**IoT@Work**

*WP 5 – EXPLOITATION AND DISSEMINATION*

*D5.3 – Final dissemination and clustering report*

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**Reference:** IoT@Work/WP5/D5.3  
**Category:** Report  
**Deliverable Responsible:** inIT  
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Giulio Vivo (CRF)  

**Due Date:** M37  
**Deliverable Date:** 04/07/2013  
**Project Start Date:** 01/06/2010  
**Project Duration:** 37 Months  
**Status:** Final  
**Availability:** Public
Executive summary

All exploitation and dissemination activities which were conducted during the third period of IoT@Work are reported in deliverable D5.3. The IoT@Work website has been continuously updated, i.e., new project results were published. IoT@Work related events were integrated as part of the news section, etc. As a major step towards a better visibility, social media integration was added to the website and could be immediately recognized by the number of visitors. In order to inform visitors and interesting experts during public events, seven technology leaflets have been created to summarize the main achievements of the project. The leaflets are supplemented by technology posters which summarize the IoT@Work technologies by focussing on the most relevant characteristics of each technology. In addition to this, two project videos were created showing the main project results in a very compact and easy to follow format. The active exchange of information with the existing stakeholder group was also continued and valuable feedback from potential end users as well as experts in the field could be gathered. The stakeholder group could be even extended by five additional members. In particular, a second stakeholder workshop in April 2013 was organized. Several members of the stakeholder group attended the event and provided their feedback about the IoT@Work results. Some interesting use-cases for the future use of the IoT@Work technologies could be developed. Furthermore, a special session at the IEEE International Conference on Emerging Technologies and Factory Automation (ETFA 2012) in Krakow, Poland was organized. The IoT@Work consortium further participated actively in the IERC and relevant events. For instance, IoT@Work organized two sessions during the IoT Week 2012 and one session during the IoT Week 2013. IoT@Work was also represented at embedded World 2013 in cooperation with the OPC foundation and invited to be part of this years’ Siemens Campus Roadshow.

Due to the research-oriented nature of the achievements, the IoT@Work consortium has mostly focused to disseminating the innovative concept of the project internally and in other R&D groups, such as in conferences, workshops, and cluster meetings. This report summarizes the dissemination and exploitation activities for the last year of the project, and provides an overview of all other relevant activities for the whole project duration, such as publications and cluster activities project.
### Document History

#### Version History

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<td>Standardization activities added, Stakeholder description added, Exploitation subsections integrated</td>
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<td>2, 4 and 5 revised</td>
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## Glossary

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<th>Description</th>
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<td>DFKI</td>
<td>German research centre for artificial intelligence</td>
</tr>
<tr>
<td>ETFA</td>
<td>IEEE International Conference on Emerging Technologies and Factory Automation</td>
</tr>
<tr>
<td>ETSI</td>
<td>European Telecommunications Standards Institute</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and communication technologies</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>IERC</td>
<td>IoT European Research Cluster</td>
</tr>
<tr>
<td>INDIN</td>
<td>IEEE International Conference on Industrial Informatics</td>
</tr>
<tr>
<td>IoT</td>
<td>Internet of Things</td>
</tr>
<tr>
<td>KommA</td>
<td>Kommunikation in der Automation</td>
</tr>
<tr>
<td>KPI</td>
<td>Key performance indicator</td>
</tr>
<tr>
<td>LMF</td>
<td>Lemgo Model Factory</td>
</tr>
<tr>
<td>MDD</td>
<td>Model driven development</td>
</tr>
<tr>
<td>QoS</td>
<td>Quality of service</td>
</tr>
<tr>
<td>WFCS</td>
<td>IEEE International Workshop on Factory Communication Systems</td>
</tr>
<tr>
<td></td>
<td>Communication in Automation</td>
</tr>
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1 Introduction

This WP deals with the planning, design, and implementation of the dissemination and exploitation policies in the project. The deliverable 5.3 is based on [1] and [2] and presents the dissemination and cluster activities of the IoT@Work project. The fundamental principle of R&D projects to disseminate the findings and achievements of the project as widely as possible to the research community and industrial companies was of major importance in IoT@Work and has been successfully achieved throughout the project by different activities. Besides the normal scientific dissemination (participating in conferences, publishing papers, etc.), additional efforts were undertaken to implement special dissemination activities to also attract an audience from the industrial community.

In order to ensure an impact on the scientific community, the academic partners and some of the industrial partners of the IoT@Work consortium published more than 40 research papers resulting from their activities in this project in national and international conferences as well as in well-known scientific journals. The complete list of publications is provided in Section 2.1. In addition to this, the consortium organized a special session at the IEEE International Conference on Emerging Technologies and Factory Automation (ETFA 2012) in Krakow, Poland where current trends in the area of Internet of Things technologies for factory automation were discussed with several experts from academia and industry.

The IoT@Work website www.iot-at-work.eu has been further maintained and optimized by integration of social networking functions. It is briefly described in Section 2.2 and detailed statistics of the website access are provided. The remaining dissemination activities are summarized in Section 2.5 including the detailed description of selected activities. Moreover, various dissemination materials representing the final project results have been created, e.g., a project video summarizing the main findings of IoT@Work.

To increase the transfer of research results to the EU industry, several internal and external dissemination events have been organized by the partners. For instance, the project was represented at the world largest industry fair for embedded devices, the embedded World 2013 in Nuremberg, Germany. Furthermore, the consortium contributed to different standardization activities, which will guarantee a sufficient usage of the project results beyond the project duration, as described in Section 2.7.

To gain valuable feedback about market opportunities and technical details, the stakeholder group was established during the first half of the project. After a first stakeholder workshop in January 2012 (details about it are provided in [2]), the second workshop took place in April 2013. The workshop mainly aimed at getting feedback on the core IoT@Work technologies which have been developed in the IoT@Work project and to investigate the added value of these technologies from a stakeholders’ perspective.

Relevant cluster activities of the IoT@Work consortium are shown in Section 4. The project consortium organized two sessions during the IoT Week 2012 and one session during IoT Week 2013. Besides, several talks were given during recent IoT Week events (2011, 2012, 2013) and the Future Internet Week. All activities are summarized in form of a table and selected activities are described in more detail. Finally, the final exploitation strategies of all industrial partners are provided in Section 5.
2 Dissemination

The dissemination activities in the third year of the project were focussed on the dissemination of the results and findings to the scientific community as well as to selected user groups and non-technical audiences. The stakeholder group could be extended by 5 additional members from industry and academia. Furthermore, the existing contacts to the experts of our stakeholder group were further used and extended, especially by means of a second stakeholder workshop in April 2013.

2.1 Publications

In order to provide a complete overview of all scientific publications, this section lists the publications in a consecutive way starting from the beginning of the project. Altogether 40 publications and 3 patents were generated in the context of IoT@Work.

2.1.1 Journal publications

2011


2013


2.1.2 Conference publications

2010


2011


2012


Technologies & Factory Automation (ETFA 2012), Kraków, Poland, September 2012.


2013


[42] Mert Ozkaya, Christos Kloukinas, **Are We There Yet? Analysing Architecture Description Languages for Formal Analysis, Usability, and Realisability**, 39th Euromicro Conference on Software Engineering and Advanced Applications (SEAA 2013), Santander, Spain, September, 2013. (Accepted for publication)

### 2.1.3 Patents

[43] GESSNER, JUERGEN, ; HOF, HANS-JOACHIM, PROF, ; HOUYOU, AMINE MOHAMED, DR, ; HUTH, HANS-PETER); Configuration of a communication network; Applicant Siemens AG [DE]; Application Number: EP20120173741 20120627

[44] FRIES STEFFEN [DE]; GESSNER JUERGEN [DE]; HOUYOU AMINE MOHAMED [DE]; HUTH HANS-PETER [DE]; SCHATTLEITNER ANGELA [DE]; METHOD AND SYSTEM FOR PROVIDING DEVICE-SPECIFIC PROPERTY DATA FOR AN AUTOMATION DEVICE IN AN AUTOMATION INSTALLATION; Applicant: Siemens AG [DE]; Application number: WO2012EP65488 20120808

[45] FISCHER KAI [DE]; FRIES STEFFEN [DE]; GESSNER JUERGEN [DE]; HOUYOU AMINE MOHAMED [DE]; HUTH HANS-PETER [DE]; SCHATTLEITNER ANGELA [DE]; METHOD AND SYSTEM FOR PROVIDING DEVICE-SPECIFIC OPERATOR DATA FOR AN AUTOMATION DEVICE IN AN AUTOMATION INSTALLATION; Applicant: Siemens AG [DE]; Application Number: WO2012EP65489 20120808

There are some more patents pending from the partner Siemens.

### 2.1.4 Distinctions

IoT@Work researchers from inIT won the Best Paper Award at „IEEE International Conference on Emerging Technologies and Factory Automation“ (ETFA) held 2012 in Poland. The ETFA conference series is the prime, and largest, IEEE-sponsored event dedicated to factory automation and emerging technologies in industrial automation.

The paper „Towards Autoconfiguration of Industrial Ethernet Systems: A case study using PROFINET IO“ of Lars Dürkop, Henning Trsek, Łukasz Wisniewski, and Professor Jürgen Jasperneite about the autoconfiguration of real-time Ethernet networks convinced the ETFA program committee. It was selected to be the best contribution among more than 150 publications. The paper dealt with the challenge of how to map the Internet of things to industrial automation systems. In this context a methodology was developed to autoconfigure real-time Ethernet networks. Up to now, all industrial devices must undergo a costly manual configuration, before they can start to operate. Their goal is to connect automation devices following a Plug-and-play mechanism in order to recognize each other and start to operate autonomously.
Figure 2.1. The authors of the ETFA’12 Best Paper Award: Professor Dr. Jürgen Jasperneite, Henning Trsek, Lars Dürkop and Lukasz Wisniewski

Furthermore, the paper “Towards Design-by-Contract Based Approach for Realisable and Connector-Centric Software Architectures” of Mert Ozkaya and Christos Kloukinas from City University was short-listed as a candidate to win the best paper award of the eighth International Joint Conference on Software Technologies (ICSOFT 2013) in Reykjavik, Iceland.

2.2 Project Website

The consortium of the IoT@Work project is actively maintaining the existing website which presents the project and project related content like publications, selected reports, member organizations, and people behind it. It has been continuously updated with new project results and information as well as with interesting events related to the project. The website is reachable via https://www.iot-at-work.eu. During the second and third year the website has been mainly maintained by the partner iniT and a screenshot of its first page is shown in Figure 2.2.
With the help of the website analysis tool Google analytics, an overview of the page hits can be generated. Main focus is put on the source of visitors and how they reached the website and which content was of interest for the visitors. Current statistics cover the period from June 2012 until June 2013. During this period some enhancements of the content have led to increased number of visitors around the update dates. Peaks around the publishing times of deliverables and publications show interest of visitors in project progress and technical details discovered. As well as technical data and descriptions the persons behind the project were in the focus of the visitors. Both topics cover the majority of page hits on the IoT@Work project website.

The average number of pages viewed per visit shows a purposive handling of the website. Typical visitors are heading directly to the documents of interest which is possible by direct navigation on the website. The following three graphs show the location of visitors, the traffic sources and the page views, respectively (cf. Figure 2.3, Figure 2.4, and Figure 2.5).

Since the last reporting, we had more than 1500 visitors from more than 60 different countries. However, the majority of visitors are located in Europe as shown in Figure 2.3. In comparison to Deliverable 5.2 the number of visitor could be increased by more than 500 visitors due to the fact of further marketing using social media integration such as Twitter and Facebook as depicted in Figure 2.6. A LinkedIn community was also built around IoT@Work. There is also a contribution pending to Insight’s “Project Magazine”¹, one of Europe’s leading science and technology magazines.

¹ Latest edition of Projects Magazine: http://viewer.zmags.com/publication/b974f238/#b974f238/1
research magazine, covering the latest innovations, research projects and breakthroughs from across Europe.

Figure 2.3. Location of visitors of www.riot-at-work.eu
Figure 2.4. Traffic sources of www.iot-at-work.eu

Figure 2.5. Page views of www.iot-at-work.eu
2.3 Technology leaflets and posters

In order to be able to inform a broader audience about our project, the IoT@Work consortium has created a general leaflet, which summarizes the main vision of the project, along with its objectives and other important facts and figures about the project. This activity is considered to be very important and was frequently used when exhibiting on trade fairs, conferences, and other similar events. The project leaflet was already shown in [2].

In addition to this, seven technology leaflets have been created to summarize the main results of the project and to inform visitors and interesting experts during events such as the Siemens Roadshow or the IoT Week 2013 in Helsinki. The IoT@Work technology posters have been created to summarize the technologies by focussing on the most relevant characteristics of each technology. Up to now, the posters were mainly used to provide a basis for discussions during the stakeholder workshop and describe the logical order of the demonstration use-case. The technology leaflets as well as the technology posters are shown in the confidential appendix.

2.4 Project Video

In order to inform the IoT@Work stakeholder group and other interested parties, the IoT@Work consortium produced a project video which is available online and mainly used for exhibitions and trade fairs to show the project goals and achievements in a very compact and easy to follow format.

The project video first introduces the status before starting the project and the future vision of IoT@Work including the main challenges to be addressed. After this the results of IoT@Work are provided based on the demonstration use-case at CRF which is considered to be the main pilot of IoT@Work. Every IoT@Work technology is briefly described following the logical order of the demonstration. The video was first shown during the IoT Week 2013 exhibition in Helsinki. It is now available on the main page of our website (see https://www.iot-at-work.eu/).

2.5 Other Dissemination Activities

A selection of different other dissemination activities during the whole project duration of IoT@Work is given in Table 2.1.

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<th>Partner</th>
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<td>KommA 2010 – Kommunikation</td>
<td>inIT</td>
<td>External</td>
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<td>Category: in der Automation (Lemgo)</td>
<td>Siemens</td>
<td>External</td>
<td>Project presentation.</td>
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</tr>
<tr>
<td><strong>Presentation of findings to other interested Siemens business units</strong></td>
<td>Siemens</td>
<td>Internal</td>
<td>A multitude of meetings with Siemens Business Units (Siemens Industry, Siemens Cities and Infrastructure, Siemens Corporate Technology) to discuss exploitation strategies of project results. (ongoing)</td>
</tr>
<tr>
<td><strong>Presentation of findings to other interested teams within the company</strong></td>
<td>EMIC</td>
<td>Internal</td>
<td>Meetings and interactions with potentially relevant teams across the company, in order to disseminate project activities, and particularly expose requirements and trends. (ongoing)</td>
</tr>
<tr>
<td><strong>Education and teaching</strong></td>
<td>inIT</td>
<td>Internal</td>
<td>Introducing the IoT@Work concepts and scenarios in the education of M.Sc. and Ph.D. students at the department of electrical engineering and computer sciences of the Ostwestfalen-Lippe University of Applied Sciences in Lemgo. (ongoing)</td>
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<td><strong>Project presentation to visitors</strong></td>
<td>inIT</td>
<td>External</td>
<td>Presentation of the IoT@Work integrated technologies in the context of the &quot;Lemgo model factory&quot; to visitors of inIT. (ongoing)</td>
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<td><strong>IoT International Forum, Berlin</strong></td>
<td>TXT</td>
<td>External</td>
<td>Contribution on capability based access control and semantics in IoT</td>
</tr>
<tr>
<td><strong>Presentation of findings to other interested teams within the company</strong></td>
<td>CRF</td>
<td>Internal</td>
<td>Meetings with potentially relevant and interested teams in different sectors of FIAT group, in particular with FGA (FIAT Group Automobiles) – ICT Division, COMAU – Powertain Systems. These meeting were carried out in order to disseminate project activities and vision, discuss exploitation and share requirements.</td>
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<td>Siemens Internal Workshop</td>
<td>Siemens Internal</td>
<td>“Future Internet Community”</td>
<td>Public</td>
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<tr>
<td>NESSOS Industry Forum Panel (28 October 2011) of the Service Wave</td>
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<td>NESSOS Workshops organised within the Future Internet Week held in Poznan</td>
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<tr>
<td>Siemens Internal Workshop</td>
<td>Siemens Internal</td>
<td>Siemens internal round table “Industrial Ethernet Working Group”</td>
<td>Public</td>
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<tr>
<td>First IoT@Work stakeholder meeting</td>
<td>All External</td>
<td>The first IoT@Work stakeholder workshop was carried out to share the intermediate project results and achievements with a qualified audience of end-users and domain experts. General organization and hosting of the meeting was done by CRF. See also <a href="https://www.iot-at-work.eu/consortium_first_stakeholder_meeting.html">https://www.iot-at-work.eu/consortium_first_stakeholder_meeting.html</a></td>
<td>Public</td>
</tr>
<tr>
<td>Hanover Fair 2012</td>
<td>inIT External</td>
<td>IoT@Work was part of the inIT booth and presented the project to a very broad industrial audience</td>
<td>Public</td>
</tr>
<tr>
<td>Meeting held in the Reply SpA (<a href="http://www.reply.it/en/">http://www.reply.it/en/</a>) premises in Turin</td>
<td>TXT External</td>
<td>Presentation of IoT@Work and corresponding TXT developments to Reply and FIDIA SpA (<a href="http://www.fidia.it">http://www.fidia.it</a>)</td>
<td>Public</td>
</tr>
<tr>
<td>University of Murcia - IoT6 cooperation</td>
<td>TXT External</td>
<td>In April 2012 TXT has agreed with the University of Murcia (Spain) to provide them the IoT@Work capability based access control software to be experimented in the FP7 IoT6 project (<a href="http://www.iot6.eu/">http://www.iot6.eu/</a>).</td>
<td>Public</td>
</tr>
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<td>Invited presentation at University of Magdeburg</td>
<td>inIT External</td>
<td>Invited speech about IoT@Work concepts during the research seminar of the real-time systems and communications group</td>
<td>Public</td>
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<tr>
<td>Workshop on Factory Communication Systems (WFCS 2012)</td>
<td>Siemens External</td>
<td>Invited talk at the industry day about IoT@Work concepts and solutions</td>
<td>Public</td>
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<td>Phoenix Contact and Phoenix</td>
<td>inIT External</td>
<td>A series of presentations about IoT@Work concepts</td>
<td>Public</td>
</tr>
<tr>
<td>Category</td>
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<tr>
<td>----------</td>
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<td>Contact Electronics</td>
<td>were given at the premises of Phoenix Contact</td>
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<tr>
<td>University of Magdeburg</td>
<td>inIT</td>
<td>External</td>
<td>Further continuous exchange and discussions regarding the Internet of things and manufacturing with researchers of the University of Magdeburg</td>
</tr>
<tr>
<td>Hanover Fair 2013</td>
<td>inIT</td>
<td>External</td>
<td>IoT@Work was represented at the inIT booth and the project results could be shown to a very broad industrial audience</td>
</tr>
<tr>
<td>Forum Industrial IT (Hanover Fair 2013)</td>
<td>inIT/ Siemens</td>
<td>External</td>
<td>Two talks during the Forum Industrial IT</td>
</tr>
<tr>
<td>KW Software</td>
<td>inIT</td>
<td>External</td>
<td>Introduction and demonstration of the real-time Ethernet autoconfiguration</td>
</tr>
<tr>
<td>&quot;Workshop sulle attività di ricerca e l'innovazione per sicurezza&quot; organised by the Italian National Research Council (CNR)</td>
<td>TXT</td>
<td>External</td>
<td>In May 2013 TXT representative (Domenico Rotondi) held a short presentation of IoT@Work Capability Based Access Control</td>
</tr>
<tr>
<td>Presentation of project findings and research outcomes</td>
<td>TXT</td>
<td>Internal</td>
<td>Several internal meetings with TXT business units (TXT NEXT and TXT PERFORM) have been arranged in order to present the outcomes of the projects</td>
</tr>
<tr>
<td>Presentation of IoT@Work pilot demonstrator and validation results to interested teams within the company</td>
<td>CRF</td>
<td>Internal</td>
<td>Meetings with interested teams in different sectors of FIAT group, e.g. FGA (FIAT Group Automobiles) – ICT Division and COMAU – Powertain Systems</td>
</tr>
<tr>
<td>Second IoT@Work stakeholder meeting</td>
<td>All</td>
<td>External</td>
<td>The second IoT@Work stakeholder workshop was carried out to present the key project results around the real automation pilot in the CRF labs. The experience and feedbacks from the stakeholders were used to evaluate the potential of the project results and their impact on</td>
</tr>
</tbody>
</table>
During Hannover Fair 2013 two presentations were given by inIT (Henning Trsek) and Siemens (Dr. Amine M. Houyou) at the Forum Industrial IT. Since information and communication technologies are playing an increasingly important role in automation, the Forum Industrial IT offered several talks and panel discussions about efficient, fully integrated solutions for customer-oriented applications with. It was integrated in the themed presentation Industrial IT during Hanover Fair 2013 and was supported by VDMA and ZVEI.

The presentation of inIT was entitled “Internet of Things at Work: Plug-and-play for industrial automation” and presented the developed plug-and-play methodology for the autoconfiguration or real-time Ethernets to enable quick adaptation to a completely new manufacturing process using a Service-Oriented Architecture (SOA) based on OPC UA.

The presentation of Siemens dealt with “Programmable networks for industrial application – Communication services for automation”. It proposed the adaptation of future Internet techniques such as network virtualization and programmable networks for industrial domains. The presented approach can provide communication services as a deployable virtual network mapped to a real physical infrastructure. According to each distributed application specification, automatic algorithms can allocate resources according to their QoS, reliability, and security needs.

The upcoming IERC Newsletter will include a description of the TXT IoT@Work SW and the news that it will be available as Open Source.

In the beginning of this year the IoT@Work Capability Based Access Control was introduced by TXT in a short presentation during the "Workshop sulle attività di ricerca e l’innovazione per sicurezza" from the Italian CNR (National Research Council). In addition to this, TXT organised a demonstration of the TXT IoT@Work contributions (ENS, DS and related access control) to the company Whirpool. This demonstration had a very positive outcome. Currently, TXT is discussing to set up a specific pilot in one of the Whirpool factories in Italy.

2.6 Showcasing and workshop activities

Several IoT@Work showcasing and workshop activities took place in the third year of the project. The consortium has organized two sessions at the IoT Week 2012 in Venice and a special session at the major IEEE conference for factory automation ETFA was organized. During the trade fair embedded World 2013 in Nuremberg (world largest industry fair in the embedded area), IoT@Work was represented on the booth of the OPC foundation showing one of the world’s smallest OPC UA server implementations. The OPC UA server was developed within IoT@Work and is specifically tailored for resource constraint embedded devices. IoT@Work was again represented at the booth of inIT at the Hanover fair 2013. Many interesting discussions with automation experts arose from this public event. TXT has organized the session on IoT for manufacturing during the IoT@Work Week 2013. The focus of the session has been to take some of the results of IoT@Work towards the interested community. Some selected activities are described in the following subsections.
2.6.1 Organized sessions at the IoT Week 2012, Venice, Italy

The IoT Week 2012 in Venice provided many insights into recent IoT developments and a unique opportunity to network and meet IoT experts from all over the world. IoT@Work actively contributed to this major IoT event by means of organizing two different sessions within the program. The demo session “Implementing IoT” was organized by the IoT@Work consortium and introduced the demonstrators and pilots from project members of the IERC. The session “IoT Exploitation” was also organized by the IoT@Work consortium in cooperation with the project “ebbits”. During this session it was discussed how the Internet of Things paradigm is going to be realized in everyday-life, permeating the whole economy and society. More details about both sessions were already provided in [2].

2.6.2 ETFA 2012 special session

To enhance the technical program and focus on specific topics and areas, ETFA 2012 conference offers the organization of special sessions, in addition to regular tracks. Special sessions can be compared to workshops, but have fewer papers which are included. They always cover specific topics belonging to one track of the conference. The IoT@Work consortium organized a special session entitled “Internet of things technologies for adaptable and agile automation systems” that was closely related to the research area of IoT@Work.

Since industrial automation systems need to become adaptable and agile, and operate in a self-* manner - especially in the context of demand driven production processes. The factory of tomorrow will consist of flexible production lines that will be able to adapt quickly to a completely new manufacturing process. The adaptability requirement is due to a consumer driven market that demands customized goods in smaller production batches, usually down to lot sizes of one. Therefore, the special session dealt with all aspects related to Internet of Things technologies in the context of industrial automation systems, such as middleware for automation systems, security aspects, and all other topics related to this field. Throughout the presentations several interesting discussions among experts arose, all related to Internet of things technologies in the context of manufacturing environments, resulting in a very successful special session which could be considered as a valuable contribution to the conference and as interesting feedback for IoT@Work.

The titles of all six contributions to the session are:

1. Towards Autoconfiguration of Industrial Automation Systems: A Case Study Using PROFINET IO
   Lars Dürkop, Henning Trsek, Jürgen Jasperneite

2. A Generic Synchronized Data Acquisition Solution for Distributed Automation Systems (from outside the project)
   Florian Pethig, Björn Kroll, Oliver Niggemann

3. Agile Manufacturing: General Challenges and the IoT@Work Perspective
   Amine Houyou, Hans-Peter Huth, Christos Kloukinas, Henning Trsek, Domenico Rotondi

4. IoT@Work Automation Middleware System Design and Architecture
   Sergio Gusmeroli, Salvatore Piccione, Domenico Rotondi

5. Security Architecture Elements for IoT enabled Automation Networks
   Kai Fischer, Jürgen Gessner

6. Employing Internet of Things Technologies for Building Automation (from outside the project)
2.6.3 Embedded World 2013

In the context of IoT@Work the Institute Industrial IT (inIT) in Lemgo have implemented one of the world’s smallest OPC UA server. It is specifically tailored for resource constraint embedded devices and was shown in cooperation with the OPC foundation at this years embedded world in Nuremberg. The OPC UA server implementation is based on the new „Nano Embedded Device Server Profile“ of the OPC Foundation and requires only approx. 10 KB of memory. The implementation opens up completely new application areas for the OPC UA standard. Besides connecting directly to sensors in industrial automation, it enables the interaction between smart phones and building automation sensors or other residential applications. Our results show impressively the high scalability of OPC UA, which even allows the integration of simplest devices into the Internet-of-Things (IoT).

Figure 2.7. inIT employee Jahanzaib Imtiaz explains the OPC UA server implementation to an interested visitor

2.6.4 Siemens Roadshow 2013

The IoT@Work project has been invited to participate in the Siemens Campus Roadshow 2013 to provide students in both Technical University of Munich and Karlsruhe Institute of Technology a possibility to get familiar with the project results. A demonstration of the IoT@Work Slice Concept from Siemens was demonstrated at both locations. Some impressions are provided in Figure 2.8.

Figure 2.8. Discussions and demonstrator at the Siemens Campus Roadshow 2013
2.6.5 Organized Session at the IoT Week 2013, Helsinki, Finland

The IoT Week 2013 in Helsinki, Finland provided insights into recent IoT developments and a unique opportunity to network and meet IoT experts from all over the world. Featured presentations were given from high-level representatives of industry, academia and politics which are complemented by workshops and panel discussions around the Internet of Things. IoT@Work will actively contribute to this major IoT event by means of organizing the session “IoT for Manufacturing” within the program.

The objective of the IoT for Manufacturing session at IoT Week 2013 was to focus on both the technological challenges posed by the adoption of IoT in the Manufacturing domain and on the potential industrial and socio-economic impacts derived from the full take-up of IoT in the whole product life cycle, including post-sales services and recycling. The session successfully fostered circulation of ideas, issues and approaches and the establishment of liaisons and synergies and promote the setup of a more synergic, systematic and coherent approach within the EU R&D community. Hence, the session was organised in two specific sub-sessions, the 1st one addressing the technological challenges, and the 2nd one about the business aspects. Both sub-sessions were conducted as a set of very interesting short presentations, mostly but not exclusively represented by EC-funded projects in several areas – IoT, FI PPP, FoF PPP. It was concluded by a panel where the audience and the presenters were heavily involved in future H2020 moderated discussions. The program of the session was as follows:

09:30 - 09:40  Introduction of the Workshop, Objectives (Sergio Gusmeroli, TXT e-solutions SpA)
09:40 - 10:00  IPv6, the Internet of Everything and Manufacturing (Latif Ladid, IPv6 Forum, Chair IEEE ComSoc IoT WG)  
10:00-10:20  OPC UA as an enabler for the Internet of Things (Lars Dürkop, Institute Industrial IT - Ostwestfalen-Lippe University of Applied Sciences, Germany)  
10:20-10:30  Knowledge as a key factor in Manufacturing (Jesus Benedicto Cirujeda, Atos Research)  
10:30-10:40  IoT@Work: Internet of Things Solutions in Manufacturing (Amine M. Houyou, Siemens AG)  
10:40-11:00  Technology strand discussion (moderated by Domenico Rotondi, TXT e-Solutions SpA)  
11:00-11:30  Coffee Break  
11:30-11:50  IoT in Production: a pilot case in automotive industry (Oscar Lazaro, INNOVALIA)  
11:50-12:00  IoT in Indoor Logistics: a pilot case in Forklift Management (Stefan Wellsandt, BIBA)  
12:00-12:10  IoT in Maintenance: a pilot case in Aeronautic industry (Roberto Sanguini, AGUSTA)  
12:10-12:30  IoT in Operations: a pilot case in White Goods industry (Alessandro Molinengo, INDESIT)  
12:30-12:50  Business / Application strand discussion (moderated by Oscar Lazaro, Innovalia, FITMAN)
Besides the organized session, the project IoT@Work exhibited some of the IoT@Work integrated technologies, focusing on the final results of the project. An impression from the IoT@Work booth during the IoT Week 2013 is shown in Figure 2.9.

Figure 2.9. Discussions during the IoT Week 2013 in Helsinki

2.7 Contributions to different Standardization Activities

2.7.1 OPC foundation

Within IoT@Work project, inIT has contributed towards the standardization process for OPC Foundation, this is being a member of Task Group "OPC UA For Devices (DI) Companion Specification" [3]. One objective of this activity was to standardize the base information model for industrial devices. Furthermore, inIT has evaluated OPC UA in the context of IoT and provided feedback to the OPC Foundation [5], [6]. We further evaluated OPC UA for optimization [4], because energy efficiency is gaining more importance and Bluetooth Low Energy (BLE) could be used to make use of potential everyday objects into the Internet of Things (IOT) - a software, platform and vendor independent common service interface that can be used in such low resource device has high potential. OPC-UA is an emerging middleware solution that addresses the above points but is bulky due to its abundant features. Further optimization is necessary to bring OPC-UA into such resource-limited devices. We have scaled down the OPC-UA protocol stack footprint down to the chip level [5]. In this work, we propose an optimization approach to minimize the OPC-UA network footprint and have demonstrated that the OPC-UA network footprint can be scaled down to fit into different devices and transport technologies with small frame size. We proposed an Optimized OPC UA Transport Profile (OOTP) that needs 7 bytes for the header information. In case of BLE, building OOTP on top of IP stack leaves 7 bytes for payload and only having OOTP in the BLE stack leaves 12 bytes for the payload. The proposed OOTP can be further optimized to use in CAN bus leaving 2 bytes for payload which might be sufficient for certain applications. We are currently working on the OOTP implementation and are planning to suggest it as a next generation of OPC-UA transport profile to the OPC foundation for low resource devices.

2.7.2 IEEE 802.1 TSN task group

Within IoT@Work project, inIT and Siemens have participated in the activities of 802.1 TSN Task Group (formally known as 802.1 Audio/Video Bridging TG). We have evaluated the specification in terms of simulation studies and prototype-
implementation to present the industrial automation application perspective on various standardization topics [7], [8], [9], [10], [11].
3 Stakeholder Group

The stakeholder group together with an on-going exchange of ideas and feedback with them is an activity of high importance for our project. The stakeholder group is used to gain additional feedback and input from experts about end-user expectations in order to keep the project in-line with the needs of tomorrow’s factories.

3.1 Members

The stakeholder group could be extended by 5 additional members from industry and academia. Furthermore, the existing contacts to the experts of our stakeholder group were further used and extended, especially by means of a second stakeholder workshop in April 2013. The stakeholder group activities of the last year can be summarized as follows:

- Frequent monitoring of the project and provision of continuous feedback in order to improve the project results.
- Participation in the second workshop for the stakeholder group which took place in April 2013 at the CRF premises.
- Feedback regarding the developed technologies and development of a use-case which could be relevant for each specific stakeholder in the future

Currently, the stakeholder group consists of 20 members listed in the confidential appendix. During the last year of the project it could be extended by five new members. The members of the stakeholder group are from several diverse business environments:

- Machine and plant engineering
- Automotive manufacturing
- Home appliance manufacturing
- Robotics
- System integration
- Industrial research
- ICT research
- Certification and technical services

3.2 Stakeholders feedback

The first IoT@Work stakeholder workshop was organized by CRF in their facilities in Orbassano. All IoT@Work partners joined the workshop and most of the stakeholder group members participated. Since many stakeholder workshop outcomes are of a confidential nature, more details are provided in the confidential appendix of [2].

The second IoT@Work stakeholder workshop had again a two days duration and was carried on April, 18th and April, 19th 2013 at the CRF premises in Orbassano. The main objectives of the workshop were to get feedback on the core IoT@Work technologies which have been developed in the IoT@Work project and to investigate the added value of these technologies from a stakeholders’ perspective. The central question to be answered was “How and to which extent can improvements of the automation processes be achieved by the developed IoT@Work technologies?”

The stakeholders were first introduced to all relevant IoT@Work technologies which have been presented in an integrated demonstration scenario. Afterwards, they got precise questions to be answered and provided their opinion about the use of the project results in possible future use-cases of their business domain. As the main
result of the workshop, all invited stakeholders presented interesting scenarios enabled by IoT@Work technologies. All of them agreed that there are manifold options to deploy the IoT@Work project results in their future systems. More details of the methodology and the results of the workshop are provided in the confidential appendix of this document.
4 Cluster activities

4.1 Summary

The consortium has been actively participating in cluster activities, especially the IERC and related projects. All relevant events are shown in Table 4.1.

Table 4.1. IoT@Work cluster activities

<table>
<thead>
<tr>
<th>Cluster activity and location</th>
<th>Partner</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYDRA programming workshop</td>
<td>Siemens</td>
<td>Evaluate the possibilities of using the HYDRA middleware platform.</td>
</tr>
<tr>
<td>ICT conference 2010, Brussels</td>
<td>Siemens</td>
<td>Contacts to other related projects and activities have been maintained and strengthened.</td>
</tr>
<tr>
<td>Future Internet Assemblies, Budapest</td>
<td>Siemens</td>
<td>Contacts to other related projects and activities have been maintained and strengthened.</td>
</tr>
<tr>
<td>Organization of the IERC meeting (activity chains application scenarios and exploitation), Bonn</td>
<td>Siemens</td>
<td>Kicking-off the activities within those activity chains, consolidating their structures and defining their goals.</td>
</tr>
<tr>
<td>IOT-A Stakeholder meeting</td>
<td>Siemens</td>
<td>Some elaborated scenarios and requirements have been provided to IOT-A.</td>
</tr>
<tr>
<td>IOT-A Stakeholder meeting</td>
<td>CRF</td>
<td>Contribution to IOT-A scenario definition.</td>
</tr>
<tr>
<td>Collaboration with IoT-A</td>
<td>Siemens</td>
<td>Coordination and know-how transfer, for instance feedback at several instances to the IOT-A team on the IoT reference model has been provided.</td>
</tr>
<tr>
<td>IERC AC04-AC05 meeting, Brussels</td>
<td>TXT</td>
<td>Presentation of the capability based authorization approach.</td>
</tr>
<tr>
<td>IoT-Week 2011, Barcelona Spain</td>
<td>Siemens/ TXT</td>
<td>Active participation to IoT Week with focus on smart cities and IOT-A Architecture feedback.</td>
</tr>
<tr>
<td>Invited as stakeholder to the EU Project ActionPlant (a project of the Private-Public Partnership “Factories of the Future”)</td>
<td>Siemens</td>
<td>Presentation of the IoT@Work approach to agile manufacturing and enabling IoT technologies.</td>
</tr>
<tr>
<td>IERC meeting, Budapest</td>
<td>TXT</td>
<td>Presentation of the IoT@Work project.</td>
</tr>
<tr>
<td>Provision of details on the capability based authorization approach to the ETSI TC M2M chairman (Mrs. Marylin</td>
<td>TXT</td>
<td>Result of the attendance of the IERC AC04-AC05 meeting.</td>
</tr>
<tr>
<td>Event</td>
<td>Organization</td>
<td>Notes</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
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<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>The same document has also been provided to the IERC reference people (Mr Ovidiu Vermesan, Mr Peter Friess, and Mr Patrick Guillemin)</td>
<td>TXT</td>
<td>AC11 session organization.</td>
</tr>
<tr>
<td>Future Internet Week – Internet of Things: Workshop (Poznan 27/10/2011)</td>
<td>Siemens-TXT</td>
<td>Workshop attendance and AC11 session chairing and presentation.</td>
</tr>
<tr>
<td>Future Internet Week – Internet of Things: Workshop (Poznan 27/10/2011)</td>
<td>TXT</td>
<td>IERC Meeting held in Berlin within the IoT International Forum.</td>
</tr>
<tr>
<td>1st IoT International Forum</td>
<td>TXT</td>
<td>IERC AC1 Meeting held in Trento (Italy) (February, 16th)</td>
</tr>
<tr>
<td>IERC AC1 Meeting held in Trento (Italy) (February, 16th)</td>
<td>Siemens</td>
<td>In this meeting TXT held a presentation on some issues and approaches it is pursuing on: semantics, directory service, event processing, access control. Siemens gave a talk about the IoT@Work architecture.</td>
</tr>
<tr>
<td>IERC AC2 workshop on IoT Interoperability held in Paris (March, 26th)</td>
<td>Siemens</td>
<td>Two presentations: about semantics as a way to face interoperability issues and the architecture.</td>
</tr>
<tr>
<td>Future Internet Week – Internet of Things: workshops and discussions (Aalborg 09-11/05/2012)</td>
<td>Siemens</td>
<td>Workshop attendance and participation to IERC coordination meeting.</td>
</tr>
<tr>
<td>IoT Week 2012, Venice, Italy</td>
<td>Siemens-TXT</td>
<td>Two sessions were organized (&quot;Implementing IoT&quot; and &quot;IoT Exploitation&quot;) and talks were given. IoT@Work was represented with a booth.</td>
</tr>
<tr>
<td>Brussels, Belgium, 9th September 2012</td>
<td>Siemens-TXT</td>
<td>IERC Meeting on Architecture</td>
</tr>
<tr>
<td>Antwerp, Belgium , 23rd till 24th October 2012</td>
<td>Siemens</td>
<td>Architecture input to IOT-A</td>
</tr>
<tr>
<td>Zurich, Switzerland, 22nd November 2012</td>
<td>TXT</td>
<td>Workshop attendance and AC11 session chairing and presentation.</td>
</tr>
<tr>
<td>Delft, Belgium, 4th till 8th February 2013.</td>
<td>EMIC – Siemens</td>
<td>IERC parallel meetings from several ACs.</td>
</tr>
<tr>
<td>IOT-A Architecture boards</td>
<td>Siemens</td>
<td>Discussing the IoT@Work /IOT-A whitepaper on comparison of both communication models.</td>
</tr>
<tr>
<td>IERC Activity Chain 4. IoT Semantic Interoperability: Research Challenges, Best Practices, Solutions and Next Steps - IERC AC4 Manifesto - “Present and Future”</td>
<td>TXT</td>
<td>TXT has contributed to the section about the IoT@Work project.</td>
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</tr>
<tr>
<td>IERC Book 2013</td>
<td>TXT</td>
<td>TXT has contributed to the section about access control issues in IoT by presenting the capability-based access control developed in the project.</td>
</tr>
<tr>
<td>IERC Activity Chain 2. DELIVERABLE D1 “Catalogue of IoT Naming, Addressing and Discovery Schemes in IERC Projects”. Our contribution is in the chapter about the IoT@Work issues on naming</td>
<td>TXT</td>
<td>TXT has contributed to the section about the IoT@Work project.</td>
</tr>
<tr>
<td>IERC Newsletter – June/July 2013</td>
<td>TXT</td>
<td>That IERC Newsletter will include a description of the TXT IoT@Work software and the news that it will be available as Open Source hosted on Google Code.</td>
</tr>
<tr>
<td>IoT Week 2013, Helsinki, Finland</td>
<td>Siemens – TXT – inIT</td>
<td>One session was organized (“IoT@Work in Manufacturing”) and several talks were given within the program, IoT@Work was represented with a booth</td>
</tr>
</tbody>
</table>

### 4.2 Selected activities

IoT@Work actively contributed to the IoT Week 2012 by means of organizing two different sessions within the program. The demo session “Implementing IoT” was organized by the IoT@Work consortium and introduced the demonstrators and pilots from project members of the IERC. The session “IoT Exploitation” was also organized by the IoT@Work consortium in cooperation with the project “ebbits”. During this session it was discussed how the Internet of Things paradigm is going to be realized in everyday-life, permeating the whole economy and society.

During IoT Week 2013 IoT@Work organized the session “IoT for Manufacturing” within the program. The objective of the “IoT for Manufacturing” session was to focus on both the technological challenges posed by the adoption of IoT in the Manufacturing domain and on the potential industrial and socio-economic impacts derived from the full take-up of IoT in the whole product life cycle, including post-sales services and recycling. Besides this, several talks were given by members of the IoT@Work consortium during the event.

TXT contributed to IERC Activity Chain 2 DELIVERABLE D1 “Catalogue of IoT Naming, Addressing and Discovery Schemes in IERC Projects” by means of a chapter about the IoT@Work issues on naming.

The IERC Activity Chain 4 Manifesto “IoT Semantic Interoperability: Research Challenges, Best Practices, Solutions and Next Steps - Present and Future” includes a chapter about the IoT@Work project.
Furthermore, the IERC Book 2013 has a contribution from TXT on the access control issues in IoT and the next IERC Newsletter will include a description of the TXT IoT@Work SW and the news that it will be available as Open Source.
5 Exploitation strategy

5.1 Siemens AG (SAG)

Siemens AG provides a broad spectrum of offerings for industry, energy control and building automation where the IoT@Work results can be applied.

Most prominent among these offerings are the PROFINET based products, covering industrial Ethernet, I/O modules and the software needed to program and manage installations of those products.

The PROFINET technology is driven by the European-centred organisation PI (PROFIBUS & PROFINET International), which comprises more than 1400 members worldwide, where Siemens has been heavily engaged from the very beginning. The PI uses the ISO standardization body to recommend a standard and members of the working groups have also been active in several standardization bodies such as IEEE. The IEEE Ethernet and QoS standardization work attempts to influence the QoS extensions to standard Ethernet to include industrial requirements. More concretely, and during the first year, the standardization work on IEEE 802.1aq known as “Audio Video Bridging” have been influenced by results and further investigations in IoT@Work. The ideas of defining an industrial communication profile in a standard originally destined for providing QoS for home-entertainment Ethernet network, is defended by the Siemens industrial business units. However, the evaluation of the scenarios and use cases where such a standard might be useful and its possible extensions can be influenced by IoT@Work results.

The application areas of interest for Siemens include manufacturing, SCADA systems, networks in ships, buildings, energy distribution networks, and more. Siemens also offers remote services for maintenance and support for the relevant products, as well as planning support and tools for the latter. Constantly improving these products and the service and planning business is vital for the company. There is a trend that unique selling points of products are not so much hardware or software quality or costs of single devices, but more the intelligence needed to adapt to different application domains and the intelligence to cut operational costs. The Siemens teams involved in the IoT@Work project have also successfully applied for EU projects destined at using IoT technologies in specific application areas such as smart grid. The Future Internet PPP project “Future Internet for Smart Energy” (Finseny), as an example, includes not only the research departments from Siemens but also business units investigating the aspects of connecting renewable energies and smart things to a future internet infrastructure.

On a longer term, we expect significant knowledge and improved core technologies for the future generations of solutions for industrial automation in general and specifically for PROFINET-based concepts and products. While the first candidate for applying the results might be in the area of factory and process automation, dissemination into other areas as mentioned before is also planned – already today PROFINET technologies are heavily used, e.g., for energy substation automation. As the success of the European PI organisation proves, a competent mix of partners is required to cover a reasonable broad range of requirements and to develop mature and innovative solutions. Thus IoT@Work brings together major European players in the area of industrial communication and automation to push for Plug&Work concepts, to feed them back into the PI and of course to be able to offer outstanding products and solutions in the mid-term future.

New exploitation topics include the rising interest of SAG business units in flexible and low-cost, yet powerful, Ethernet technologies. Here specifically IoT@Work will intensify the work regarding Shortest Path Bridging (SPB), designated as a major
enabler of the IoT@Work slice concept augmenting the AVB work. The slice concept on its own is also gaining more interest (for allowing an automatic control and management in the network) and will be a prominent part of internal dissemination.

![Figure 5.1. From Industry 1.0 to Industry 4.0 (Source: DFKI 2011)](image)

Since the start of the project, there have been additional developments within the Siemens products that confirm the trend followed in the IoT@Work goals:

1. Totally Integrated Automation (TIA), which Siemens’ Totally Integrated Automation (TIA) portal already makes it possible to utilize recurring data set to plan, test, and implement automation processes. “Automation has long since moved beyond the simple controlling of production processes. It's now also about rapidly adjusting machinery and plants to new products,” says Dr. Thomas Hahn, who manages all of the activities associated with Industry 4.0 (cf. ) at Siemens Corporate Technology (CT).

2. The first OPC UA certified products

3. The network management products SINEMA server, which offer functions and components for planning, monitoring and controlling networks. SINEMA server and SNMP-OPC server network management products support you with the main network management tasks in industrial environments.

4. RuggedNMS™ – Network Management Software: Specifically for the rugged communications industry, RuggedNMS™ provides a comprehensive platform for monitoring, configuring, and maintaining mission-critical IP-based communications networks, such as those found in substation automation and “Smart Grids” for electric utilities, intelligent transportation systems, and advanced control and automation for industrial processes.

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5.2 European Microsoft Innovation Center (EMIC)

The European Microsoft Innovation Center GmbH (EMIC) – since 2012 known as Microsoft Research Advanced Technology Labs Europe – has been driving research, development, and incubation efforts in the project, in two technology areas:

- Dependable device management. EMIC particularly investigated how enterprise system management approaches can be leveraged in a more dependable way. In the IoT@Work project, EMIC has been applying possible solutions to specific use cases central in the project, in order to learn and get feedback from this application domain.

- Complex event processing. EMIC particularly explored the possible value of complex event processing for end-to-end infrastructure monitoring with a strong device/network emphasis and at the same time with a cross-layer, heterogeneous nature.

EMIC’s general exploitation strategy is aimed at impacting Microsoft product roadmaps and future offerings. Microsoft is a leading provider for software technology and platforms. This covers the entire lifecycle of software and system development, such as design, implementation, monitoring, and control.

Specific targets of Microsoft businesses relevant to IoT@Work include the Windows Embedded Business and the Server and Tools Business:

- The Windows Embedded Business in particular tries to bring smart devices towards service oriented devices, which could be used for industrial automation, home automation or process monitoring and control.

- The integration of heterogeneous infrastructures and the investigation of how various devices and actuators can be connected with the backend, such as MS Dynamics or SQL Server, are furthermore key aspects for Microsoft and are meant to support the flexible and easy integration of large-scale heterogeneous environments.

- This also includes monitoring and management of such infrastructures as in scope of the System Center suite of products inside the Server and Tools Business.

EMIC’s specific exploitation goals for IoT@Work included:

- Get firsthand experience about embedded systems in a concrete domain such as factory automation, understand customer problems and extract (security) requirements. Evaluate impact and applicability of Enterprise security technologies on industrial control systems.

- Establish EMIC relationship with customers and partners in the embedded domain.

- Develop patterns and architectural guidance how Microsoft’s enterprise products integrate with embedded systems, e.g. in a factory automation scenario.

- Develop technologies (bridge components, algorithms and protocols) that deliver benefits of enterprise security within the embedded domain – without impairing reliability.

The dependable device management efforts provide possible insights and valuable learning in relation to the roadmap and directions for Microsoft’s system management offerings. The complex event processing efforts provide possible insights and valuable learnings in relation to the roadmap and directions for Microsoft’s system
monitoring offerings as well as thinking around agile system integration. Both efforts provide feedback to roadmap and directions for Microsoft offerings around smart devices and ‘device-to-cloud’ scenarios.

5.3 TXT e-Solutions (TXT)

IoT@Work exploitation focuses mainly on the market segments in which its TXT NEXT Business Unit operates. These are specifically:

- The Aerospace & Defense market segment for TXT NEXT activities on Digital Manufacturing and Managed Service & Consulting: in this market segment manufacturers have to face increasing complexity of production equipment and systems, as well as increasing relevance of production delocalization and/or co-design and co-production on new products (e.g. Boeing 787 Dreamliner), with more stringent constraints on timeliness, cost control, safety measures, production processes and plant monitoring, etc.;
- The High Tech Manufacturing market segment, where companies have to face a progressively increasing challenging and dynamic scenario that envisages shorter products life cycles, the need to optimize and maximize the usage of the production systems, and to readapt the production systems to new productions or to dynamically share these systems to concurrently produce different products according to real-time demand.

To meet these needs and constraints these production Environments envisage an increasing deployment of smarter production equipment, as well as of more dynamic and flexible communication patterns among devices, controlling applications, and internal and external subjects.

The TXT NEXT solutions often have to be designed and developed according to specific software development standards (e.g.: MIL-STD-498, RTCA/DO-178B, DO-200/201, CMMI).

Obviously, ICT solutions for these market segments have to be able to provide a high level of reliability, adaptability and re-configurability, have to heavily reduce human intervention, (re-)configuration time and error rates, provide a wider and more controlled access to production data and systems and offer extensive support for all manufacturing phases and departments (Engineering, Manufacturing, Support, etc.).

The IoT@Work research areas and prototypes fit therefore in the TXT NEXT strategies and market needs, both as a way to improve its knowledge and know how, for exploring new approaches and technological solutions, and to validate in real contexts these approaches and solutions, so that they can be engineered and embedded in TXT NEXT solutions and technical expertise.

The following IoT@Work R&D areas are of particular relevance for the TXT NEXT business unit (and partially to the TXT PERFORM BU):

- Device self-configuration and self-adaptability features;
- IoT awareness (which means taking into account the availability of network and production devices having more intelligence and connectivity capability);
- Technologies for production plant data collection, management and provision;
- Technologies for advanced access control systems that are able to operate in production environments envisaging many internal and external subjects (e.g. suppliers, maintainers, etc.), and to scale and reduce management overhead;
- Applications for near-real-time production data analysis;

3 http://www.txtgroup.com/txtnext/
• Easy to use systems to acquire information about production equipment, services, and production data and status;
• Resiliency and security features.

The internal exploitation activities have been pursued both directly involving people of the operative BUs in many phases of the project (from the design of TXT developed functional elements, to their evaluation, revision and enhancements), as well as via specific internal meetings focused on informing people in the mentioned BU about faced issues, adopted technologies, outcomes, etc..

TXT has also performed exploitation toward external subjects, like:
• Other IERC projects (e.g., IoT6 project via the collaboration with the University of Murcia) of its software. Action that is now being completed providing openly the TXT software;
• Towards industrial partners to promote and exploit the solutions developed in the IoT@Work project (e.g., to Whirpool).

Finally, IoT@Work focused on features and research issues (e.g., IoT, Agile Manufacturing, Distributed Manufacturing and Virtual Factories and Enterprises) that are relevant for the TXT Research and Innovation division, which is the TXT division actually involved in the IoT@Work project.

The TXT Research and Innovation plans to further develop and exploit IoT@Work outcomes on other R&D activities. For example, in the Factories of the Future MSEE project (Manufacturing Service Ecosystem), in the Technology-Enhanced Learning TELL-ME project (Technology Enhanced Learning Livinglab for Manufacturing Environments), as well as in the FI-PPP FITMAN (Future InTernet for MANufacturing) Use Case trials project.

5.4 FIAT Research Center (CRF)

Exploitation of CRF mostly consists in the promotion of the IoT@Work achievements towards the industrial end users of the FIAT group. Key findings of the project are representing real breakthroughs in terms of automation flexibility and may bring significant benefits, once implemented in the settlement or renewal of the automotive production plants. An example of these achievements is the IoT@Work architecture, that can facilitate and reduce interruption time of production line during the Plug&Work bootstrapping of devices in new factories and in-operation adaptation or extension at field level. Another example comes from the domain of the remote maintenance of factory equipment and devices, where the chances offered from the new Internet based functionalities, enable the access to the internal factory elements to establish machine-to-machine communication and trust relationship management between objects/systems.

IoT architecture & technologies are expected to be useful (and appealing for an application in the automotive sector production sites) in the management cycle of the automated production lines, enabling for advanced & future monitoring, prediction of failure tools that get hints and allow efficient prevention and in case quick reparation. Additionally, an effective, reliable and optimized set up of new or updated software devices has a high potential for its adoption, including Plug&Work functionalities as well as data integration capabilities from different platforms within the mainstream of handling goods across the factory.

Exploitation plan of CRF focuses on transferring the IoT@Work project results to the lead users by means of identifying and establishing the most effective strategy of utilization of project results linking the project results, the respective lead users, and
the transfer processes together. The first step is to identify which aspects, elements and technologies are important regarding the exploitation activity.

The IoT@Work architecture integrates some key components and features (examples of which are listed above). Each component is expected to be primarily exploited by the organizations and project partners leading the respective technologies. Even though IoT@Work is not specifically directed at the design and usage of automotive production lines, these achievements and exploitable results are very well applicable to the automotive sector and can be applied in other domains as well. From a general point of view, also the following broader exploitation possibilities could be envisaged, even though only indirectly sustainable by CRF.

For instance, other industrial sectors beyond automotive could represent very valid candidate targets for exploitation. The IoT@Work consortium may want to consider to attract the aerospace, ship-building / ship-repair, high-tech & electronics and goods industries via the dissemination / exploitation channels established by the consortium.

During the exploitation implementation phase the following aspects regarding exploitation could be then defined, analysed and consolidated:

- What will be exploited? Results and products/services (benefits to market, tools, training, consultancy...)
- How will it be exploited? Distribution channel (ways of transferring results to the market)
- Who will be the target groups? Market information (description of market, market size, lead users)

The integrated exploitation approach and effort of CRF will be accompanied by suitable supportive activities, samples of which are described below.

Wherever possible, research results will be exploited for the external development, refinement, and support of new products and services through so-called transfer activities. These products and services will lead to a competitive advantage of the IoT@Work consortium and will substantially contribute to the benefit of the targeted group of end-users and customers. In order for the exploitation to be effective, an integrated approach should be taken, combining experience and expertise from the development departments (technical expertise) and solution management (business expertise), and the involvement of the end-user partners and stakeholders. Continuous analysis of transfer opportunities will also be used to tune up the exploitation opportunities wherever needed.

Actions that could be undertaken for exploitation of project results are:

- Transfer of IoT@Work results to lead user groups by leveraging on the already implemented dissemination activities, including international or national workshops, events, internet, etc.;
- Direct transfer of IoT@Work results to lead users internal to the FIAT group (FGA, COMAU) by IoT@Work partners, while carrying out consultancy and knowledge transfer projects in partnership with CRF;
- Transfer of IoT@Work results to lead user external to the FIAT group through intermediary partners, consultancy firms, software firms, potential new firms to be settled on purpose;

In order to implement the exploitation strategy, it could be useful to concentrate on keeping the dissemination effort which is already going on. For this purpose it is expected that activities like participation at fares such as Hanover Fair, Automation workshops and conferences, etc. will take place also once the project activities are concluded.
6 References


[10] Imtiaz, Jahanzaib; Jasperneite, Jürgen: Performance impacts of different models. IEEE 802.1 AVB Task Group Real Time communication Symposium [Presentation], Munich, Germany, Jan 2012.