunications (IMT) for 2020 and beyond-

[3] ETSI MEC White Paper - https://portal.etsi.org/Portals/0/TBpages/MEC/Docs/Mobile-edge_Computing_-_Introductory_Technical_White_Paper_V1%2018-09-14.pdf

IMT2020[4]. The network studies are hosted by ITU's Standardization Sector (ITU-T), benefiting from the strength of ITU-T standardization in wireline communications. It aims at virtualisation of all 5G networking and servicing functions and system optimisations for all compute, networking and storage resources and facilities, inclusive of energy optimisation of 5G compute & connectivity infrastructure.

- ITU-T IMT2010- 1st Standardization group on 5G Networking in the areas of Overall 5G Networking architecture and 5G Network Softwarization functional area – ITU-T IMT2020 group http://www.itu.int/md/T13-SG13-151130-TD-PLEN-0208/en; Report on Gap Analysis (presented and accepted at SG13 meeting in December 2015): 1. "High Level Architecture" - 5G networking architecture (non-radio networks, software defined networks, clouds, devices) + 'gaps' (i.e. further work); 2. ''Network Softwarization" - 5G Network Softwarization functional area (definition, architecture, Integrated Network Management, Orchestration; Mobile Edge Computing; Distributed Cloud for Service Providers; In-network Processing; Resource Usage Optimization; Resource Abstraction; Migration towards softwarized networks, RAN Virtualization; Capability Exposure) + 'gaps' (i.e. further work) - http://itu.int/en/ITU-T/focusgroups/imt-2020/Documents/T13-SG13-151130-TD-PLEN-0208!!MSW-E.docx

DOLFIN results in energy information base concepts & energy control platform deployment were provided to the ITU-T IMT2020 FG / SG13 group.

UCL is contributing to this group in the areas of architecture and network softwarization.

2.1.8. ITU-T Future Networked Systems Group/SG13: Future networks including cloud computing, mobile and next-generation networks

ITU-T FN group has produced a number of reports which were approved by ITU-T as recommendations (e.g. standards) UCL acted as vice chair of ITU-T FN group.

- ITU-T Y.3001 Recommendation (Q4 2013) – "Future Networks: Objectives and Design Goals". This Recommendation describes objectives and design goals for Future Networks (FNs). This Recommendation assumes that the target timeframe for FNs fall approximately between 2015 and 2020. In the appendix, this Recommendation describes technologies elaborated in recent research efforts that are likely to be used as an enabling technology of each design goal. It is downloadable at: http://www.itu.int/rec/TREC-Y.3001-201105-I.
- ITU-T Y.3011 Recommendation (Q1 2014) – "New Framework of network virtualization for Future Networks". This Recommendation describes the framework of network virtualization for Future Networks (FNs). It is downloadable at: http://www.itu.int/rec/TREC-Y.3011-201201-I.
- ITU-T Y.3021 Recommendation (Q4 2014) – "New Framework of energy saving for Future Networks". This recommendation describes the framework of energy saving for Future Networks (FNs). It first presents the need for energy saving of networks themselves, and

[4] ITU-T IMT2020 Focus Group - http://www.itu.int/en/ITU-T/focusgroups/imt-2020/Pages/default.aspx

reviews potential technologies. The document then identifies major functions and their cyclic interactions, analyses possible impacts of introducing the technologies, and itemises the high-level requirements for introducing the technologies. It is downloadable at: http://www.itu.int/rec/T-REC-Y.3021-201201-I

- ITU-T Recommendation Y.3300 (2014) - Framework of software-defined networking https://www.itu.int/rec/T-REC-Y.3300-201406-I/en

DOLFIN results in energy information base concepts, energy control platform deployment, and interfaces with the Energy Efficient DC ecosystems were provided and are part of the ITU-T IMT2020 / SG13 group.

2.1.9. Ad hoc Working Groups

In this category we categorize Working Groups, which do not provide directly standards but recommendations instead. These groups include:

- ***DC Cluster Collaboration initiative,*** which constitutes an attempt of the EC to coordinate a group of eight (8) FP7 projects related to energy efficient, Green DC operation and DC-Smart Cities interaction. The goal of the DC Cluster Collaboration is to establish sets of well-defined metrics to render the quantification, evaluation and comparison of the projects' results feasible, from a combined technical and financial perspective.

- DOLFIN actively participates in the DC Cluster activities. Specifically, DOLFIN was involved in Task 1, assisting in the identifying of the already existing metrics and methodologies. DOLFIN also participated in analysing the energy metrics and methodologies and determining their limitations. Notably, DOLFIN (UCL) acted as one of main coordinator of this task 1 – an additional deliverable to the DoW contract was produced as common DC Cluster collaboration activity. Moreover, DOLFIN acted as both coordinator (SYN) and developing project (SYN, UCL, I2CAT) in Task 4 of the DC Cluster, being responsible for the determination of the measurement and verification plans of the metrics. Last, DOLFIN participates in Task 5 activities of the DC Cluster and will continue contributing to the already established measurement and verification methods of the DC-Cluster introduced KPIs in the context of Task 6.

- **The Green Grid (TGG).** The Green Grid (TGG) mission is to drive effective and accountable resource efficiency across the entire ICT ecosystem. The Data Centres (DCs) is a special area, which need to be highlighted. The DCs have changed considerably as the evolution of information technology has enabled it to become the critical nerve center of today's enterprise. As business demands increase, so does the number of DCs facilities which are running into resource limits related to power, cooling, and space, making the resource efficiency of DCs an important topic of discussion. As a global consortium comprised of end-users, policy-makers, technology providers, facility architects, and utility companies, The Green Grid aims to address this significant topic.

  DOLFIN is actively monitoring the TGG activities and SYN will participate in the TGG EMEA Forum 2014, on October 28 - 29, 2014 in Brussels, Belgium. The agenda will build on The Green Grid's "industry firsts" in several strategic areas, including work on the Data Center Maturity Model, Lifecycle of the Data Center, Utility and Resources, and ICT Benefits to Society and Environment.

- **The Smart Grid Stakeholder Group (SGSG)** has been established in June 2009 to create a liaison between the industry organisations involved in the evolution and roll out of the Smart Grid. The Group is open to all industry organisations who have or who intend to have an involvement in the Energy or ICT/Future Internet arena. This network is intended to be the forum to:
  - Share new technological, marketing, business and regulatory/standardization information in EC member states and worldwide
  - Make technological and market announcements targeting mutual benefit of the participants
  - Advance the mutual understanding between the energy and ICT industries on common challenges and technical/engineering solutions,
  - Form new cooperation / strong consortia for common research activities, including common or federated trial implementations,
  - Build strong alliances, e.g. for targeted standardization activities, and
  - Identify new mutual beneficiary business opportunities.

DOLFIN has been represented by SYN in the 10th SGSG meeting that took place on the 20th of May, 2014, and was co-located with the Smart Grids Week in Graz, Austria. The main focus has been to foster information, knowledge exchange and networking between the Smart Grid, energy production, distribution and consumption, and the ICT industry. SYN used the forum for information exchange between experts and champions in the related areas of interest that comprise energy efficiency and interfacing with the Smart Grid.

2.1.10. EUDCA - European Data Centres Association

The European Data Centre Association (EUDCA) (European Data Centre Association) has been formed by a group of DC industry professionals and companies in the 2011 and nowadays it has evolved into an international reference point for the DC industry throughout Europe. EUDCA has a clear mandate to be the voice of the European Data Centre Industry and to work with the European Commission initiatives as well as cross-border activities including legislation, Cloud networking, infrastructure and data protection. Among the participants of this association there are different European Data centre operator's companies like Telecity Group, Cofely, Lamba Hellix and Data4, but currently the activities of the association do not foresee the organization of conference or events.

DOLFIN consortium (SYN) has established very close collaboration with Lamba Hellix, one of the founding members of EUDCA, and will be invited in the next EUDCA events, as a candidate member.

2.1.11. CLIMA 2016

The 12th REHVA World Congress CLIMA 2016 (CLIMA 2016) will be held in Aalborg, Denmark in May 2016. This event is the leading International scientific congress in the field of HVAC (Heating, Ventilating and Air-Conditioning). The scope of the congress is to offer researchers, industry, building owners, engineers and policy-makers a platform for the exchange of scientific knowledge and experiences on innovative technical solutions and on practical applications.

The main topics of the 2016 edition are:

- Designing and building an energy efficient HVAC system.
- Sustainable energy for buildings

- Efficient HVAC Systems
- Smart building operation and management

The DOLFIN partner (SYN) is co-chairing the Topical Session 9 related to "Sustainable Energy for Data Centres" in the context of the EU Project Session and Workshop. Moreover, NXT and SYN will present the paper "An Energy Consumption Optimization Platform for Green Data Centres".

2.1.12. Data Cloud Congress

The Data Cloud Congress (Data Cloud Congress) is the Europe's largest DC and cloud congress and exhibition with more than 100 speakers, experts and enterprise infrastructure leaders that will join the two-day conference that will be held in Monaco on 8th and 9th of June 2016. The agenda will include keynotes, panel sessions and discussion sessions with an expected audience of 2000 delegates coming from over 60 countries across industry sectors including Cloud Service Providers, Fibre and Connectivity Owners and Operators, Power and Cooling Solutions Specialists. The Data Cloud Exhibition brings together power companies, infrastructure and connectivity leaders, data centre service firms, cooling specialists, European and global organizations, investors and government agencies.

2.1.13. DatacentreDynamics - Europe

DatacentreDymanics is a global Business to Business media and publishing company that develops products to help professionals in the ICT dependent organizations making risk-based infrastructure and capacity decisions. They operate in 42 different countries and organize live events, online and print publishing, business intelligence and professional development focusing on the complexities of technology convergence.

This year's event is "*Building the ZettaStructure*" (DatacenterDynamics) which is the name given to the physical layer of hardware, facilities and networks that extend beyond the traditional data centre environment. The event will be held in London on the 1st and 2nd of November 2016, coming from companies that run data centre-scale infrastructure and it will explore the 'borderlands' between physical infrastructure and the Software-Defined Data Centre. Though the event will take place after the end of the DOLFIN project, we consider it as one of the events with major potential impact. The agenda of the event, though not finalized yet, will cover different topics of great interest and relevance to DOLFIN scope. There is also the possibility to join the event for free as a "Qualified end-user Delegate" with full access to the conference programme until mid of September. It's worth mentioning that this event is not oriented towards the researchers or academia environment, but strictly to companies that own or operate DC infrastructure.

2.1.14. EU Eco-Management and Audit Scheme

The EU Eco-Management and Audit Scheme (EMAS) is a management instrument developed by the European Commission for companies and other organisations to evaluate, report, and improve their environmental performance. To help organisations to reach such objective, the JRC identifies, evaluates and documents best environmental management practices (BEMPs) for different sectors in close co-operation with the stakeholders concerned. To do so, the EMAS in conjunction with JRC follows the so-called frontrunner approach, i.e. it studies those techniques, measures or actions that are implemented by the organisations within the sector that are most advanced in terms of environmental performance in each of many areas, such as energy efficiency, resource efficiency, emissions, but also supply chain management. The results of this work are Sectorial Reference Documents (SRDs) on best environmental management practice.

In this context, SYN was invited to participate in the kick-off meeting for the preparation of the EMAS Sectorial Reference Document for identifying Best Environmental Management Practices in the Telecommunications and ICT services Sector, introducing the energy-efficiency related activities of both DOLFIN and the EC DC Cluster.

2.2. Open Source Solutions

The following are open source solutions for software defined infrastructures (networks, cloud services)

- Open Daylight – software defined infrastructure platforms that enable control and programmability http://www.opendaylight.org
- OpenStack - Open source software for building private and public clouds - http://www.openstack.org
- OPNFV - Open Platform for Network Function Virtualisation solutions https://www.opnfv.org/

DOLFIN system results which are open solutions in particular UCL's source solutions in energy management concepts and systems will be provided to the OPNFV and Open Daylight.

Conclusions

This deliverable presents the final results and activities performed for dissemination and standardisation of the DOLFIN consortium.

In the first chapter of the document we listed the dissemination channels, results and activities that consortium has carried during the life of the project and we presented a list of the main dissemination activities performed where we presented DOLFIN consortium's point of view.

During the life time of the consortium members have published:

• **4** white papers

• **1** transaction paper

• **1** Journal /magazine papers

• **15** conference papers

In the 2nd chapter we presented our standardization results and activities performed.

During the life time of the project the consortium members have:

• monitored the work progress in **19** relevant defacto / dejure SDOs Standard Organisations (SDOs) and open source projects

• actively participated in the activities of **4** relevant defacto / dejure SDOs

• contributed to **5** relevant published standard documents

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