RELYonIT
dependability for the internet of things

Research by Experimentation
for Dependability on the
Internet of Things

Funded by the European
Union's Seventh Framework
Programme

D-5.2 – Report on 2nd year cooperation, dissemination and joint activities

Grant Agreement no: 317826
www.relyonit.eu

Date:	February 2, 2015
Author(s) and affiliation:	Marcel Baunach (TUG), Carlo Alberto Boano (TUG), Koen Langendoen (TUD), Alejandro Veiga (ACCIONA), Marius Montón (WOS), Felix Jonathan Oppermann (TUG), Utz Roedig (ULANC), Kay Römer (TUG), Rafael Socorro (ACCIONA), Thiemo Voigt (SICS), Marco Antonio Zúñiga and Koen Langendoen (TUD)
Work package/task:	WP5
Document status:	Final
Dissemination level:	Public
Keywords:	Dissemination, Exploitation.

Abstract This deliverable presents concrete dissemination and exploitation efforts during the second phase of the project. Dissemination includes the publication of several conference papers, posters, and demonstrations, as well as a number of invited presentations of the project to external stakeholders, the scientific community, and the general public. The industrial partners report on past and future exploitation of the project results. Both industrial partners describe their specific plans on the exploitation of the RELYonIT technology after the project completion. Coordination with correlated research projects and research units was continued and the academic partners used the work carried out within RELYonIT in a number of lectures and seminars.

Disclaimer

The information in this document is proprietary to the following RELYonIT consortium members: Graz University of Technology, Swedish Institute of Computer Science AB, Technische Universiteit Delft, University of Lancaster, Worldsensing, Acciona Infraestructuras S.A.

The information in this document is provided "as is", and no guarantee or warranty is given that the information is fit for any particular purpose. The user uses the information at its sole risk and liability. The above referenced consortium members shall have no liability for damages of any kind including without limitation direct, special, indirect, or consequential damages that may result from the use of these materials subject to any liability which is mandatory due to applicable law.

Contents

List of Figures

List of Tables

Executive Summary

This document summarizes the continuous efforts of the consortium with respect to the dissemination and exploitation of the results within the second phase of the project. On the dissemination side, we can report the publication of conference papers, posters and demonstrations, a journal paper, as well as a large number of invited presentations of the project to external stakeholders and at public events.

Regarding exploitation, the industrial partners present their activities to prepare the integration of the RELYonIT technology and know-how within current and future products. Coordination with related research projects and research units was continued. The academic partners have used the work carried out within the RELYonIT project in a number of lectures and seminars.

1 Introduction

This deliverable reports on all dissemination, exploitation, and joint activities carried out during the second phase of the RELYonIT project. Specifically, this report covers dissemination activities such as publications, invited talks, and publicity (Chapter 2); exploitation activities (Chapter 3); as well as joint activities among the members of the RELYonIT consortium and with external partners and projects (Chapter 4).

2 Dissemination

Continuing the efforts started in the first phase of the project, the goals and the results were continuously disseminated to industry, academia, and the general public whenever possible through a number of different means. The following sections describe different levels of dissemination activities for promoting the wide adoption of our research and technology within the second phase of the project.

2.1 Publications

A significant number of RELYonIT-related articles has been published at a number of leading conferences, workshops, and journals in our research field, such as the IEEE/ACM International Conference on Information Processing in Sensor Networks (IPSN), the ACM Conference on Embedded Networked Sensor Systems (SenSys), as well as the ACM Transactions of Sensor Networks. Most of the articles have been co-authored by two or more project partners.

- SICS and TUG published a poster abstract titled "Temperature Hints for Sensornet Routing" [8] at the *11th ACM Conference on Embedded Networked Sensor Systems (SenSys)* in November 2013. In the poster abstract, temperature effects on the routing layer are analyzed, finding that temperature fluctuations may cause undesirable behavior of routing protocols such as CTP and RPL. An approach to make these protocols more robust to temperature fluctuations by augmenting the ETX link metric with temperature hints is then proposed.

- ULANC, TUG, and SICS published a demo abstract titled "How Temperature Affects IoT Communication" [7] at the *11th European Conference on Wireless Sensor Networks (EWSN)*. In this demonstration, we show how ambient temperature affects the performance of an IoT application. Specifically, we connect remotely to TempLab, our temperature-controlled testbed, and show how temperature affects the operation of a state-of-the-art routing protocol. **This demonstration received the best demo runner-up award.**

- TUG, ULANC, and TUD published a demo abstract titled "A Testbed Infrastructure to Study the Impact of Temperature on WSN" [3] at the *11th IEEE Conference on Pervasive Computing and Communications (PerCom)*. In this demo, we present TempLab, our testbed infrastructure based on infra-red heating lamps that allows to vary the onboard temperature of sensor nodes on a large scale in a repeatable fashion. Using this experimental infrastructure, we show the effects of temperature variations on network performance.

Figure 2.1: Presentation of TempLab at the 13th International Conference on Information Processing in Sensor Networks (IPSN) held in Berlin, Germany during October 2014.

- TUG, TUD, ULANC, and SICS published a paper titled "TempLab: A Testbed Infrastructure to Study the Impact of Temperature on Wireless Sensor Networks" [5] at the *13th International Conference on Information Processing in Sensor Networks (IPSN)*. This paper presents the design and implementation of TempLab, an extension for wireless sensor networks testbeds that allows to control the on-board temperature of sensor nodes and to study the effects of temperature variations on the network performance in a precise and repeatable fashion. TempLab can accurately reproduce traces recorded in outdoor environments with fine granularity, while minimizing the hardware costs and configuration overhead.

- ULANC and TUG published a paper titled "Estimating Packet Reception Rate in Noisy Environments" [6] at the *9th IEEE International Workshop on Practical Issues in Building Sensor Network Applications (SenseApp)*. In this work we show that it is possible to obtain a meaningful representation of the expected interference levels at the target location by measuring the probability distribution function of idle period lengths, and use this to estimate the packet reception rate before network deployment. We further illustrate how to exploit this methodology to estimate the reception rate as a function of the used packet length.

- TUG and SICS published a paper titled "Mitigating the Adverse Effects of Temperature on Low-Power Wireless Protocols" [4] at the *11th IEEE International Conference on Mobile Ad hoc and Sensor Systems (MASS)*. In this paper, we show the adverse effects of temperature on communication protocols and propose two mechanisms to dynamically adapt the clear channel assessment threshold to temperature changes, thus making data link layer protocols temperature-aware.

- ULANC published an article titled "Constructing Schedules for Time-Critical Data Delivery in Wireless Sensor Networks" [10] in the *ACM Transactions on Sensor Networks* (TOSN) in August 2014. The paper addresses the problem of finding the best TDMA schedule for industrial process automation and control applications which can support delay and reliability requirements within an environment subject to interference.

- TUG published a joint poster abstract with ETH Zürich titled "Automatic Configuration of Controlled Interference Experiments in Sensornet Testbeds" [9] at the *12th ACM Conference on Embedded Networked Sensor Systems (SenSys)*. This poster abstract presents an approach to automatically configure the JamLab testbed extension [2]. The system selects a suitable set of nodes to act as jamming device by employing simulated annealing optimization and thus makes the configuration of larger testbeds more traceable.
- SICS and Uppsala University have published a joint paper entitled "Detecting and Avoiding Multiple Sources of Interference in the 2.4 GHz Spectrum" at the *12th European Conference on Wireless Sensor Networks (EWSN)* held in Porto, Portugal during February 2015. In contrast to previous work, this paper presents a system that is able to detect multiple sources of interferences: this helps to choose adequate mitigation strategies.

2.2 Presentations

In addition to the publication of papers and posters at scientific conferences and workshops, the project partners also used the opportunity to introduce the project goals and results as part of invited talks and presentations.

- Chamath Keppitiyagama (SICS) gave a talk on "Sensor Hints for Sensornet Routing" at FORTH-ICS in Crete, Greece, in September 2013.
- Kay Römer (TUG) delivered an invited talk entitled "Dependable Sensor Networks" during the 4th International Conference on Intelligent Sensor Networks (ISN) held in Eindhoven, The Netherlands, on November 12, 2013. Also, he was an invited panelist during the plenary panel session of this conference. ISN is an industry conference with more than 100 participants mostly from industry but also from research institutions.
- Carlo Alberto Boano (TUG) gave a seminar talk entitled "The Impact of Temperature on Wireless Sensor Networks" at TU Graz on November 11, 2013.
- Marco Zúñiga (TUD) gave an invited talk entitled "Communicating Networked Embedded Systems with Visual Light: Open Research Problems" at Uppsala University, Sweden, on November 2013.
- Marco Zúñiga (TUD) gave an invited talk entitled "Monitoring the density of mobile crowds with a lightweight cardinality estimator", at SICS, Sweden, on November 2013.
- Kay Römer (TUG) gave an invited talk entitled "Environmental Testbeds for Dependable Sensor Networks" at the Dagstuhl Seminar on Geosensor Networks on December 1, 2013. Dagstuhl Seminars are research workshops where invited leading experts meet for one week to discuss the latest research.
- Luca Mottola (SICS) gave an invited talk entitled "Engineering Cyberphysical System Software" at Peking University in Beijing (China), hosted by Dr. Zhi Jin, on January 15, 2014.

- Kay Römer (TUG) delivered an invited talk entitled "Environment-Aware Protocols for Networked Embedded Systems" during the Dagstuhl Seminar on Algorithms for Wireless Communication on January 26, 2014. Dagstuhl Seminars are research workshops where invited leading experts meet for one week to discuss the latest research.
- Chamath Keppitiyagama (SICS) gave a talk on "Sensor Hints for Sensornet Routing" at the UNIGE in Geneva in February 2014.
- Andreas Mauthe (ULANC) delivered a presentation on transition in future communication systems, including IoT networks. RELYonIT was specifically discussed as one example within this space at the Federal University of Rio de Janeiro, Brazil, on June, 11 2014.
- Kay Römer (TUG) delivered an invited lecture entitled "ICT Challenges and Solutions for Industry 4.0" during the Seminar "Industry 4.0" at the University of Leoben on June 25, 2015. The talk focused on the use of reliable IoT Technologies for Smart Production. About 40 industry representatives participated in the seminar.
- Marco Zúñiga (TUD) gave an invited talk entitled "OpenLight: Software-Defined VLC, Shining a Light on Embedded Networks" for the European Cooperation in Science and Technology, Action IC1101 OPTICWISE on July 2014.
- Màrius Montón (WOS) was a lecturer at the PhD summer school "Internet of Things and Smart Cities Ph.D. School 2014" organized by University of Parma in Lerici, Italy during September 2014.
- Thiemo Voigt (SICS) gave a presentation at RBCCPS, IISc, India, titled "Supporting CPS / IoT with Wireless Sensor Networks" in September 2014.
- Thiemo Voigt (SICS) gave a presentation at IIT Mumbai, India, titled "Supporting CPS / IoT with Wireless Sensor Networks" in September 2014.
- Thiemo Voigt (SICS) gave a presentation at the University of Colombo, Sri Lanka, titled "Supporting CPS / IoT with Wireless Sensor Networks" in September 2014.
- Kay Römer (TUG) served as an invited panelist during the session "Experimenting and Piloting on Internet of Things" during the FIRE Forum 2014 on October 15, 2014. He also gave a short presentation of the RELYonIT project.
- Màrius Montón (WOS) gave an invited lecture in PhD summer school "IoT 360 PhD summer school" organized by the European Alliance for Innovation, Rome, Italy, on October 30, 2014.
- Kay Römer (TUG) delivered an invited talk entitled "Hot Sensor Networks" during the 5th International Conference on Intelligent Sensor Networks (ISN) held in Eindhoven, The Netherlands, on November 4, 2014. ISN is an industry conference with more than 100 participants mostly from industry but also from research institutions.

Figure 2.2: The RELYonIT demo at the 11th European Conference on Wireless Sensor Networks (EWSN) held in Oxford, United Kingdom, during February 2014. The demonstration received the best demo runner-up award.

- Luca Mottola (SICS) gave a tutorial entitled "Engineering Cyberphysical System Software" at the 22nd International Symposium on Foundations of Software Engineering (FSE), held in Hong Kong, China, on November 16, 2014.
- Kay Römer (TUG) gave an invited talk entitled "Dependable Sensor Networks" during the Cyber-Physical Systems Workshop at the EIT-ICT Lab in Budapest on December 1, 2014.
- Marco Zúñiga (TUD) gave an invited talk entitled "Strengthening Wireless Sensor Networks: Extreme Conditions, Environmental Dynamics and Graph Filters" at The University of Edinburgh, United Kingdom, on December 2014. In this talk, work from RELYonIT was presented as part of recent advancements in IoT.
- Kay Römer (TUG) delivered an invited talk entitled "Reliable Information and Communication Technologies for Sustainable Systems" during the Workshop "Sustainable Systems" at Graz University of Technology in May 2014. A delegation of the state government of the Austrian State of Styria participated in this workshop to discuss the use of ICT in future Smart Cities.
- Andreas Mauthe (ULANC) delivered a presentation on heterogeneous autonomic networks with a focus on IoT at the Federal University of Para, Belem, Brazil on July. 7 2014. RELYonIT and possibly extensions have been discussed with researchers there.

Figure 2.3: The RELYonIT demo at the Future Internet Assembly 2014.

2.3 Demonstrations

The progress and results of the RELYonIT project were also presented by means of practical demonstrations at a number of scientific events. Besides disseminating results and ideas to the research community, this also provided us with an excellent opportunity to receive feedback on the employed approach and developed solutions. It further served as a forum to establish contacts for future collaborations.

- Demonstration titled "How Temperature Affects IoT Communication" [7] at the *11th European Conference on Wireless Sensor Networks (EWSN)* in Oxford, UK on February 18, 2014 (see also Fig. 2.2). **The demonstration received the best demo runner-up award.**
- Demonstration at the *Future Internet Assembly 2014* in Athens, Greece from March 18–20, 2014 (see also Fig. 2.3 and Fig. 4.1).
- Demonstration titled "A Testbed Infrastructure to Study the Impact of Temperature on WSN" [3] at the *11th IEEE Conference on Pervasive Computing and Communications (PerCom)* in Budapest, Hungary on March 25, 2014 (see also Fig. 2.4).

Figure 2.4: The RELYonIT demo at the 11th IEEE Conference on Pervasive Computing and Communications (PerCom) held in Budapest, Hungary, during March 2014.

2.4 Publicity

In addition to the previously outlined efforts to disseminate RELYonIT ideas and results to the scientific community, the project also made some efforts to inform the general public about project goals, ideas, and results. Several press releases served as a way to arouse the interest of potential future users in industry. During the second year, the RELYonIT project attracted continuous attention in the following media:

- The project consortium published an article entitled "RELYonIT: No dependability, no Internet of Things" in the *FIRE Magazine 2014* [11].
- The project consortium published an article entitled "RELYonIT: Dependability for the Internet of Things" in January 2015 on the *IEEE IoT Newsletter* (`http://iot.ieee.org/newsletter/`).
- The *Wireless Sensor Network Magazine* published an article titled "Automatic Configuration of Controlled Interference Experiments in Sensornet Testbeds" on October 2014 (`http://www.wsnmagazine.com/automatic-configuration/`).
- WOS published a news item about starting experiments on their website (`http://www.worldsensing.com/news-press/relyonit-european-project-first-integrated-experiments.html`).
- WOS published a new item about the FIA demo on their website (`http://www.worldsensing.com/news-press/worldsensing-participates-in-the-future-internet-assembly.html`).
- TUG published a press release entitled "Smartes Parken und Co.: Wie Informationstechniker der TU Graz das Internet der Dinge zuverlässiger machen" (Smart parking & Co: How computer engineers of TU Graz make the Internet of Things more reliable) about the results of the RELYonIT project in January 2015 (`http://presse.tugraz.at/pressemitteilungen/2015/27.01.2015.htm`).

- SICS published a press release entitled "RELYonIT – robusta lösningar för Sakernas Internet" (RELYonIT– robust solutions for the Internet of Things) about the results of the RELYonIT project in January 2015.
- *Computerwelt.at* published an article titled "TU Graz macht 'Internet der Dinge' zuverlässiger" (TU Graz makes 'The Internet of Things' more reliable) on January 27, 2015 (`http://www.computerwelt.at/news/wirtschaft-politik/forschung-wissenschaft/detail/artikel/107783-tu-graz-macht-internet-der-dinge-zuverlaessiger/`).
- *Der Standard* published an article titled "Intelligent parken: Techniker erhöhen Zuverlässlichkeit von Park-Apps" (Smart parking: technologies that increase the reliability of parking-apps) on January 27, 2015 (`http://derstandard.at/2000010939153/Intelligent-parken-Techniker-erhoehen-Zuverlaesslichkeit-von-Park-Apps`).
- The website *www.uni-protokolle.de* published an article "Smartes Parken: Informationstechniker der TU Graz machen das Internet der Dinge zuverlässiger" (Smart parking: computer scientists of TU Graz make the Internet of Things more reliable) on January 27, 2015.
- The website *innovations report* published an article titled "'Smartes' Parken: Informationstechniker der TU Graz machen das 'Internet der Dinge' zuverlässiger" ('Smart' parking: Computer engineers of TU Graz make the 'Internet of Things' more reliable) on January 27, 2015 (`http://www.innovations-report.de/html/berichte/informationstechnologie/smartes-parken-informationstechniker-der-tu-graz-machen-das-internet-der-dinge-zuverlaessiger.html`).
- The website *BUSINESS.NEWZS* published an article titled "'Smartes' Parken: Informationstechniker der TU Graz machen das 'Internet der Dinge' zuverlässiger" ('Smart' parking: Computer engineers of TU Graz make the 'Internet of Things' more reliable) on January 27, 2015 (`http://business.newzs.de/2015/01/27/smartes-parken-informationstechniker-der-tu-graz-machen-das-internet-der-dinge-zuverlaessiger/`).
- The website *Ad Hoc News* published an article titled "Innovationen – Intelligent parken: Techniker erhöhen Zuverlässlichkeit von Park-Apps" (Innovations – engineers increase the reliability of parking apps) on January 27, 2015 (`http://www.ad-hoc-news.de/innovationen-intelligent-parken-techniker-erhoehen--/de/News/41563927`).
- The website *BOERSENPOINT.DE* published an article titled "Innovationen – Intelligent parken: Techniker erhöhen Zuverlässlichkeit von Park-Apps" (Innovations – engineers increase the reliability of parking apps) on January 27, 2015 (`http://www.boersenpoint.de/boersenportal/maerkte-nachrichten/unternehmensmeldungen/nachricht/innovationen-intelligent-parken-techniker-erhoehen-zuverlaesslichkeit-von-park-apps-1523322/`).
- The website *mynewsdesk* published an article titled "Robusta lösningar för Sakernas Internet" (Robust solutions for the Internet of Things) on January 27, 2015

(http://www.mynewsdesk.com/se/sics/pressreleases/robusta-loesningar-foer-sakernas-internet-1109629).

- The Austrian press agency *APA* published an article titled "Intelligent parken: Techniker erhöhen Zuverlässlichkeit von Park-Apps" (Intelligent parking: engineers increase the reliability of parking apps) on January 28, 2015 (http://science.apa.at/rubrik/natur_und_technik/Intelligent_parken_Techniker_erhoehen_Zuverlaesslichkeit_von_Park-Apps/SCI_20150128_SCI39391351422143622).
- The website *NEWSAT* published an article titled "Intelligent parken mit Park-Apps – Forscher der TU Graz erarbeiten Lösungen für höhere Zuverlässigkeit" (Intelligent parking with parking apps – Scientist at TU Graz develop solutions for higher reliability) on January 28, 2015 (http://www.news.at/a/park-apps-intelligent-parken).
- *ELEKTRONIK TIDNINGEN* published an article titled "Contiki bevisar sig i EU-projekt" (Contiki is used by EU project) on January 28, 2015 (http://www.etn.se/index.php?option=com_content&view=article&id=60405).
- *UNI.at* published an article titled "Intelligent parken: Techniker erhöhen Zuverlässlichkeit von Park-Apps" (Intelligent parking: engineers increase the reliability of parking apps) on January 28, 2015 (http://www.uni.at/innovation-forschung/intelligent-parken-techniker-erhoehen-zuverlaesslichkeit-von-park-apps/).
- *Kronen Zeitung* published an article titled "Das 'Internet der Dinge' – ITIer der TU Graz machen 'Smart Features' zuverlässiger" (The 'Internet of Things' – Researchers of the institute ITI at TU Graz make 'Smart Features' more reliable) on January 29, 2015.
- *Wissenschaftler.de* published an article titled "'Smartes' Parken: 'Internet der Dinge' zuverlässiger" (Smart parking: 'Internet of Things' more reliable) on January 29, 2015 (http://www.wissenschaftler.de/news/item/5864-%E2%80%9Esmartes%E2%80%9C-parken-%E2%80%9Einternet-der-dinge%E2%80%9C-zuverl%C3%A4ssiger).
- *Die Presse.com* published an article titled "Computer mit Verständnis für Umwelteinflüsse – Software findet Parklücken und Schäden an Gebäuden." (Computers with understanding for environment factors – Software finds empty parking spots and demage in buildings.) on January 30, 2015 (http://diepresse.com/home/science/4651720/Computer-mit-Verstaendnis-fur-Umwelteinflusse).

2.5 Organization of Events

Conferences and workshops provide an adequate platform for the presentation of novel findings, techniques, and their application in theory and practice. These international events are commonly organized by universities and also create valuable opportunities for researchers from academia and industry to get in touch and exchange ideas or discuss visions. RELYonIT project partners participated in the organization of a number of major WSN and IoT conferences:

- Kay Römer (TUG) served as the general co-chair of the *International Conference on Architecture of Computing Systems (ARCS)* held in Lübeck, Germany, during February 2014. The special focus of this edition was on "Embedded computer systems connecting computing with the physical world".
- Kay Römer (TUG) served as the program vice-chair for the *11th IEEE International Conference on Pervasive Computing and Communications (PerCom)* held in Budapest, Hungary, during March 2014, which focuses, among others, on communication systems and protocols for embedded devices.
- Kay Römer (TUG) served as the program chair for the track "Systems and Applications" of the *1oth IEEE International Conference on Distributed Computing in Sensor Systems (DCOSS)* held in Marina del Rey, CA, USA, during May 2014.
- Kay Römer (TUG) served as the demonstration co-chair of the *12th ACM International Conference on Networked Embedded Sensing Systems (SenSys)* held in Memphis, TN, USA, during November 2014.
- Thiemo Voigt (SICS) served as track chair at the *11th IEEE International Conference on Mobile Ad-hoc and Sensor Systems (IEEE MASS)* held in Philadelphia, PE, USA, during October 2014.
- Thiemo Voigt (SICS) serves as track chair at the *35th International Conference on Distributed Computing Systems (ICDCS)* held in Columbus, OH, USA, during June 2015.

2.6 Teaching

Ideas and concepts developed in the RELYonIT project were also integrated into the teaching curriculum at the academic partners. In addition, a number of student theses were based on topics with a strong relevance to the project.

Lectures, seminars, labs:

- TUD master course "SmartPhone Sensing", April-June 2014. In this course students develop apps for indoor localization based on WiFi signals, which are prone to interference. Thanks to the insights gained within the RELYonIT project, we make students aware of the many potential sources of interference that RF signals can face.
- TUG master course "SmartPhone Sensing", June-July 2014. This course was a shorter version of the course given at TU Delft. The outcomes and relation to the RELYonIT project are the same as the above bullet point.
- TUD lecture as part of a PhD Colloquium "Think Globally, Act Locally: On the Reshaping of Information Potentials", Technische Universitat Darmstadt (TU Darmstadt), Germany on February 2013. This talk exposed students to the challenges and solutions of processing data when faced with high network dynamics.

- TUG master course "Context-Aware Computing" is devoted to self-adaptive and self-organizing networked embedded systems. The course covered especially modeling of and parameter adaptation of sensor networks and uses results from RELYonIT.
- TUG master course "Location-Aware Computing" is devoted to networking protocols for sensor networks and also covers MAC and routing protocols that are a research subject in RELYonIT.
- TUG master laboratory course "Mobile Computing" is devoted to real-time computing in sensor networks, which is closely related to research in RELYonIT aiming at a more predictable latency.
- Thiemo Voigt (SICS) gives a course "Internet of Things" at Uppsala University, from January to March 2015. The course includes topics relevant to the RELYonIT project.

Student thesis:

- Platon Efstathiadis (TUD) is working on his MSc thesis entitled "SMoT: A Smartphone Based Mobile Testbed" with defense planned for 2015. This thesis is motivated in part by insights obtained within the RELYonIT project.
- Si Li (TUD) defended his MSc thesis entitled "Network Lifetime Analysis of Data Collection Protocols" on August 2014. The thesis has been carried out within the RELYonIT project.
- Carlo Alberto Boano (TUG) defended his PhD thesis entitled "Dependable Wireless Sensor Networks" in November 2014. The thesis has been carried out within the RELYonIT project.
- Felix Jonathan Oppermann (TUG) is working on his PhD thesis entitled "Programming and Configuration of Wireless Sensor Networks" with the defense planned for 2015. The thesis is being carried out within the RELYonIT project.
- Horst Fuchs (TUG) defended his Bachelor thesis entitled "The Impact of Temperature Variations on Clear Channel Assessment Operation in Wireless Sensor Networks" in August 2014. The thesis has been carried out within the RELYonIT project.
- Lenka Hanesová (UzL) defended her Master's thesis entitled "Reliable Low-Power Wireless Communications between Wireless Sensor Nodes despite Radio Interference" in February 2014. The thesis has analysed the impact of temperature on MAC protocols.
- Bernward Jelonek (UzL) defended his Bachelor thesis entitled "A Wireless Sensor Network Testbed with Temperature Control" in February 2014. The thesis contained a portion of TempLab's implementation, the testbed used in WP4 to replay the impact of temperature variations on communication performance.

3 Exploitation

In the following section, the industrial partners Worldsensing and ACCIONA describe exploitation activities and highlight future internal and external exploitation opportunities.

3.1 Worldsensing

Worldsensing's core business is centered on the development of the smart city and smart transportation market, offering complete end-to-end technology and services on top of ultra low power wireless sensor technology.

WOS' prime product, referred to as FastPrk [13], is targeting the outdoor smart parking market, being it privately owned (such as shopping malls) or public (such as town halls). It addresses the obvious headache of losing a lot of time, money, and health by not being able to find a parking spot quickly. It also addresses the enormous traffic problem and occupation optimization in cities improving the street parking management and income optimization due to strict parking enforcement. The technology is composed of sensors installed in each parking spot that communicate wirelessly with an Internet-enabled gateway to inform about the absence/presence of a car.

The other division that constitutes the company is the Industrial Division, focused on structural health monitoring and hazard control, with the deployment of wireless sensors to monitor different parameters of buildings, tunnels, pillars or other structures as well as seismic and micro-seismic monitoring for geological markets (CO_2 reservoir control, dam monitoring, etc.). These markets' requirements are very high in terms of reliability and quality control, and are very difficult to accomplish with the available radio technologies. Indeed, current deployments are still using wired communication protocols. Worldsensing is confident to achieve the high-grade requirements for these markets allowing the company to enter and exploit this huge potential market.

With WOS being part of this project, the cooperation allows us to position and brand us as a company making a significant and viable step towards more sustainable and reliable M2M/WSN/IoT deployments.

3.1.1 Exploitation Activities During Project Execution

WOS business units were continuously updated with the opportunities offered by the RELYonIT project. Clearly, RELYonIT results can be applied to WOS' Loadsensing business unit (currently named Industrial Division). Loadsensing is the line of products designed to wirelessly monitor infrastructure assets like bridges or tunnels where ambient conditions can be extreme and monitoring system reliability is a very important aspect of the overall product.

Periodic internal reports and meetings kept the Industrial Division up-to-date with latest news about the various RELYonIT steps. Also, both Divisions were informed about the demo

site experiments carried out by project members. Although the demonstrator use case was focused on one of the Divions (Traffic Division) expected results and enhancements were of interest for the two Divisions.

3.1.2 Future Exploitation Activities

With the final results of the RELYonIT project, the Industrial Division is working on the design of a new line of products, focused on critical hazard monitoring. As announced in previous Deliverable D5.1, Industrial Division has started the requirements definition of a new product for critical hazard monitoring (oil and gas pipelines, dams, shell prospecting, CO_2 reservoir monitoring, etc.) The enhancement on radio communications can also be suitable for this WOS product named SpiderNano. This new product famliy is a seismic data acquisition unit with real-time characteristics and high throughput. These systems are typically deployed in hazardous environments like jungles, deserts, or tundra in case of oil prospecting. The product is currently under development, and its engineering team is periodically updated with RELYonIT achievements.

The Industrial Division has showed interest in enhancing real-time monitoring systems with more reliable radio links. Due the nature of the typical deployments of this product usually in depopulated areas, the most interesting output of the RELYonIT project is the temperature correction mechanism developed in the project. With the addition of these techniques to the SpiderNano product, we expect to achieve a reliability of 99.99%, which is similar to the current wired solutions found in the market. This high reliability will enable Worldsensing to offer one of the first real-time data acquisition devices with wireless communications in the market.

Due to the explosion of new LPWAN radio technologies in the last two years (Sigfox, Lora by Semtech, Weightless, etc.) new perspectives in the Traffic Division (in charge of Smart Parking application FastPrk) is being informed about the RELYonIT outputs. In these periodic meetings the company's Chief Technology Officer (CTO) is also present in order to synchronize the needs and vision of the company with the last news about technical advancements.

Worldsensing has detected that it can enhance some of the protocols and technologies being used in the last year with the temperature correction methodology in the case of FastPrk product using LPWAN technologies. The company is studying the implementation of these methods in its products and the publication of the enhancements to the community.

With all this knowledge, the company has a new set of tools in order to decide what product of the portfolio will enhance and what kind of new products can be designed. The vision inside the company is that a disruptive multi-hop network based on long range radio technologies is possible to implement and it will take advantage of the new solutions designed in the RELYonIT project.

This multi-hop network will be used by the Industrial Division to increase the operating range and reliability of the products, opening new markets like the monitoring of tunnels or wide space open areas like harbors. In these two new use cases, the reliability is critical due the nature of the environment to monitor.

Also, the increase of reliability due to interference control and temperature compensation that still enables a low power consumption will give the company the chance of adding side-products such as in-field assets and/or person management and tracking, hence enabling new markets.

3.2 ACCIONA

ACCIONA Infrastructure is a leading European construction company constructing and managing buildings and civil infrastructures under the sustainability principles. It has an international presence in more than 30 countries employing 15.800 people. In 2010, it had a total turnover of 3,1 billion Euro. It is part of ACCIONA Group, whose business lines are Construction, Real Estate, Urban-Environmental Services, Energy, Logistic and Transport. In this section, we report on past exploitation activities during the project and the planned exploitation activities that go beyond the finalization of the project. If the reader would like to check more information about the ACCIONA's Business Model, the General exploitation strategy and the transfer opportunities, please refer to D-5.1.

3.2.1 Exploitation Activities During Project Execution

As it was reported in D-5.1, during the first year of the project, a number of face to face meeting among the different ACCIONA business units took place. As the results of the project were becoming more mature and promising, additional meetings with the managers of the ACCIONA business units with possible interests in taking advantage of the project results were scheduled. One of the major outcomes of these meetings was the decision to start working on the deployment of a small demo site to begin evaluating the potential of RELYonIT results. All the three business units were requested to suggest possible use cases with a high relevance to their business focus. In parallel, the innovation unit was involved directly in the project and contacted the project coordinator to determine if the aforementioned demo activity could be run within the scope of the project, although it was not initially planned by the original Description of Work. After a thorough discussions among the members of the consortium, it was agreed to include a new use case demonstration within the project. Although the three business units (ACCIONA Services, Transmediterranea, Infaestructures) were all very interested in the results of the project, it was decided to prioritize the collaboration with ACCIONA Infraestructures, as their needs fit best with the advantages of RELYonIT technology. Different possible use case scenarios were considered, all of them directly related to the infrastructure construction field, and two potential use cases were selected:

- **Pressure measurement application in semi-submersible offshore concrete structure.** The key aspect here is to collect pressure measurements in different locations of the concrete structure caused by the ocean waves. ACCIONA is currently building the Oceanic Platform of the Canary Islands (`http://www.plocan.eu/en/home-2.html`).
- **Thermal Properties Measurement Application of Traditional Insulation Systems for Energy Efficient Buildings.** In order to build energy-efficient buildings, it is very important to carefully test the insulating materials used in the construction to reduce heat transfer. These tests are typically carried out in specialized laboratories, but ACCIONA has gone one step further and a demo park has being built in order to carry out more accurate tests.

Although both use cases are of significant interest to the company, only the second one was chosen for implementation within the project as the relevant market is more consolidated and

the company possesses a more thorough knowledge. In addition, the demo park is easier to access than the oceanic platform, which made it more suitable for the required experimentation. The second use case will be re-evaluated based on the final results of the RELYonIT project.

Once the use case was selected and communicated to the rest of the consortium, there was a need of analysing the use case more deeply and to collect detailed and accurate requirements from the involved business unit. Planning of the requirement collection and the use case implementation was immediately started by an internal meeting of the involved groups of the innovation unit (new materials and ICT) and the staff dedicated to the management of projects in the new materials field. The resulting requirements are described in deliverable D-4.4. During the actual experimentation phase, the experiments relevance to the company's business perspective was constantly monitored and correctives measures were implemented to ensure the lesson learned could lead to logical decisions for ACCIONA. Finally, given the results achieved in the DEMOPARK temperature experiments, the company has decided to adopt RELYonIT improvements in all the WSN to be deployed in the future new material tests, especially the ones that need the sensors nodes to be outdoor (e.g. on the building facades).

3.2.2 Future Exploitation Activities

After the completion of the project, concrete exploitation actions are already planned. Internal meetings among innovation and business units will continue to discuss the results of the project and to make sure that everybody is in-line regarding the next steps. On the innovation side, a stable collaboration group will be created including one researcher from the New Material group and one researcher from the ICT group. The aim of this working group is to more efficiently provide technical support to the involved business units and thus facilitate the utilization of RELYonIT technology and know-how. The next immediate step will be the selection of the most appropriate future experiments, to be carried out both in the demo park and in a real infrastructure. Some preliminary experiments, that will aid the decision, are already running right now. The most promising scenario involves new kind of auto washable paint, researched by our innovation department. Thanks to the improvements developed inside RELYonIT, the communications among the sensors nodes installed on the building facades will be stable enough to allow not to loose samples during the months which the experiment will be running, as the system will be stronger against temperature variations (expected to be relevant, as the motes will be deployed outdoor).

As a second step, a building to install the new material will be chosen, either a newly constructed or a refurbished one. In the interest of efficiency, the company will try to select a building within Spain or at least the European Union, even though most current projects are outside Europe due to the economic crisis. The first deployment will be closely guided by the innovation unit, more specifically by the working group introduced earlier. During this deployment, it is crucial to transfer the expertise regarding reliable WSNs to the construction unit and the main implication that brings this fact: simplified deployment of the nodes, as it is not needed to take into account the sun incidence (and the shadows) to select their outdoor locations. As the construction project will deal with new materials, some highly-qualified engineers will be leading the working group and we will therefore implement expertise transfer. In the following months, a deep analysis of the WSN behaviour and performance will be conducted by the innovation unit based on collected data traces. They will be also prepared

to arrange any corrective action to be taken, if necessary.

Depending of the success of the whole process, the managers of the different business units involved will make a decision about the feasibility of incorporating this service into the formal procedures inside the company. If the outcome is positive, the updated process, involving the use of reliable WSN technology, will be adopted by units in respective geographical zones (e.g., if a first successful test is carried out in Australia, all the construction units there will implement this) Periodic meetings will be arranged with the other business units that provided uses cases in the beginning of RELYonIT project, but were postponed (mainly, due to a lack of resources). It will be investigated, if it makes sense to introduce WSNs with RELYonIT improvements into other specific business areas of Transmediterranea and ACCIONA Services. The use of advanced WSN and IoT technology will give ACCIONA a competitive advantage in a highly competitive market.

4 Joint Activities

During the second period of the project, the partners of the consortium participated in a number of internal meetings and external events. This includes FIRE related activities, such as the Future Internet Assembly 2014 in Athens, Greece. In addition, collaborations with a number of external partners and projects were performed.

4.1 Internal Project Meetings

The whole consortium met three times during the second period of the project. These meetings were used to discuss fundamental research issues and for detailed planing of the prevailing work.

4.1.1 Second Project Review in Brussels

On November 20, 2013, the second review of the project took place in Brussels, Belgium. The agenda of the meeting is summarized in Table 4.1. One the day before the review meeting, a technical meeting among all project partners was held on the premises of the Steiermark-Büro Brüssel, the representation of the Austrian state of Styria in Brussels. Besides the preparation of the review, project progress and future work have been discussed.

4.1.2 Project Meeting in Oxford

A RELYonIT technical meeting took place on February 19–20, 2014 in Oxford, United Kingdom. The meeting was subsequent to the *11th European Conference on Wireless Sensor Networks (EWSN)* (February 17–19, 2014), where we presented our demonstration "How Temperature Affects IoT Communication" [7].

The meeting focused on the experiments required for the work in WP1 and WP2. In addition, we discussed details of the RELYonIT software architecture and specified the interaction of the individual components.

4.1.3 Project Meeting in Barcelona

A RELYonIT technical meeting took place on June 16–18, 2014 in Barcelona, Spain.

A focus of the meeting where lessons learned from the first integrated experiment and the preparation of the second integrated experiment. In addition, challenges regarding protocol modelling and the protocol selection and configuration framework were discussed. Based on this discussion, possible solutions were evaluated and a strategy to overcome the challenges was selected. Finally, the meeting also provided an opportunity for all partners to inspect the WOS demo site and assess its suitability for future experiments.

Table 4.1: Agenda of the Second Review Meeting in Brussels.

Start		End	Topic
8:30	-	8:45	Welcome (EC, UZL)
8:45	-	9:15	Project Overview (UZL)
9:15	-	10:00	WP4: Experimentation & Applications (SICS)
10:00	-	10:45	WP1: Models (ULANC)
10:45	-	11:00	Break
11:00	-	11:45	WP2: Protocols (TUD)
11:45	-	12:15	WP3: Configuration (UZL)
12:15	-	13:30	Lunch
13:30	-	14:00	WP5: Dissemination & Joint Activities (UZL)
14:00	-	14:30	WP6: Management (UZL)
15:00	-	15:30	Reviewer Internal Meeting (EC)
15:30	-	16:00	Feedback to consortium and closing (ALL)

4.1.4 Teleconferences

In addition to the physical meetings, 19 general teleconferences in which all partners participated were held. Partners actively reported about their progress and discussed the next steps to be pursued. These conferences also included discussions about technical and scientific challenges.

In addition, a large number of more focused telephone conference, individual calls, Skype calls, as well as chats were employed to discuss specific aspects, challenges, and solutions. This also includes a dedicated phase of particularly intense communication between October 6 and October 17, 2014, to support the integration of the individual software components. During this phase, all affected parties participated in daily phone calls and made sure to be constantly available for further interaction to quickly clarify arising issues.

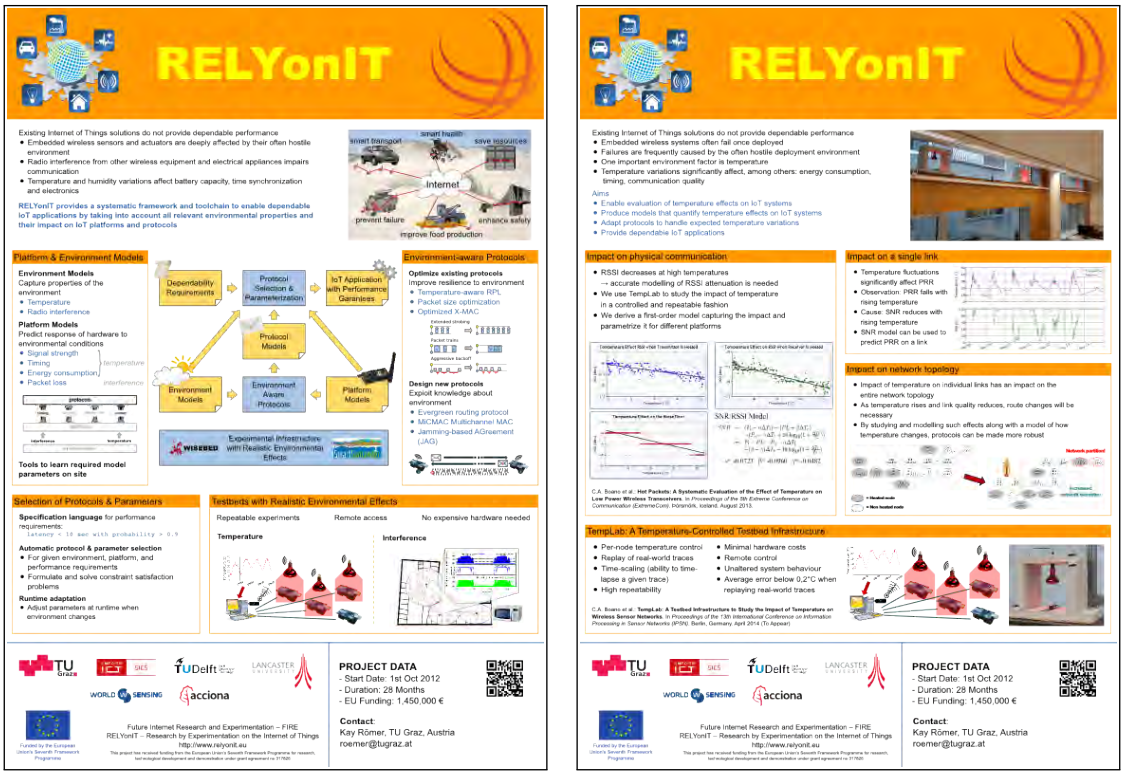
4.2 Staff Exchange

Staff exchange between the project partners provided an additional opportunity for focused collaborative work.

- Nicolas Tsiftes (SICS) visited TUG on February 10-13, 2014. He conducted research for the RELYonIT project together with TUG members, mainly regarding temperature-aware routing and MAC protocols, which later led into a joint publication [4].

- Marco Zúñiga (TUD) visited TUG as a guest professor from July 7 to August 18, 2014. During his stay, he intensely cooperated with TUG members on the RELYonIT project. He delivered two research talks on topics related to RELYonIT and he also gave a lecture course entitled “Smart Phone Sensing”.

- Koen Langendoen (TUD) visited TUG on November 18-20, 2014. He gave a talk on topics related to RELYonIT and served as a co-referee during the defense of Carlo Alberto



(a) Main poster

(b) Demo poster

Figure 4.1: Posters presented at the RELYonIT demo at the Future Internet Assembly.

Boano's PhD thesis which has been carried out within the RELYonIT project.

- Luca Mottola (SICS) visited TUG as a guest professor from January 19 to February 20, 2015. During his stay, he intensely cooperated with TUG members on selected topics within the RELYonIT project. He delivered two research talks on topics related to RELYonIT and he also gave a lecture course entitled "Networked Embedded Software" which is closely related to the topics covered within the project.

4.3 Collaborations with External Partners

To supplement the work conducted within the RELYonIT project, we sought cooperation with a number of projects and research institutions.

4.3.1 Future Internet Assembly 2014 in Athens, Greece

From the 18th to the 20th March 2014, TUG and ULANC participated at the Future Internet Assembly 2014 in Athens, Greece (`http://www.fi-athens.eu/`) to present a project demo (see Fig. 4.1 and Fig. 2.3). A large number of FIRE projects were present at FIA and the demo booth provided valuable opportunities for the discussions of project ideas and results.

4.3.2 FIRE Board Meeting 2014 in Munich, Germany

TUD participated in the FIRE board meeting on "Technology Trends in Future Internet Testbeds" held in Munich, Germany on September 18th, 2014. In particular, the discussion on the theme of 5G networking was relevant considering the RELYonIT consortium's experience with testing low-level networking protocols.

4.3.3 Interaction with FIRE Testbeds

The SmartSantander FIRE project provides an "Internet of Things" experimental facility in a city setting. RELYonIT collaborated with SmartSantander regarding the use of collected environmental traces. The TWIST FIRE testbed provides an indoor "Internet of Things" testbed. Experiments involving modification of the sensor node program code and which required low-level programming of communication transceivers were carried out on the TWIST FIRE testbed. TWIST was chosen for these experiments as SmartSantander does not provide the required low-level access on nodes.

4.3.4 ETH Zurich

Partner TUG cooperated with Marco Zimmerling for work on an automatic configuration of JamLab-based interference testbeds based on simulated annealing. This collaboration provided additional expertise on mathematical optimization in the relevant application area. It also led to a publication [9] and will be the foundation for further shared work.

4.3.5 China Electronic Technology Corporation (CETC)

Partner TUG participated in an official Austrian scientific delegation that visited China in December 2014. On that occasion, a memorandum of understanding regarding a collaboration in the area of Internet of Things has been signed with the China Electronic Technology Corporation (CETC) which also involves technologies developed in RELYonIT.

4.3.6 DEWI Artemis Project

The Dependable Wireless (DEWI) ARTEMIS project is coordinated by the Virtual Vehicle Competence Center (ViF) in Graz, Austria, and investigates use cases that require dependable wireless communication. TUG supervises a PhD student employed by ViF who is working on dependable wireless communication for vehicles.

4.3.7 Vienna University of Technology

A collaboration among TUG and the Institute for Computer Engineering at Vienna University of Technology has been set up to jointly work on resilient protocols for sensor networks. A meeting and a joint workshop have been held discussing models underlying such protocols, the applications of such protocols, as well as the type of protocols needed.

4.3.8 Fraunhofer Institute for Integrated Circuits (IIS)

A collaboration between Fraunhofer IIS and partner TUG has been set up regarding debugging of wireless connectivity problems in industrial environments. A member of Fraunhofer IIS will pursue his PhD on this topic under the supervision of partner TUG.

4.3.9 EVARILOS (ICT FP7, FIRE experimentation)

A key insight obtained from RELYonIT is that, ultimately, the reliability of IoT networks will depend on the generalization of models and protocols for most (if not all) link dynamics. We have focused on temperature and interference, but mobility is an important dynamic, too. To strengthen our models on link dynamics, TUD is currently working with the EVARILOS project. EVARILOS focuses on indoor localization, but the testbed includes mobile robots. We are now looking forward to include mobile dynamics into our general framework. This collaboration is done with Dr. Vlado Handziski, TU Berlin.

4.3.10 Darmstadt University of Technology

ULANC has a collaboration with the project Multi-Mechanisms Adaptation for the Future Internet within the Collaborative Research Centre 1053 MAKI (`http://www.maki.tu-darmstadt.de/sfb_maki/index.en.jsp`) run by Darmstadt University of Technology, Germany. Dr. Andreas Mauthe is an academic at ULANC and a TU Darmstadt Research Fellow visiting Darmstadt University frequently. Due to a partial topical overlap the RELYonIT work and results are being discussed and used. MAKI aims to create networks and systems which are adaptive to changes, particularly during ongoing operations. Environmental challenges as studied in RELYonIT are considered in MAKI as changes to which future networks must react.

4.3.11 Austrian Institute of Technology (AIT)

Dr. Andreas Mauthe was Visiting Scientist at the Austrian Institute of Technology (AIT) (January to March 2014) and worked there on research related to secure and reliable network and system infrastructures. During this time results of RELYonIT where considered and new ideas based on these for an extension of a resilience Framework have been discussed.

4.3.12 Universidade Federal do Rio Grande do Sul

Dr. Andreas Mauthe was Professor Visitante do Exterior, Universidade Federal do Rio Grande do Sul, Brasil (April to July 2014) under the "Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES)" programme and during the visit discussed the research results with the group at UFRGS. New joint project ideas based on this are being developed. The RELYonIT research is considered by a PhD student in the area of resilient networking in the context of IoT.

4.3.13 Anglian Water

ULANC together with Anglian Water is looking at the interconnection of pumping stations in the context of wastewater networks. Communication between pumping stations must be

reliable to ensure correct decision making. The quality of wireless links is subject to environmental conditions, in particular weather conditions. The RELYonIT research output (models of temperature impact on communication links) is used within this project to facilitate wireless link selection.

4.3.14 University of Pisa

A PhD student from University of Pisa stayed with SICS for six months to work with issues on TSCH (Time Slotted Channel Hopping), a protocol for industrial environments where the network performance needs to be predictable and hence shares similar goals as the RELYonIT project.

4.3.15 Technische Universität Braunschweig

TUG offered the use of the TempLab testbed to researchers of the Institute of Operating Systems and Computer Networks at the University of Braunschweig, Germany. Their goal is to evaluate the performance of energy-efficient voltage scheduling of peripheral components when wireless sensor nodes are exposed to changing environmental conditions. Towards this goal, they plan to use the testbed infrastructure developed within WP4.

4.4 Exchange of Ideas with External Partners

Beyond the research and administrative collaborations with other projects described in the previous section, partners of the project actively approached several other research projects and institutions to introduce the RELYonIT project and to exchange ideas related to the research topics of the project. These interactions are briefly described below.

4.4.1 ETH Zurich

TU Graz is setting up a collaboration with ETH Zurich in the broad area of Smart Cities and Buildings. A joint workshop of TUG and ETH Zurich has been held on November 25-26, 2015, where partner TUG presented RELYonIT technology and discussed the potential of applying it in the context of smart buildings and cities.

4.4.2 Neuroth AG

Partner TUG participated in a workshop in January 2015 with Neuroth AG discussing the possibility of using RELYonIT results for dependable wireless communication with hearing aids.

4.4.3 Anton Paar GmbH

Partner TUG participated in a workshop with Anton Paar GmbH discussing the possibility of using RELYonIT results for dependable wireless communication among sensors and measurement equipment.

4.4.4 State Government of the Federal State of Styria, Austria

Partner TUG presented the project and the smart parking use case to a delegation of the Styrian state government and discussed the potential of applying RELYonIT results in Smart City initiatives in the city of Graz, Austria.

4.4.5 Singapore Technologies Electronics Limited / Ministry of Foreign Affairs Singapore

A meeting of partner TUG with Soo Kok Leng, Ambassador of Singapore to Austria and Chairman of Singapore Technologies Electronics Limited has been held in November 2014 where the RELYonIT project and the smart parking use case have been presented. The application potential of RELYonIT results in the context of Smart City projects in Singapore has been discussed.

4.4.6 Research Center on Telecommunications Vienna GmbH (FTW)

A meeting of partner TUG with the directors of FTW has been held in January 2015 were the RELYonIT project has been presented and the potential for future collaborations on this topic has been discussed.

4.4.7 EIT ICT Labs Budapest

A meeting of partner TUG with representatives of the EIT ICT Labs in Budapest has been held in December 2014 where the RELYonIT project has been presented and the potential for future collaborations has been discussed.

4.4.8 Virtual Vehicle Research Center GmbH (ViF)

A meeting of partner TUG with representatives of ViF has been held in January 2015 where the application potential of RELYonIT results in the automotive context and potential collaborations on this topic have been discussed.

4.4.9 University of Trento, Italy

TUD has been in contact with Prof. Gian Pietro Picco and Dr. Amy Murphy. Prof. Picco's group has deployed IoT networks in the wild on various scenarios and seasons during the year. We have been exchanging information about the effects of temperature on the performance of outdoor networks. Prof. Picco's group also found that the performance of IoT networks degrades with higher temperatures.

4.4.10 Arrowhead Project

The cooperation initiated during the last year has been more intensive. ACCIONA has carried out several discussions, mainly with SMEs involved in the project, that already have WSN related products. They were very interested in RELYonIT outcomes. As Arrowhead is heavily based in demonstrators pilots, it is foreseen to take advantage of them in real environments.

4.4.11 MANTIS Project

Partner ACCIONA is involved in the MANTIS ECSEL project to be started in March 2015. The main objective is to provide a proactive maintenance service platform architecture based on Cyber Physical Systems that allows to estimate future performance, to predict and prevent imminent failures and to schedule proactive maintenance. The findings of RELYonIT have been taking into account when the proposal was designed, as a relevant part of the platform deals with the monitoring of several parameters by WSN installed in production machinery, etc.

5 Conclusions

In deliverable D-5.2 we summarized all collaboration, dissemination, and exploitation activities conducted in the second part of the RELYonIT project.

The implementation of the dissemination strategy outlined in the description of work enabled the RELYonIT project to receive good visibility within the scientific and industrial community, as well as with the general public. This has been manifested by a significant number of publications at scientific conferences and workshops and by substantial media coverage. Internal and external cooperation activities enabled a fruitful exchanges of ideas and allowed us to secure access to required resources and facilities.

Bibliography

[1] ACCIONA, S.A. The ACCIONA website. [Online]. Available: http://www.acciona.com/

[2] C. A. Boano, T. Voigt, C. Noda, K. Römer, and M. A. Zúñiga, "JamLab: Augmenting sensornet testbeds with realistic and controlled interference generation," in *Proc. of the* 10^{th} *International Conference on Information Processing in Sensor Networks (IPSN)*, Apr. 2011, pp. 175–186.

[3] C. A. Boano, K. Römer, J. Brown, U. Roedig, and M. A. Zúñiga, "Demo abstract: A testbed infrastructure to study the impact of temperature on wsn," in *Proceedings of the* 11^{th} *IEEE Conference on Pervasive Computing and Communications (PerCom), demo session.* IEEE, Mar. 2014, pp. 154–156.

[4] C. A. Boano, K. Römer, and N. Tsiftes, "Mitigating the adverse effects of temperature on low-power wireless protocols," in *Proceedings of the* 11^{th} *International Conference on Mobile Ad hoc and Sensor Systems (MASS).* IEEE, Oct. 2014.

[5] C. A. Boano, M. A. Zúñiga, J. Brown, U. Roedig, C. Keppitiyagama, and K. Römer, "TempLab: A testbed infrastructure to study the impact of temperature on wireless sensor networks," in *Proceedings of the* 13^{th} *International Conference on Information Processing in Sensor Networks (IPSN).* IEEE, Apr. 2014, pp. 95–106.

[6] J. Brown, U. Roedig, C. A. Boano, and K. Römer, "Estimating packet reception rate in noisy environments," in *Proceedings of the* 9^{th} *International Workshop on Practical Issues in Building Sensor Network Applications (SenseApp).* IEEE, Sep. 2014, pp. 583–591.

[7] J. Brown, U. Roedig, C. A. Boano, K. Römer, and N. Tsiftes, "Demo abstract: How temperature affects iot communication," in *Adjunct Proceedings of the* 11^{th} *European Conference on Wireless Sensor Networks (EWSN), demo session*, Feb. 2014, pp. 40–41.

[8] C. Keppitiyagama, N. Tsiftes, C. A. Boano, and T. Voigt, "Temperature hints for sensornet routing," in *Adjunct proc. of the 11th ACM Conference on Embedded Networked Sensor Systems (SenSys)*, Nov. 2013.

[9] F. J. Oppermann, C. A. Boano, M. Zimmerling, and K. Römer, "Poster abstract: Automatic configuration of controlled interference experiments in sensornet testbeds," in *Proceedings of the* 12^{th} *ACM Conference on Embedded Networked Sensor Systems (SenSys), poster session.* ACM, Nov. 2014.

[10] W.-B. Pöttner, H. Seidel, J. Brown, U. Roedig, and L. Wolf, "Constructing schedules for time-critical data delivery in wireless sensor networks," *ACM Transactions on Sensor Networks (TOSN)*, vol. 10, no. 3, August 2014, to be published.

[11] RELYonIT Consortium, "RELYonIT: No dependability, no internet of things," in *FIRE Magazine: Net-Xperiment Future.* European Commission's DG CONNECT, Mar. 2014, p. 23.

[12] H. Wennerström, F. Hermans, O. Rensfelt, C. Rohner, and L.-A. Nordén, "A long-term study of correlations between meteorological conditions and 802.15.4 link performance," in *Proc. of the* 10^{th} *SECON Conference*, Jun. 2013.

[13] Worldsensing. The FastPrk website. [Online]. Available: http://www.fastprk.com

[14] ——. The Worldsensing website. [Online]. Available: http://www.worldsensing.com

