SEVENTH FRAMEWORK PROGRAMME

Specific Targeted Research Project

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D7.5.2 Report on Cluster Activities M24

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TERMS AND ACRONYMS

AC	Activity Chain
ARM	Architecture Reference Model
DoW	Description-of-Work
FI	Future Internet
FIA	Future Internet Assembly
FinES	Future Internet Enterprise Systems
FI-PPP	Future Internet Public-Private Partnership
HID	Hierarchical Identifier
HTTP	Hypertext Transfer Protocol
ICO	Internet-Connected Objects
ICT	Information and Communication Technologies
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IERC	Research Cluster for the Internet of Things
IoT	Internet of Things
IoPTS	Internet of People Things and Services
IP	Integrated Project
IP	Internet Protocol
JXTA	Juxtapose
P2P	Peer-to-Peer
RFID	Radio Frequency Identification
SCE	Service Creation Environment
SME	Small Medium Enterprise
SSN	Semantic Sensor Networks
W3C	World Wide Web Consortium
VO	Virtual Object

1 INTRODUCTION

1.1 Scope

The OpenIoT project is committed to participating and contributing to EC clustering mechanisms, notably in the Research Cluster for the Internet-of-Things (IERC) (primarily) and in the cluster of Future Internet Enterprise Systems (FinES). The project's contributions to these clusters are an essential element of the project's dissemination and exploitation strategy, and therefore a critical task of the project's work plan as part of its dissemination/exploitation work package (i.e. WP7). Furthermore, the project aspires to contribute to the development of a pan-European approach for IoT systems and technologies, notably in terms of IoT and cloud computing convergence, which is among the core research topics of the project. OpenIoT's participation in IERC and FinES clusters is the main vehicle for contributing to such a pan-European approach.

The present deliverable illustrates OpenIoT's contribution to these clusters during the first two years of the project's lifetime (i.e., for the period December 2011-November 2013). The deliverable is therefore an enhanced version of deliverable D7.5.1, which reported on the project's cluster activities during the first year of OpenIoT's lifetime. Note that both deliverables (D7.5.1 and D7.5.2) constitute the annual releases of deliverable D7.5, which is a living document reporting on the cluster activities of the OpenIoT project. A third release of this living document will be provided at the end of the project and will include the full set of OpenIoT's contributions to European project clusters.

In general, during the second year of the OpenIoT project the partners have continued their active contributions to the IERC cluster and its activity chains as already planned and reported in deliverables D7.4 (dealing with the planning of OpenIoT's cluster activities) and D7.5.1 (which included some information about contributions planned for the second year of the OpenIoT project). Note that apart from actively contributing to the IERC cluster, OpenIoT has during its second year, been very actively involved in FIA (Future Internet Assembly) activities, which are also reported in the deliverable. However, the project has been less active in the FinES cluster, which is currently under a transformational stage towards Horizon 2020.

1.2 Audience

This deliverable targets the following readership:

- The members of the OpenIoT consortium, for which the document serves as a report of their main accomplishments in the first two years regarding clusters activities.

- The EC and the IERC/FinES cluster coordinators, who may use the document (as informative input) in order to audit the project's contributions to the relevant clusters.

- Other IERC projects, which could find in this document information about OpenIoT's contributions to the IERC.

- EU project researchers and engineers, who are interested in the detailed reports about FIA events and IERC cluster results.

1.3 Summary

As part of its dissemination and exploitation activities in WP7 of the project, OpenIoT has continued its participation and contribution to EC clustering mechanisms in the area of the Internet-of-Things. In particular, the project has committed to actively participate in the European Research Cluster on the Internet-of-Things (http://www.internet-of-things-research.eu/) (IERC cluster), which coordinates IoT related activities at the European level and pursues their convergence and consolidation towards a unified European approach. OpenIoT has been very active in the IERC, since it is involved in the coordination of two important activity chains, namely the second and fourth activity chains. At the same time, OpenIoT has been a very active contributor to Future Internet Assembly conferences.

This deliverable report on the project's participation and contribution to EC cluster mechanisms during the first two years of the project. It is therefore the second of a series of three annual reports, which describe how OpenIoT has participated and contributed to the IERC cluster, the FIA and the FinES during the three years of its lifetime. The deliverable is essentially an enhanced version of the report that has been provided in the first year of the project (D7.5.1), since it practically enriches this report with information about OpenIoT's cluster contributions during the second year of the projects' lifetime. The deliverable starts with a report on the project's contributions to the IERC cluster, where the individual contributions to the various activity chains are detailed. Following the presentation of OpenIoT's contributions to the IERC cluster, the deliverable reports the project's contributions to FinES and finally it ends up discussing contributions to the FIA.

In terms of specific contents, the deliverable enhances the earlier D7.5.1 along the following lines:

- It reports on OpenIoT's contributions to the IERC activity chains during the second year of the project (i.e., during the period December 2012-November 2013). Emphasis is given to the activities that were organized, coordinated and led by OpenIoT, which include the production of deliverables, the organization of meetings and the organization of workshops. Such activities were mostly part of activity chains AC2 and AC4, where OpenIoT serves as the coordinator.

- It report on OpenIoT's participation to recent IERC meetings i.e., general IERC meetings not bound to some specific ACs.

- It details OpenIoT's involvement (and active participation) in the organization of sessions during FIA 2013 in Dublin. In particular, the project organized two successful sessions, one on the IoT architecture and another on the business aspects of IoT.

- It provides an outlook on the project's cluster contributions during the third year of the project, through reporting activities that have already started and will be completed during the third year of the project. In this way, the project commits to its continued participation and contribution to IERC and FIA.

Note that the document reports collectively on all the contributions of the project since the start of the project. In this sense it subsumes deliverable D7.5.1 (i.e., the earlier version of this report).

1.4 Structure

This deliverable is structured as follows:

- **Section 2** is devoted to the description of the project's contribution to the IERC cluster. The reporting of the various contributions includes a detailed description of the project's participation in the various activity chains (AC). Special emphasis is put on the description of the activities within the activity chains where the project has a leading role (namely AC02 and AC04). Furthermore, a discussion of OpenIoT's participation to general IERC meetings is provided.

- **Section 3** focuses on the description of the project's contributions to the FinES cluster, notably in terms of participation in FinES meetings, where OpenIoT has delivered presentations. OpenIoT has also been contributing to a FinES publication. Note however that these contributions have taken place during the first year of the project, rather than during the second year.

- **Section 4** lists the project's contributions in the Future Internet Assembly conference, including details about the project's participation in FIA 2012 (in Aalborg, Denmark) and FIA 2013 (in Dublin, Ireland).

- **Section 5** is the final concluding section of the deliverable.

2 OPENIOT PARTICIPATION AND CONTRIBUTION TO THE IERC CLUSTER

2.1 Overview of OpenIoT Contributions to IERC

As already illustrated in Deliverables D7.4 and D7.5.1, OpenIoT employs several modalities in order to contribute to the IERC, including participation and contribution in IERC meetings, participation and contribution in the various activity chains of the IERC, coordination of activity chains (notably Activity Chain 2 (AC02), but partly Activity Chain 4 (AC04) as well), contribution to IERC documents and deliverables, contribution to the cluster's publications, bilateral collaborations with other IERC cluster projects, as well as organization of sessions and workshops. In the scope of the first two years of the project, most of these modalities have been substantiated. In particular, the project has been an active contributor to several activity chains and it has participated in several meetings (including general IERC meetings). Furthermore, OpenIoT has contributed to IERC-related publications, while it has also initiated bilateral collaborations with other projects. These activities are detailed in the following sections. It is noteworthy, that OpenIoT did not have the chance to participate in IERC meetings in Delft, Netherlands (February 06-08, 2013), given that these meetings had an overlap with OpenIoT's annual review/audit meeting with the European Commission and its experts in Brussels (held, February 8th, 2013).

2.2 OpenIoT in general IERC

OpenIoT is committed to participating in general IERC meetings. Such meetings are not bound to specific activity chains. They are however important meetings, since steering decisions concerning the individual activity chains are usually taken. During the second year of the OpenIoT's project lifetime, the project has participated in a number of such meetings as listed in the following table:

Table 1: Overview of OpenIoT's participation in general IERC Meetings

Date	Location	Scope / Summary
21/03/2013	Brussels, Belgium	This meeting was devoted to the introduction of IERC and its activities to new IoT/SmartCities projects, i.e. projects that were successfully evaluated as part of the FP7–SMARTCITIES–2013(ICT). Most of these projects will be joining several of the activity chains of the IERC. Thus, the meeting provided an excellent opportunity for OpenIoT to understand the objectives and scope of these projects in order to plan future collaborations as part of the IERC ACs, notably within AC2 and AC4 which are led by OpenIoT.
18/06/2013	Helsinki, Finland	This meeting included presentations from new potential members of the cluster, including presentation from smart city initiatives (beyond EC projects). Furthermore, a future roadmap concerning the activities of the various ACs was presented. This included the need for the production of a consultation paper by the IERC AC2, which is coordinated by OpenIoT.
13/09/2013	Zurich, Switzerland	This meeting discussed the status of the various Activity Chains and provided insights on the main outputs that are expected by IERC in the coming months in several areas (e.g., consultation documents, international collaborations such as EU-China and EU-Korea collaboration, open IoT platforms, liaison with FI-PPP projects, and more).
07/11/2013	Vilnius, Lithuania	This IERC meeting was co-located with the ICT 2013 event in Vilnius. Its main purpose was to discuss a roadmap and next steps for the production of the 2014 Strategic Research Agenda for the Internet-of-Things, which shall address the broadening of the IoT domain with research issues and outcomes from other areas such as cloud computing, smart microsystems and cyber physical systems. This was fully in-line with the scope of the IoT cross-objective in Horizon 2020.

As already outlined, participation in general IERC meetings was important in order to understand the overall direction of the IERC cluster, as well as the need and the way to consolidate results from multiple activity chains. Apart from steering of the work of individual ACs, IERC meetings provided opportunities for interactions across activity chains, but also for discussion of strategic research directions.

2.3 OpenIoT in IERC AC1

The first activity chain (AC1) (entitled «Architecture approaches and models») of the IERC plays an instrumental role in the IERC cluster given that it deals with the development of a reference IoT architecture, which shall be influencing both the architectures and several other technological developments of the rest of the IERC projects. Therefore, OpenIoT has closely followed the evolution of this activity chain through participating in all meetings as outlined below.

2.3.1 Participation and Contribution in Meetings

Within the first year of the project, OpenIoT has actively participated in all IERC AC1 meetings, which are summarized in Table 2.

Table 2: Overview of OpenIoT's participation in IERC AC01 Meetings

Date	Location	Scope / Summary
16/02/2012	Trento, Italy	This was the kick-off meeting of AC1, where the scope and goals of the activity chain were discussed. Furthermore, a number of IoT architectures (developed in IERC projects such as IoT-A, IoT@Work, iCore and SmartAgriFood) were presented.
10/09/2012	Brussels, Belgium	This meeting was devoted to the presentation of the IoT ARM (Architecture Reference Model), which was developed by the IoT-A project as a reference model that could be followed/adopted by other IoT projects. Along with a discussion on the ARM, it was agreed that all projects would audit the ARM, try to map/adapt their architecture, or use it as a blueprint for new architectures.
22/11/2012	Regensdorf, Switzerland	The aim of this meeting was to solicit IERC project's feedback on the structure and use of the ARM in the scope of the architecture development processes of the various projects. OpenIoT presented its overall assessment about the ARM, as well as how it has impacted the development of the OpenIoT architecture. Furthermore, the presentation included a more detailed mapping of functional groups of the ARM to building blocks of the OpenIoT architecture. As part of this mapping, OpenIoT has been auditing the completeness and generality of the reference model, while also providing insights into potentially missing pieces. At the same time, OpenIoT has provided comments on aspects of the ARM that could be enhanced (notably in terms of non-functional characteristics such as scalability and reliability). A detailed analysis of the relationship of the ARM to the OpenIoT architecture is also included in Deliverable D2.3.

Note that the above-listed meetings were held during the first year of the OpenIoT project. During the second year of OpenIoT, AC1 issues were mostly discussed during general IERC meetings, where a follow-up leadership scheme for IERC AC2 was also discussed. The reason for this was that the leading project in IERC (IOT-A) is concluding its activities within 2013, and therefore a follow-up scheme of architecture issues is currently under establishment.

2.3.2 Review and Alignment to the IERC AC1 / IoT-A ARM

In line with the architecture directions discussed in AC1 and the relevant action points agreed during the AC1 meetings, OpenIoT has performed a comparative analysis of its architecture (as detailed in Deliverables D2.2 and D2.3 of the project) with the ARM introduced by IoT-A. The full analysis is included in OpenIoT Deliverable D2.3. In a nutshell, this analysis has revealed the general alignment of several modules of the OpenIoT to the ARM, yet it has also underlined some structural deviations. Most importantly, OpenIoT has identified some missing pieces in the ARM, which would not allow the ARM to fully fulfil the project's needs/requirements. These missing pieces concern mainly the needs of OpenIoT to keep track of utility metrics for accounting, billing and (utility-driven) resource optimization purposes. Furthermore, OpenIoT has underlined the fact that the ARM could pay more emphasis on guidelines and best practices for scalability and reliability, given that these important topics were only marginally addressed by the ARM version reviewed by OpenIoT. The respective requirements and ideas have been communicated to the IoT-A team in order to be taken into account in the next iterations of the reference model.

2.3.3 Implementation of OpenIoT Architecture / IoT-A ARM

During the second year of its lifetime, the OpenIoT project has released an initial open source implementation of the OpenIoT architecture, which is an instantiation of the IoT-A's ARM. This implementation is available (as open source software with accompanying documentation) at: https://github.com/OpenIotOrg/openiot/ (see: https://github.com/OpenIotOrg/openiot/wiki/OpenIoT-Architecture for the architecture section). Apart from being an important milestone for the OpenIoT project, we strongly believe that this is a crucial milestone for IERC as well (and in particular for IERC AC1), since it provides a concrete implementation of the ARM, which is the major outcome/result of the first activity chain.

2.4 OpenIoT in IERC AC2

2.4.1 Coordination of the Activity Chain

Since the commencement of the OpenIoT project, the consortium has assumed the leadership and coordination of the second activity chain AC2 (titled: «Naming and addressing schemes - means of search and discovery»), dealing with naming, addressing and resource discovery in IoT. Due to its coordinating role, the project has allocated considerable effort in this activity chain, particularly in defining its scope

and target outcomes, as well as the expected project's contributions. During the first year of the project, AC2 has actively started its activities and already produced a first deliverable. OpenIoT has the leading role in the development of this deliverable, which will serve as valuable input to the next steps of the activity chain. As part of the coordination effort, OpenIoT has also been in charge of the organization and coordination of two physical AC2 meeting within the first two years of the project's lifetime, while it has also coordinated several audio-conferences (organized based on the WebEx facility). More detailed information on meetings, scope, and the produced deliverables of the activity chain (AC2) are provided in following paragraphs.

2.4.2 Identification of Contributing Projects

Given its coordinating role in the AC2, OpenIoT had first to identify the preliminary scope of the activity chain and accordingly to invite the various IERC projects to declare their interest and intention to contribute to the activity chain. The outcome of this process was the identification of ten (10) IERC projects, which declared their commitment to contribute to the activity chain. Note that some other IERC projects declared that they do not essentially perform research on IoT addressing and discovery (rather they are using existing/legacy schemes), and therefore did not have interest and made no commitment to contribute to the activity chain. There were also a few projects (including projects within and beyond IERC), which declared their interest to follow the developments of the activity chain as observers, without providing genuine research contributions. Overall, the task of identifying the AC2 contributors was important, since it paved the way for forming a committed team that could contribute to the target goals of the activity chain. Table 3 illustrates the (main) IERC contact list, which includes the AC2 representatives of all projects that contribute to the activity chain. The table includes the representatives of all ten contributor projects that were initially identified and committed to working on the IERC AC2 topics. At the same time, it also includes representatives of other projects that participate as observers in the activity chain, as well as the representative of the GAMBAS project who joined the effort at a later stage (i.e., following the commencement of the AC2 activities).

Table 3: List of IERC project's contact people for AC2

No.	Contact Point	E-mail	Project
1	Ovidiu Vermesan	Ovidiu.Vermesan@sintef.no	IERC Cluster Coordinator
2	Klaus Moessner	k.moessner@surrey.ac.uk	IoT.est
3	Christoph Thuemmler	C.Thuemmler@napier.ac.uk	MUNICH
4	Luis Muñoz	luis@tlmat.unican.es	SmartSantander
5	Richard Rees	r.rees@scanology.eu	CEN TC 225
6	Harald Sundmaeker	sundmaeker@atb-bremen.de	SmartAgriFood
7	Amine Houyou	amine.houyou@siemens.com	IoT@Work

8	Domenico Rotondi	Domenico.Rotondi@TXTGroup.com	IoT@Work
9	Septimiu Nechifor	septimiu.nechifor@siemens.com	iCORE
10	Martin Bauer	martin.bauer@neclab.eu	IOT-A
11	Antonio Skarmeta	skarmeta@um.es	IoT6
12	John Soldatos	jsol@ait.gr	OpenIoT
13	Stephen Pattenden	telemetra@telemetra.com	TAHI
14	Pedro Marron	pjmarron@uni-due.de	CONET
15	Claudio Pastrone	pastrone@ismb.it	ebbits
16	Francesco Sottile	sottile@ismb.it	BUTLER
17	Payam Barnaghi	p.barnaghi@surrey.ac.uk	IoT.est
18	Paul Chartier	paul.chartier@praxisconsultants.co.uk	CASAGRASS2
19	Patrick Guillemin	Patrick.Guillemin@etsi.org	CEN TC 225
20	Anthony Furness	anthony.furness@BTconnect.com	CASAGRASS2
21	Josiane Xavier Parreira	josiane.parreira@deri.org	GAMBAS

OpenIoT Deliverable D7.4 includes an initial description of the expected contributions of these projects to the second activity chain of the IERC. This information is not repeated/replicated in this deliverable. Note also that the above list of participants and contributing project is expected to be enriched during the third year of the project, when smart city projects (successful as part of the call SMARTCITIES–2013(ICT)) will be joining the Activity Chain.

2.4.3 Organization, Coordination and Contribution in Meetings

As already outlined, OpenIoT has had the leading role in the AC2 meetings, being actually in charge of their organization and coordination, in terms of agenda and goal setting, meeting moderation and preparation of meeting minutes and action points. Table 4 reviews the AC2 meetings organized and coordinated by OpenIoT. The table reviews (collectively) all the meetings, including meetings organized during the first year of the OpenIoT project, but also meetings organized during the second year.

Table 4: Organization and coordination of AC2 meetings

Date	Location	Scope / Summary
09/05/2012	Aalborg, Denmark (co-located with the FIA)	This was the kick-off meeting of AC2, where the scope and goals of the activity chain were discussed. Furthermore, most of the contributing projects (namely IoT-A, iCore, IoT.est, IoT6, BUTLER, ebbits, SmartAgriFood) gave presentations on their work and directions associated with the core topics of AC2, i.e., IoT naming, addressing and discovery. As part of this meeting's action points, the participating projects agreed to develop a catalogue of their IoT naming/addressing/

		discovery solutions in the form of a deliverable. Furthermore, they provided an outlook for future deliverables of the activity chain, which were to be more detailed following the completion of the first catalogues and taxonomy of the various schemes. Note that as part of the activity chain's future contributions it was agreed to produce a set of best practices for the optimal use/exploitation of legacy and emerging addressing/discovery schemes in IoT applications. These best practices would leverage the experience of the various projects from the actual/practical implementation of naming, addressing, and discovery solutions as part of their trials and validating applications.
18/12/2012	Teleconference / Virtual Meeting (WebEx facility)	The purpose of this virtual IERC AC2 meeting was to review the first (completed) deliverable of the activity chain, and accordingly to detail the next steps in terms of the production of addressing/discovery best practices, but also in terms of the development of a reference scheme for addressing/discovery (to complement the reference architecture of AC1). Note that this later direction emerged as a result of the coordination efforts between AC1 and AC2.
24/04/2013	Teleconference / Virtual Meeting (WebEx facility)	As part of this virtual meeting, the AC2 contributors have discussed the next steps in the planning of the activity chain, including the directions to be followed and the deliverables to be produced. It was agreed that a practical deliverable with concrete identification and naming use-cases/scenarios already implemented/integrated by the contributing projects should be produced. Furthermore, the participants planned the next IERC AC2 physical meeting, which was decided to take place during the IoT Week.
19/06/2013	Helsinki, Finland (co-located with the IoT Week, 2013)	As part of this meeting, three projects (IoT-A, IoT@Work, ebbits) provided detailed presentations of their identification and discovery activities. Other projects (e.g., OpenIoT, Iot.est) provided shorter updates of their activities. Furthermore, the structure of coming deliverables was discussed, along with the contents of a position paper of the AC2. The latter position paper was requested as part of the IERC steering meeting (in Helsinki) and it was aimed at consolidating and summarizing the outcomes of the IERC AC2 work so far. This position/consultation paper will serve as a basis for communicating IERC AC2 results to FI projects, but also to stakeholders of the international collaborations (such as the EU-China collaboration).

Note that for all the above meetings, OpenIoT has produced and distributed detailed meeting minutes including several action points for the project participants. The meeting minutes are available in the eRoom collaboration facility, which is provided and maintained by the IERC Coordinator (Ovidiu Vermesan from SINTEF).

2.5 Coordination and Authoring of Deliverables

2.5.1 Deliverable IERC-AC2-D1 («Catalogue of IoT Naming, Addressing and Discovery Schemes in IERC Projects»)

During the first year of the OpenIoT project's lifetime, the second activity chain of the IERC cluster has allocated significant efforts towards producing its first deliverable entitled: «Catalogue of IoT Naming, Addressing and Discovery Schemes in IERC Projects». The production of this deliverable was agreed on (among the participating projects) in the scope of the kick-off meeting of the activity chain, given that it was judged to be a first class opportunity to document and illustrate the different projects' directions and efforts in the area of IoT naming, addressing and discovery schemes. The production of the deliverable commenced in July 2012 and was completed end of 2012, with the active participation/contribution of eleven (11) projects (namely BUTLER, ebbits, GAMBAS, iCore, IOT-A, IoT6, IoT@Work, IoT.est, OpenIoT, SmartAgriFood, and CEN TC225). All the projects have presented their research efforts, while also illustrating their provisions for addressing migration, and scalability issues. The document has been also been publicly available on-line, since early 2013 [IERC-AC2-D1].

OpenIoT has played a major part in the production of this deliverable through undertaking a key role in the following activities:

• Structuring, editing, and quality control of the deliverable.

• Soliciting, collecting, formatting, and editing the projects' contributions.

• Analysing and comparing the contributions, while at the same time creating a taxonomy of the various naming, addressing, and discovery schemes.

• Identifying main issues that should be tackled in the scope of a reference addressing and discovery scheme, which is one of the future tasks of the activity chain.

• Providing the introductory and concluding sections of the deliverable.

Overall, this deliverable was a tangible result of the activity chain during the reporting period, which paved the ground for the chain's activities in 2013. OpenIoT has had the leading role in the production of this deliverable. The activity chain has planned the production of more deliverables in the forthcoming couple of years, which will focus on the documentation of best practices on IoT naming, addressing, and discovery, as well as on the specification of reference addressing and discovery schemes.

2.5.2 Position Paper on Identification and Discovery

During the second year of the project's lifetime, OpenIoT coordinated the production of a position paper on IoT naming, addressing, and discovery issues [IERC-AC2-PositionPaper-2013]. The paper reflected positions and viewpoints of the second activity chain (AC2) of the European Research Cluster on the Internet-of-Things (IERC). The positions of the activity chain are structured around the main challenges in IoT identification and discovery. In particular, the relevant challenges are first introduced and a set of appropriate solutions is accordingly presented based on the

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research and practical experiences of the individual IERC projects that contribute to AC2. Specifically, solutions and recommendations for globally unique identifiers, interoperability between different identification schemes, support of hierarchical identifiers, the semantic and contextual description of Internet-Connected objects, intelligent discovery and discovery of mobile objects are presented and discussed.

An early version of the position paper has been provided for the consultation among relevant stakeholders within and outside the EU (e.g., China) with a view to soliciting feedback and subsequently enhancing the scope and acceptance of the various positions/recommendations. Subsequent versions/releases of the position paper will take into account the results of this consultation process, involving interactions and reception of feedback from various stakeholder groups. Several additional releases are expected within 2014 and will be reported in the next annual version of the present OpenIoT deliverable (D7.5.3)

2.5.3 Future Plans – Outlook

The future plans of the activity chain include the completion of the position papers following the consultation process outlined above, along with the production of a new deliverable with practical naming, addressing and discovery use cases from each of the contributing projects. The members of the AC have also planned the production of best practices for the development and integration of versatile and dynamic solutions within IoT applications. Furthermore, more interactions and better alignment to the work of other activity chains will be pursued. This includes alignment to the IERC ARM (of AC1), but also to security and privacy efforts (based on discussions with AC5). In order to achieve these targets a number of meetings and tele-conferences will be organized in 2014 as well (including at least one physical meeting).

OpenIoT is committed to its leading role in the coordination of the activity chain, with a view to accomplishing the objectives mentioned above.

2.6 OpenIoT in IERC AC4

2.6.1 Joint Coordination of the Activity Chain

OpenIoT has been actively participating in the 4th activity chain (AC4) of the IERC (entitled «Service openness and interoperability issues/semantic interoperability»). The main objective of the IERC AC4 is to specify service openness and standardize interoperability issues when possible. Since standardization needs to ensure interoperability, AC4 not only addresses technological interoperability issues but also semantic interoperability capabilities. Semantics play an important role in OpenIoT, thus the OpenIoT consortium has allocated efforts on semantic interoperability within the scope of AC4. Recently, with the re-organization of activity chains within the IERC, and as result of the continued collaboration and active participation in this IERC activity chain, the OpenIoT project was nominated as co-leader and joint coordinator.

2.6.2 Organization and Contribution in Meetings

As part of the contributions and efforts in the IERC AC4, OpenIoT has been in charge of the co-organization and joint coordination of the AC4 meetings and workshops within the first year of the project's lifetime. The next meeting of the activity chain has also been scheduled for the first quarter of the second year of the project's lifetime. Table 5 reports the three meetings and workshops that have been organized after the IERC AC4 kick-off meeting in Poznan, Poland on 28/10/2012. Table 5 moreover includes the next AC4 meeting plan, which is scheduled for the next reporting period.

Table 5: Organization and Coordination of AC4 meetings

Date	Location	Scope / Summary
26/03/2012	Paris, France (co-located with 1st CoAP Plugtest and PROBEIoT)	After the IERC AC4 kick-off meeting in Poznan, Poland on 28/10/2012, the IERC AC4 ran a one-day workshop on March 26th 2012 in Paris, France. It was co-located with the PROBEIoT project meeting. Short presentations of the AC4 project participants were followed by open discussions to identify challenges on service openness and interoperability issues.
19-20/06/2012	Venice, Italy (co-located with IoTWeek 2012)	This event was a two-day meeting and hands-on workshop co-located with the IoTWeek with the following main objectives: Day 1: Discussions and two plenary talks "**ETSI M2M and the Needs for Semantics**" "**W3C Semantic Sensor Networks: Ontologies, Applications, and Future Directions**" • Follow up on IERC AC4 activities related to service openness and interoperability. • Introduce the relevant activities of contributor EU projects. • Discuss specific IoT data and semantics interoperability methods. • Specify the main outcomes in the period 2012-2014, i.e., ontologies, white papers etc. • Agree on dates for next meetings. Day 2: Hands-on Session / Workshop • Review of contributions received for 2012 IERC AC4 manifesto / white paper / deliverables. • Review of content and ToC for contributions. • Define some methods, procedures and operational tools (i.e., web repository, wiki page) to collect and share all the semantic interoperability information for the white paper / manifesto.
22-23/10/2012	Mandelieu, France (co-located	This event was a two-day workshop including tutorials focused on semantic modelling, knowledge representation and ontology engineering for the IoT domain.

	with the 4th ETSI M2M Workshop)	The first session (Day 1): Tutorial 1, designing semantic models for IoT. In this tutorial the participants reviewed the state of the art in research and development on IoT-related ontology engineering. They also discussed the methods for concept modelling and knowledge representation for the IoT domain and some best practices in ontology engineering.
		The second session (Day 2): Tutorial 2, a hands-on experience on semantics for resource gateway interaction and semantic model interoperability focused on practical ontology design and processing. In particular, the session introduced some useful tools for ontology engineering, compatibility checking, processing, and visualisation.
		The third session (Day 2): Tutorial 3, semantic technologies for IoT (presented to ETSI M2M participants) which was focused on providing the basics on ontologies (e.g., theoretical foundations and their languages), ontology query and reasoning, Linked Data, IoT domain modelling methods, and the challenges to support IoT resource and service discovery.
15/04/2013	Guilford, United Kingdom (co-locatd with the 19th European Wireless Conference EW 2013)	This time participants and delegates from flagship EU projects on IoT and attendees ran a full day event focused on practical issues about ontology matching and sensor data processing/collection and addressing interoperability issues for distributed sensor data environments, with discussions on semantics, interoperability and data exchange. As in previous IERC AC4 editions the contributions and outcomes from the meeting are included in the IERC-AC4 manifesto/white paper on Semantic Interoperability. OpenIoT and other flagship EU projects on IoT attendees had a full day event focused on practical issues about ontology matching and sensor data processing/collection and addressing interoperability issues for distributed sensor data environments, with discussions on semantics, interoperability and data exchange. (http://www.probe-it.eu/?p=1305).
17-20/06/2013	Helsinki, Finland Co-located with IoT-Week 2013	This workshop focused on various parallel and inter-related interoperability challenges, and presented the status of the IERC activity chain 4 on interoperability. Further, semantic interoperability activities were presented which are of specific interest to many communities. Future visions and action plans were addressed, in particular for 2014 aiming towards horizontality of interoperability across active projects within IERC projects portfolio and beyond.
18/06/2013	IERC-AC4 Webinar (organised under aegis of the EU under	A Webinar organised under the aegis of the European Commission by the EuroAfrica-ICT/P8 Project (KICTB, Kenya with the support of Sigma Orionis, France and CSIR, South Africa) and in collaboration with the Probe-IT Project was running, the webinar main objectives were to:

	EuroAfrica-ICT/P8, 2013)	• Raise awareness on Africa-EU ICT cooperation opportunities within the Horizon 2020 EU (European Union) Research Programme. • Enhance the participation of African organisations in EU-funded collaborative research projects. • Highlight the range and excellence of ICT research in Africa. • Provide a forum for discussion and debates on recent developments and perspectives in the field. • Provide inputs and follow-up on joint Africa-EU R&D/ICT priorities, opportunities, and challenges. • Support the EC (European Commission) and the AUC (African Union Commission) in identifying possible impediments to fostering cooperation between the two regions and find the right means to overcome them. • Enhance the development of Africa-EU collaborative ICT research projects and identify potential African partners. In the framework of this webinar, OepnIoT, Probe-IT and IoT.est, organised two presentations on IoT and Semantic Interoperability tools. Participation was open and profiled to experts in ontologies, semantic web technologies, data modelling, and knowledge engineering.

2.6.3 Coordination and Authoring of Deliverables

OpenIoT continues allocating efforts and playing a coordinating role in the AC4 document generation. The planned IERC AC4 planned documents for 2013 have been release and a second version is already in process for one of them.

The documents reflect a set of visionary perspectives and best practices on semantics and interoperability representing the European Approach. OpenIoT has leading efforts to coordinate and author these IERC-AC4 deliverables:

• **IERC-AC4-D1 «Catalogue of existing IoT projects focusing on interoperability».** This document shall briefly review the state of the art in IoT approaches, with references and focus on semantic interoperability. This document will also present the interoperability schemes used by the IERC projects contributing to the fourth activity chain.

• IERC–AC4 Manifesto release

OpenIoT as co-leader in the IERC-AC4 on interoperability announced the release of the first version of the document called: Semantic Interoperability: Research Challenges, Best Practices, Solutions and Next Steps - IERC AC4 Manifesto [IERC-AC4-Manifesto-2013]. The document is the result of approximately 18 months collective discussion under coordination of Probe-IT (P.Cousin), OpenIoT (M.Serrano) and IoTest (P.Barnaghi). In this document recent trends and challenges on interoperability are discussed. This document also explained the growing importance of semantic web and their technologies, frameworks

and information models for supporting data interoperability. Examples on how IoT is taken as a reference example in enterprise applications and services, and the importance of the economic dimension is considered in this first release of the IERC AC4 Manifesto download file: available at http://openiot.eu/?q=node/124. A version 2 of this document is under preparation as well as a short summary and recommendations towards a position paper for the end of the year.

- **IERC-AC4-D2 «Best practices in semantic interoperability for the IoT»** This document shall contain best practices on semantic interoperability in IoT addressed within current European and other international projects, while also providing insights into possible standard practices reflecting the European approach to interoperability.

- IERC–AC4 White Paper (In progress)

OpenIoT has allocated significant efforts towards producing the white paper stemming from the fourth activity chain of the IERC cluster. The production of this deliverable in the form of a White paper was agreed on among the participating projects and it represents an opportunity to document and illustrate the different projects' directions, best practices, and efforts in the area of IoT focused on standardization and interoperability.

The production of the deliverables commenced in June 2013 just after the IoT Week 2013 in Helsinki and is planned to be finished in early 2014, to be officially presented in the Future Internet Assembly in May 2014. Active participation/contributions of eleven (11) projects (namely PROBEIoT, OpenIoT, IoT.est, GAMBAS, BUTTLER, IoT6, IoT@Work, ebbits, iCore and SmartAgriFood), five (5) IoT initiatives (IoT Council, IoT Forum, EU-China, EU-Korea, EU-Japan) and four external liaison projects (ISN, WOT, ETSI M2m and W3C SSN-XG). All the projects have presented their research efforts and experiences illustrating their provisions on semantic interoperability best practices.

OpenIoT is playing a major role in the production of this deliverable (IERC Ac4 White paper), through undertaking a key role in the edition of this document.

2.6.4 Future Plans

IERC AC4 will deliver further deliverables with best practices for the implementation of practical IoT semantic interoperability. The Activity Chain 4 (AC4) will continue organizing meetings, workshops and tutorials. OpenIoT will therefore continue its leading role in the joint coordination of the activity chain.

2.7 OpenIoT in IERC AC5

2.7.1 Participation and Contribution in Meetings

OpenIoT contributes to the fifth activity chain of the IERC AC5 (entitled «Governance, Privacy and Security issues») on the basis of its utility-driven security and privacy schemes for IoT. During the reporting period, OpenIoT has participated in one meeting organized by IERC AC5 during the IoT Week in Venice. The details are provided in Table 6 below.

Table 6: Overview of OpenIoT's participation in IERC AC05 Meetings

Date	Location	Scope / Summary
20/06/2012	Venice, Italy (co-located with IoT Week 2012)	OpenIoT participated in the AC5 workshop on IoT security and privacy, where it presented the project's approach towards controlling privacy leakage at the user level. The project's approach involves: (a) monitoring data leakage and environmental semantics, (b) quantifying privacy leakage and associated risks (that impact on user utility) and (c) adjusting privacy enabling mechanisms accordingly.

OpenIoT has not participated in AC5 face-to-face meetings in 2013, mainly due to the overlap of its annual review with the meeting organized in Delft, Netherlands in February 2013. However, several interactions between AC2, AC4, and AC5 have been established in order to align the results of the three activity chains. OpenIoT has acted as a catalyst for these interactions, mainly due to its leading/coordinating role in 2013.

OpenIoT has also contributed to producing the white paper on "Governance, Privacy and Security for the IoT" as part of the fifth activity chain of the IERC cluster. The production of this deliverable correspond of one of the white papers the IERC is planning to release in early 2014 as part of the blueprint documents containing the different aspects for the IoT domain emanating from EU-ICT IoT flagship projects.

2.8 OpenIoT in other IERC Activity Chains

OpenIoT has declared its interest and availability to participate in other IERC activity chains as well. As illustrated in Deliverable D7.4, the project has in particular appointed contact points for AC7 (Cluster support), AC8 (Link to Future Internet initiatives), AC9 (National cluster liaison), AC10 (International co-operation), AC11 (Application scenarios and Pilots) and AC12 (Dissemination activities), yet activity in these ACs has been low in the scope of the reporting period. Note that as of September 2012, a rearrangement of activity chains has been introduced, which in addition to AC1, AC2, AC3, AC4 and AC5 (which remain unchanged) focuses on the following (new/updated) ACs:

- AC6 - Standardisation and pre-regulatory research.
- AC7 - IoT-enabling technologies.
- AC8 - Cognitive technologies for IoT.

OpenIoT does not plan to contribute to these ACs, since it has strategically focused on the chains presented in the previous paragraphs. Nevertheless, the project will endeavour to communicate standards-related developments performed in the project or within the ACs which are coordinated by the project, to the sixth activity chain (AC6).

2.9 Contribution to Joint Documents, Deliverables and Cluster Publications

During the reporting period, OpenIoT has been both a contributor and a reviewer of the IoT Strategic Research Agenda (SRA) for 2012, which was developed in the scope of the IoT-I project (notably as part of its D1.3 deliverable). In the scope of the SRA, OpenIoT has contributed to the research topics associated with the IoT/cloud convergence, as well as on topics associated with the use of social networks and social media in conjunction with IoT. At the same time, the project has reviewed the section relating to next generation sensor-driven business process management.

In addition to contributing to the SRA, OpenIoT has been regularly providing inputs to the IERC newsletters.

OpenIoT has provided inputs to the IoT Strategic Research Agenda for 2014, including contributions highlighting the pertinence and interrelationships of IoT to other fields such as cloud computing and cyber-physical systems.

OpenIoT partners published major contributions In IERC, IoT Cluster Book 2013. Under the editorship of Philippe Cousin, Probe-IT Project Manager, Martin Serrano, OpenIoT Project Manager, Payam Barnagui, IoT.est Project Manager, key partners of Uninova and University of Rennes II have made major contribution to "IoT Interoperability" in publishing a full chapter in the yearly successful IoT Cluster Book 2013. The chapter is called "Simpler IoT word(s) of tomorrow, more interoperability challenges to cope today.

The IoT Cluster Book 2013 book aims to provide a broad overview of various topics of the Internet of Things (IoT) from the research and development priorities to enabling technologies, architecture, security, privacy, interoperability and industrial applications. It is intended to be a standalone book in a series that covers the Internet of Things activities of the IERC Internet of Things European Research Cluster from technology to international cooperation and the global "state of play". The book builds on the ideas put forward by the European research Cluster on the Internet of Things Strategic Research Agenda and presents global views and state of the art results on the challenges facing the research, development and deployment of IoT at the global level. The book and the IERC AC4 contributions can be download via free online access http://www.riverpublishers.com/view_details.php?book_id=176

2.10 Bilateral Collaboration with other (IERC) Projects

2.10.1 IoT6 / OpenIoT Exchange of GSN Libraries

As result of the direct interaction between IoT6 and OpenIoT project members in the framework of semantic interoperability research activities, an early collaboration emerged. OpenIoT uses GSN as the assigned Global Sensor Network technology platform, in which project members, have extensive experience in defining application programming interfaces (APIs). IoT6 was facing the problem of finding an adequate solution for implementing the constrained application protocol (CoAP) for GSN. OpenIoT provided the experience and the developed module for the Virtual Sensor XML package that satisfied this requirement.

2.10.2 GAMBAS / OpenIoT Collaboration on SSN Interfaces

OpenIoT has adopted SSN-XG as the ontology that describes the sensor data and makes the information accessible in a standard format (RDF). Today's information is accessed via the Web which requires persons to memorize long URLs, click through web pages or browse through search results. The GAMBAS project is looking for standard modules to get services providing distraction-free support. To realize this vision, services themselves must adapt to the user's situation, behaviour and intents at runtime. This requires services to gather and process the user's context. In particular, it is necessary to have models and infrastructures to support the interoperable representation and scalable processing of contextual information. OpenIoT provided the developed SSN interfaces that could support the collection of such context information.

2.11 EU-China Collaboration – International Collaborations

As already outlined, work and results of the IERC AC2 activity chain formed the basis for initial discussions and exchange of viewpoints between EU and Chinese experts as part of the respective international collaboration. To this end, the two parties (and corresponding groups of experts) have exchanged documents and position papers on naming, addressing and discovery issues. These issues will be discussed in the scope of follow-up audio-conferences to be held late 2013 (i.e., December 2013) and in 2014. OpenIoT has played an important role in these discussions, as a result of its leading role in activity chain 2 and the production of relevant position papers and deliverables. OpenIoT expects/plans to continue this consultation process (as part of the international collaboration) also in 2014.

Apart from contributing to the EU-China international collaboration, OpenIoT (through its Australian partner CSIRO) has offered to initiate a possible EU-Australia collaboration in IoT issues. To this end, OpenIoT has been discussing with the leadership of international collaborations within IERC, the pre-requisites and possible next steps for setting up such a collaboration.

2.12 OpenIoT Participation and Contribution to the FiNES Cluster

2.12.1 Overview of OpenIoT Contribution to FInES

OpenIoT contributes to FInES in the technology domain, Internet-of-Things being an important enabling technology for a variety of application domains, in particular The Sensing Enterprise. OpenIoT collaborates with FInES for mapping all IERC and IoT-related FInES projects with regards to their functionality/product and application/market focus.

OpenIoT aims to coincide with the following FInES roadmap topics:

- 2.4 Enterprise 2.0

- 3.19 Smart Objects Exploitation

The OpenIoT Architecture addresses the following FInES research challenges:

- 1 Unified Digital Enterprise

- 8 Autonomic Computing Components and Subsystems

2.12.2 Participation in Meetings

During the annual period covered by the present version of the D7.5 deliverable, OpenIoT has participated in two FinES meetings as described in Table 7.

Table 7: OpenIoT's participation in FinES Meetings

Date	Location	Scope / Summary
09/05/12	Aalborg, Denmark	At this meeting, OpenIoT presented an overview of the project, its architecture and how it contributes to the FInES roadmap and research challenges.
12/10/12	Brussels, Belgium	At this meeting, OpenIoT presented preliminary results from the SME survey, in particular assumed reasons/challenges for using the Internet-of-Things in the future. Two of the OpenIoT use cases were introduced and further exemplified under the headings Smarter Manufacturing and Smarter Agriculture. There were 50 participants, including the coordinator of FP7 Objective 1.3 Digital Enterprise.

In both meetings, OpenIoT delivered presentations which were related to the core research topics of the OpenIoT project. The abstracts of these presentations (as submitted/provided to the FinES meetings organizers) are listed in the following tables (Table 8 and Table 9).

OpenIoT has also capitalized on its presence in the scope of the second (of the listed) FinES meetings in order to attempt to map the business focus of IERC and

FInES projects in product and market dimensions. The objective of this effort is to identify complementarities between the various projects, along with possible synergies from overlaps. As part of this task, OpenIoT has distributed a survey on paper and electronically to all FInES/IERC projects starting with the meeting participants. The survey was also announced in the OpenIoT presentation at the FinES meeting in Brussels. The mapping framework with indications for OpenIoT is given in Appendix I.

Table 8: OpenIoT's Presentation in the FinES Panel «The Sensing Enterprise»

(May 9, 2012, Aalborg, Denmark, co-Located with the FIA Meetings)

FInES Workshop: "*Translating Knowledge into Growth: Views from ICT Research to Support Future Business Competitiveness*".
State-of-the-art IoT systems could facilitate enterprises to sense the status of their surrounding environments and accordingly to use the sensed information in order to track and trace tangible and intangible assets. On this basis, they can essentially help enterprises to adapt to regulatory requirements, as well as to measure business value and utility. As a result, more and more enterprises are seeking to adopt robust IoT infrastructures, which could be flexibly integrated with enterprise systems (such as ERP and MRP systems). In the scope of this presentation, we will introduce the goals and technical capabilities to be developed in the scope of the FP7 OpenIoT project, which produces an open source middleware infrastructure enabling utility-driven access to a multitude of IoT resources (including both physical and virtual sensors and Internet-connected objects). The presentation will emphasize on the merits of the OpenIoT infrastructure, which relies on: (a) its ability to define, represent, integrate and link virtual sensing devices (such as fusion information stemming from multiple devices, as well as information from social networks, (b) the measurement and metering of utility, which can be a key element in the scope of billing, accounting and resource management of Future Enterprise Systems, (c) the provision of support for intelligent selection and combination of sensors for a given sensing process, based on reasoning over large sets of sensors that could be used to deliver value to an enterprise, and (d) its open source nature that could empower its exploitation by enterprise seeking open solutions at a fair Total Cost of Ownership (TCO). The presentation will also discuss the main building blocks of OpenIoT, including the popular Global Sensor Networks (GSN) middleware, the W3C Semantic Sensor Networks ontology, the use of sensor information as Open Linked Data, as well as a range of utility-based algorithms. A key characteristic of OpenIoT is its integration with popular cloud infrastructures, for the purpose of hosting and managing the sensed data and accordingly delivering them to enterprise systems. The talk will conclude with a discussion of use cases that have motivated the development of OpenIoT in the areas of smart cities systems, manufacturing applications and large scale e-science experiments.

Table 9: OpenIoT's Presentation in the FInES «Sensing Enterprise session»

October 12, 2012, Belgium (hosted by the European Commission DG CONNECT Unit E3 Net Innovation at Avenue de Beaulieu 25, Room 0/S1, 1160 Brussels)

FInES Cluster Meeting
The OpenIoT project focuses on providing an open source middleware framework enabling the dynamic formulation of service requests in self-managed cloud environments for IoT applications. OpenIoT therefore contributes to the Enabling Technology Space of FInES. The OpenIoT middleware framework will serve as a blueprint for non-trivial IoT applications, including the Sensing Enterprise (Quality-of-Being 5 in the FInES roadmap v3.0).
The OpenIoT manufacturing application area addresses the Sensing Enterprise from an industrial perspective. OpenIoT will be a key enabler for reactive enterprises by supporting emerging very large-scale sensor deployments in typical industrial plants that streams huge amounts of sensor data that needs to be analysed both in real-time and in back-office "big data" analysis. OpenIoT will allow complex queries on the sensor data without programming for quickly appearing analysis needs, or alternatively to provide the data needed by enterprise systems.
OpenIoT will be fully cloud-based, enabling easy and flexible deployment. Its open source nature will enable wide adoption and a transformative change towards Enterprise 2.0 (FInES topic T2.4) and Smart Objects Exploitation (FInES topic 3.19). The presentation will introduce the aims of the OpenIoT project and highlight how it will be applied in the manufacturing domain. The OpenIoT architecture will be briefly presented, and its possible connection to FInES Research Challenges 1 Unified Digital Enterprise and 8 Autonomic Computing Components and Subsystems will be explored.

2.12.3 Contribution in FinES Publications

As part of its contribution to the FinES cluster, OpenIoT plans to contribute to the publications of the cluster. This effort has already started on the basis of an OpenIoT book chapter, which has been included in the 2012 Cluster Book. The abstract of the proposal (and the book chapter) is presented in Table 10. Note that the preparation of the book chapter was completed in July 2012. OpenIoT plans to contribute to future publications of the FinES cluster as well.

Table 10: Abstract of OpenIoT chapter in the FinES 2012 Book

The deployment and provisioning of utility-driven services (such as "Sensing-as-a-Service", "Location-as-a-Service", "Traceability-as-a-Service") will greatly benefit from a cloud-based open middleware framework, which could be deployed over multiple infrastructure providers (such as smart cities, municipalities and private enterprises) in order to deliver on-demand access to Internet-of-Things (IoT) devices and services. This paper introduces advances towards the formulation of an open source integrated solution for Internet-of-Things into the cloud, providing design principles

for cloud enterprise environments and best management practices for the converging utility-driven IoT infrastructures. This paper also presents the architectural components of a framework, which emphasizes on-demand establishment of IoT cloud-based services based on the automated formulation of Internet-connected objects. The framework introduced is founded on the widely used GSN infrastructure. The framework leverages standards, notably the W3C Semantic Sensor Networks (SSN-XG) ontology and the IETF COAP protocol, providing support for enabling intelligent (sensors/devices) services search, discovery and use. The service requirements from analysing the state of the art and efforts towards the convergence of cloud computing and IoT are also introduced and discussed.

2.12.4 Future Plans

During the first year of its lifetime, OpenIoT has actively contributed in the FinES cluster, notably in terms of issues relating to the Sensing Enterprise, but also in terms of the wider use of IoT systems and platforms to the wider topic of future enterprise systems. In addition to its emphasis on cloud-based IoT systems, OpenIoT focuses also on the convergence of IoT with utility computing through researching utility metrics and utility-driven mechanisms for resource optimization, security, and privacy.

Following OpenIoT's participation in the October 2012 meeting of the cluster, the OpenIoT project has fostered liaison and links with FinES projects, as part of the attempted mapping of the projects' goals to product and market dimensions. This mapping has served as a starting point for the collaboration of OpenIoT with other FinES projects. As such it is another factor reinforcing the project's participation and contributions to the FinES cluster.

The liaisons of the OpenIoT project with FinES projects, notably FI-PPP projects, are deemed important for the community building efforts of OpenIoT. In particular, FI-PPP projects and their participants are candidates for integrating and reusing OpenIoT's open source components.

During 2013, OpenIoT has not participated in FinES meetings, given also the transformation of the cluster and the cessation of its activities in the previous forms. However, it has started capitalizing on links and contacts to FinES cluster projects as an opportunity of attracting users and contributors to the OpenIoT open source developments. An example of such a collaboration relates to the linking/liaison with the FITMAN project, which has taken into account several of the OpenIoT open source developments (such as the X-GSN project).

Another catalyser for the OpenIoT results and for establishing new links and contacts is the RFID in Europe community where OpenIoT has started participation by attending the RFID in Europe event. Particularly RFID Research Session where OpenIoT was presented amongst the latest research topics in RFID that affect the business and manufacturing industry. **RFID in Europe London 2013** took place on October 15th 2013 as a co-hosted event with **RFID Journal LIVE! Europe.**

The goal of RFID in Europe is to promote the adoption of RFID and related technology solutions, and to connect with European end-users, operators, solution providers, universities, research establishments, government and non-government organization.

3 OPENIOT PARTICIPATION AND CONTRIBUTION TO THE FIA

3.1 Participation and Presentations in FIA Events

3.1.1 FIA, Aalborg, Denmark (May 2012)

In the scope of the FIA in Aalborg (May, 2012), OpenIoT has participated (based on a short presentation) in the standardization session. OpenIoT's presentation has emphasized the potential standardization contributions of the project, which concern the reuse and extension of the W3C SSN ontology and related techniques, but also the pursuit of *de facto* open source software based standardization through the OpenIoT open source software project.

The OpenIoT consortium co-located a project meeting at FIA Aalborg, bringing the opportunities to other communities beyond the IoT to learn the objectives and observe the progress of the project. Moreover, OpenIoT partners had the opportunity to interact directly with other active communities for having a broader view on research trends and other project perspectives within the IoT domain and beyond. The project meeting was scheduled as a two-day meeting. The first day was aimed at presenting and monitoring the progress of the project. During the second day, OpenIoT use cases were discussed aiming for a clearer understanding and discussion towards upcoming project realizations (testbed, demos, etc).

3.1.2 FIA, Dublin, Ireland (May 2013) (John, Martin, Johan, Reinhard)

As part of its participation in FIA meetings, OpenIoT proposed the organization of two sessions, which were subject to the normal voting process for selecting FIA sessions. The two sessions were selected.

The first session of OpenIoT was entitled «IoT Architecture as an element of the FI Architecture». The goal of the session was to investigate IoT architectures as building blocks of the emerging FI architectures. The aim was to discuss different IoT architecture proposals, along with how they interface to other elements of the FI architectures and/or «Open Source Software Practices» and/or «IoT Business Models». It was also within the objectives of the session to discuss the advantages of open source solutions and the challenges and new business opportunities on emerging IoT research areas.

The second session that was proposed by OpenIoT was entitled «Where is the business in the Internet-of-Things?». Its main goal was to investigate business models associated with IoT application and services, but also to identify the stakeholders engaged in the realization of these business models.

OpenIoT contributed also articles in the FIA Book 2013, with emphasis on semantics for IoT, but also architectures and building blocks for IoT/cloud convergence.

In the sequel we provide more detailed information and reports about the OpenIoT FIA 2013 activities and presence.

3.1.2.1 Report on OpenIoT FIA 2013 Session «IoT Architecture as an element of the FI Architecture»

3.1.2.1.1 Purpose & Audience

This session had the following main objectives:

(a) To present the state-of-the-art on Internet of Things Architectures (and their implementation), including efforts undertaken in the European Research Cluster on the Internet of Things (IERC cluster), the standardization bodies and the open source community.

(b) To explore the practicality and the merit of holistic integrated IoT architectures and to compare their potential with the wide range of ad-hoc silo architectures that are currently developed to serve specific applications.

(c) To identify the next steps in the development of IoT architectures, with emphasis on solutions that will facilitate the development of Internet-of-Things solutions useful and their integration to the emerging Future Internet Architecture(s).

The session addressed researchers, engineering and project/programme managers working on IoT systems and solutions, along with services developers, integrators and solutions providers of both IoT applications and web-based applications.

3.1.2.1.2 Summary of the Session

The IoT architectures session at FIA Dublin was organised in a dynamic and interactive form with the participants. The main topics were divided in sessions by presenting expert visions with the objective to start open discussions in this session. The focused areas were 1) IoT Solutions and Open Source vision: To introduce the IoT Architectures Open Source concept to people working on other parts of the Future Internet. 2) Standardisation and Working Groups Interconnection: To identify interconnections between Standardisation Activities and specialized working groups and with other parts of the Future Internet community and its stakeholders. 3) IoT architecture-realization and next steps: IoT architectures and technologies for planning of next steps and input preparation for designing the Future Internet.

Some relevant quotes from this session are:

There is no single Internet of Things, which means that although main IoT principles could be common, there are some specific needs to be tackled. More and more the smart objects are becoming just a small part of the whole picture, and the relevance will be on the services and applications.

Much of the work on IoT has been centred on sensors and the networking or connectivity (i.e., the infrastructure) but several new areas are emerging, such as the Identity, Naming and Discovery of the things. Additionally, any object is being able to be a source of information enabling the IoT, but in the context of an Internet of Services, further research attention is also needed.

Smart phone mobility is becoming more the catalyst for the growing of the IoT and that means that it is being seen as an extension of the paradigm of E2E services of the initial Internet.

This session gave academic participants, IoT stakeholders and the general audience the opportunity to express their views and solicit from the experts their opinion on these and other related IoT issues.

3.1.2.1.3 Key message(s) of the session

Key messages resulting from the session include the following:

- For IoT to go mainstream, the IoT community should provide the means (i.e., technologies, techniques, tools) for the large community of web developers to program/develop sensors and IoT applications. In short "make IoT accessible and programmable to the large community of web developers".

- A few general reference architectures may exist (such as the IOT-A architecture), but a large number of applications specific IoT architectures (i.e. IoT applications silos) are likely to co-exist as well.

- Breaking the technological and organizational IoT silos is a key to maximizing the ROI (return-on-investment) associated with the significant investments on IoT infrastructures.

3.1.2.1.4 Main Conclusions of the session

The global landscape of IoT applications includes already a wide range of IoT architectures and technology platforms, which have been developed independently. Therefore, despite the emergence of solid reference architectures and standards-based architectures, the number of IoT applications silos is likely to proliferate. The integration and interoperability of these silos is a key to enhancing the added value of IoT applications, while at the same time maximizing existing and future investments on the (usually costly) IoT infrastructures. Existing standards and techniques for semantic interoperability could serve as a basis for integrating these silos. At the same time they could provide the means to access and program non-trivial IoT applications over the web, which could allow the large community of web developers to develop innovative IoT applications. The opening of IoT application development to the large pool of web developers, could give a significant boost to IoT-based innovation, since it will enable wider communities to engage with IoT development and accordingly to generate and implement novel ideas.

3.1.2.2 Report on OpenIoT FIA 2013 Session «Where is the Business in the Internet-of-Things?»

3.1.2.2.1 Purpose & Audience

In this session we reported preliminary results from an ICT SME's survey for defining Internet-of-Things requirements towards year 2020, and also explored the IoT business models, business opportunities and its challenges for the industry.

We addressed common business issues, attacking the topic from a practical and non-academic slant.

Active participation by the audience was facilitated in working on three example business cases to figure out the respective target group, value proposition and possible revenue streams. The results were documented on business canvas sheets. The audience also mapped the use cases of their projects and business, in market and technology dimensions.

The session targeted business owners, innovation facilitators, entrepreneurs, technologists interested in the commercialisation of IoT innovations, and also European policy makers.

3.1.2.2.2 Summary of the Session

The Internet-of-Things community firmly believes that its technology will transform the world, but exactly how will that come about? According to Gartner 2012, IoT will ride on the hype curve for the next ten years. The EU Digital Agenda and national Internet-of-Things initiatives in for example China, UK and Sweden keep pushing IoT forward. Big companies like Intel, Cisco and IBM launch ambitious long-term business development programmes. SMEs such as for example COSM, ThingsSpeak, Ubidots and Intoino try to make inroads into this emerging trillion-dollar market.

The discussions during the workshop showed that the research area of the Internet of Things is still very much technology driven. Many fascinating developments are showing the technological potential, however the broad community does not see its imminent demand fulfilled. The session however showed convincingly that there is a keen interest among IoT researchers and developers for business development facilitation.

Sustainable new solutions necessarily need viable business models. While the IoT technical research results will slowly permeate the market, a much quicker uptake and stronger market penetration can be achieved by engaging existing SMEs and larger companies. The SME survey with 39 respondents performed by the OpenIoT project showed that there are strong perceived barriers against SME adoption of IoT technologies, which need to be identified and addressed. In particular the perceived complexity and risks of adopting IoT for product development needs to be addressed.

IoT projects and product development act in a fragmented landscape with relatively few existing products, and a largely uncoordinated set of use cases addressed by projects. In an on-going effort, the OpenIoT project has mapped 18 IoT projects and companies within the FInES and FIA communities.

Technology-driven IoT projects need external business development facilitation. Existing companies need more digestible information about IoT technologies and new solutions.

3.1.2.2.3 Key message(s) of the session

The key messages of the session were the following:

- The IoT community needs to reach out with clearer messages and examples of business benefits.

- Look for Disruptive Innovation – apply a different set of values.

- Business Development facilitation attracts interest from ICT experts – there are a lot of potential business cases.

Overall, it was communicated that the Internet-of-Things community needs to reach out to SMEs and other companies and explain the potential for Internet-of-Things solutions to facilitate disruptive innovation and other business benefits. Only then will the barriers of knowing too little and perceived risks stop impeding its uptake. Facilitating business development helps move IoT researchers towards commercialising. Continued mapping of IoT use cases to technology areas and market segments will identify gaps and synergies for Horizon 2020.

3.1.2.2.4 Main Conclusions and Recommendations of the session

The main recommendation from this workshop is to strengthen the business perspective as a driver in EU-funded Internet-of-Things projects. This could be done by encouraging the direct engagement of business developers in the requirement analysis phases also in technology oriented projects, and to apply user-centric development methods. True innovations need the combination of enabling technologies and realistic business models.

A separate support action is recommended to inform companies about the business benefits of IoT, and to survey and map the use cases of IoT projects and products in terms of the market dimension and the technology dimension. Identified overlaps should be used to facilitate joint business modeling workshops with projects and existing product companies. Identified gaps should be reported for targeting in later calls for project proposals.

3.2 Activities and Plans towards FIA 2014 (Athens, Greece, March, 2014)

3.2.1 Overview

OpenIoT has recently participated (actively) in the preparation of two session proposals for FIA 2014. However, these sessions have not been finally selected by the steering committee, even though they had a decent position in the relevant voting process (both ranked within the top 10 sessions in terms of the number of votes). OpenIoT intends to secure its presence in FIA, through participation in the organization of parallel activities such as pre-FIA workshops and IERC meetings to be scheduled for the FIA week. In the sequel we provide a short outline of the submitted IoT proposals:

3.2.2 Information on Session Proposal: «Virtualization and Service Openness in the Future Internet: Research Experiences and Envisaged Roadmap towards integrating Open Platforms»

The main goal of the (proposed) session was to explore and discuss virtualized devices and functions on open platforms, nowadays it is a common practice to think/design cross solutions between software and infrastructure in order to provide integrated solutions for some of the complex problems in the current and future

Internet. In this FIA Athens 2014 session, we will particularly discuss the role of virtualization of devices and infrastructure and other emerging technologies to facilitate the easy integration of the virtual with the physical worlds in the Future Internet.

The emergence of open platforms, providing fully documented virtualized devices and functions, spanning across the OSI layers, able to be interconnected in different ways to serve different purpose (not limited to vertical application domains) and open for expansion and update will be instrumental in the development of novel applications over the Future Internet. During recent years, several EC projects have developed open platforms in key areas of the Future Internet (such as cloud computing and the internet-of-things) and demonstrated their use for virtualizing FI resources and services. Building on experiences from building, deploying and using such platforms, the main goal of the session was to explore how existing platforms can support virtualization in FI, while at the same time identifying missing pieces and future research directions. The session intended particularly to emphasize the service oriented approach for accelerating the time-to-market of innovative solutions by various actors including service providers, application integrators, telecom operators, and in particular for SMEs and entrepreneurs in general by moving from the usual capital upfront investment model to an operational expense, thus linking costs to the success of the business, reducing risks and providing factual benefits. Practical examples and experiences were to be given in the areas of smart cities, manufacturing, logistics, security and more.

Note that this session was organized in collaboration with other IoT projects, namely FP7 BULTER, FP7 iCORE, FP7 VITAL, FP7 GAMBAS and FP7 ClouT.

3.2.3 Information on Session Proposal: « IoT technology as a proponent of new Business Models and Social Engagement in Smart Cities»

The goal of this (proposed) session was to shed light in IoT as an enabler of business opportunities and social engagement in smart cities, as well as to discuss the social and business implications of IoT deployments in modern smart cities. During the session, the audience was planned to have the chance to attend position statements and experts' discussion on:

• The role of IoT technology building blocks as enablers of new business opportunities in smart cities.

• Smart cities business models empowered by IoT technologies, along with relevant business opportunities.

• The anticipated role of the different smart city stakeholders (city authorities, citizens, businesses, policy makers) in the development of a successful business ecosystem.

• The role of communities and social media/networks in the deployment and operation of IoT applications in smart cities.

- Ways for lowering the barriers for citizens' engagements in IoT applications in the smart city, including the alleviation of privacy concerns and the provision of incentives for users/citizens participation.

The session intended to give to the audience the chance to interact with the experts through Q&A, but also through interactive dialogue.

Note that this session was organized in collaboration with several IoT projects for Smart Cities applications, namely FP7 VITAL, FP7 RERUM, FP7 COSMOS and FP7 CityPulse.

4 CONCLUSIONS

This deliverable has reported on the project's contributions to cluster activities during the first two years of the project's lifetime (i.e., December 2011 - November 2013). Specifically, the project's contributions to the IERC and FinES clusters have been described, along with OpenIoT's participation in FIA meetings and sessions. Most of the relevant efforts of the project have been allocated to its contributions to the IERC cluster and its activity chains. Indeed, OpenIoT has had a leading/coordinating role in two of the activity chains (AC2 dealing with naming, addressing and discovery, as well as AC4 dealing with semantic interoperability). As part of these activity chains, OpenIoT has organized key meetings and coordinated the production of important IERC deliverables and position papers. At the same time, the project has also had an active role in the scope of other activity chains (such as AC1 dealing with IoT reference architecture schemes, and AC5 dealing with security and privacy). Note that the OpenIoT's open source implementation and release can be seen as an important milestone for IERC (and its AC1 activity chain), since it constitutes a tangible instantiation of the AC1 ARM, which is a major result of the IERC.

The project's active presence in the above chains has been reflected in a variety of contributions, which included presentations to meetings and workshops, organization of workshops, contributions to deliverables and other cluster publications, as well as planning of future contributions and outcomes of the activity chains. OpenIoT has been present with an active role in the vast majority of IERC meetings, which have been organized during the first two years of the project's lifetime (i.e. December 2011 - November 2013). Note also that OpenIoT has had the leading role in the production of the main deliverables of activity chains AC2 and AC4, including a deliverable on «semantic interoperability» and a position paper highlighting IERC's work of naming, addressing and discovery. The project's active participation in the IERC clustering mechanisms indicates that OpenIoT acknowledges of using results of the project towards developing a pan-European approach to several aspects of IoT applications/platforms design and implementation. Furthermore, it illustrates the project's commitment to the IERC clustering mechanisms, which will also drive its continued contribution to the IERC activities.

In addition to contributing to IERC, where OpenIoT has nominally an important role (as AC2 coordinator and AC4 joint coordinator), the project has actively participated in FinES meetings, while at the same time delivering relevant presentations in this cluster as well. The project's research is very relevant to several topics of the FinES cluster and a driving force for continuing the project's contributions to FinES. However, the project's contribution to FinES have been mainly taken place during the

first year of the project, since in 2013 FinES has been undergoing transformation towards Horizon 2020.

Overall, the project has an active (and sometimes leading) participation in the activities of the IERC, which typically exceeds the expectations reflected in OpenIoT's initial plans. The project acknowledges the importance of these European-level cluster mechanisms, as a means of interacting with other projects, sharing results and experiences and ultimately collaborating in the development of a pan-European approach in key technical/scientific areas of the Internet-of-Things. Therefore, OpenIoT intends to continue its participation and contribution to the above clustering mechanisms. OpenIoT's achievements and contributions in the scope of the period covered in this report provide a sound basis for continuing and intensifying the relevant efforts. The full set of IERC activities and achievements of the OpenIoT project will be thoroughly presented in the final version of deliverable D7.5, i.e., D7.5.3, which is due at the end of the project's lifetime.

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OpenIoT/2013

APPENDIX I – USE CASE MAPPING FOR IERC AND FINES

Internet-of-Things Use Case Mapping

			Project:	
			Cluster (if any):	FInES

Mark your areas!

Web site:

function / market	Individuals	Public Admini-stration	Agriculture	Manufac-turing	Health & Care	Education	Energy	Retail	Enter-tainment	Finance	Transport
Sensing											
Remote Control											
Automation											
Service Discovery											
Semantic Layer											
Sensor Aggregation											
Location Awareness											
Middleware											
Large Scale Deployment Support											
Security (incl. Privacy)											
Real-time analysis											
Big Data analysis											
Testbed											

OpenIoT Use Cases

OPENIoT

Internet-of-Things Use Case Mapping

		Project:	OpenIoT
		Cluster (if any):	IERC
		Web site:	www.openiot.eu

function / market	Individuals	Public Admini-stration	Agriculture	Manufac-turing	Health & Care	Education	Energy	Retail	Enter-tainment	Finance	Transport
Sensing	o	o	O	o	o						
Remote Control	o	o	o	o							
Automation	o	o	o	o							
Service Discovery	O	O	O	O	o						
Semantic Layer	O	O	O	O	o						
Sensor Aggregation	o	O	O	O	O						
Location Awareness	O	O	O	o	O						
Middleware	o	O	O	O	O						
Large Scale Deployment Support		o	o	o	o						
Security (incl. Privacy)	o	o			o						
Real-time analysis											
Big Data analysis											
Testbed											

Use cases:

Smart City

Manufacturing

Agriculture

(E-science)

(Health & Care)

OpenIoT/2013