Preface (by the Programme Officer Georgi Kuzmanov)

DEWI is one of the largest research and innovation projects funded by the ARTEMIS programme. This activity brings together leading industrial and academic partners from all over Europe in pursuit of innovative wireless solutions for a wide group of application domains – ranging from ground, rail and air transport to smart cities and infrastructures. The project successfully went through its first monitoring period and has just reached its second year milestones with the next review meeting scheduled in the end of April 2016. While the first year was mainly dedicated to „setting up the scene“, when the consortium identified key requirements and specifications to substantiate the proposed wireless interoperability concept; the second year has been dedicated to the development of an integrated interoperability framework and the demonstration of its advantages through several appealing prototype developments. Potentially, DEWI could positively impact our daily routines in the very near future allowing a vast variety of services and products to further improve our life quality and comfort. Moreover, the DEWI consortium is in a strong position to influence current and future wireless and interoperability standards with its technological achievements. Therefore, ECSEL-JU is eagerly supporting this daring research and innovation endeavour with a clear attitude of a partner contributing in its way to the common goal - the final success of DEWI.
The ARTEMIS project DEWI (“Dependable Embedded Wireless Infrastructure”) focuses on the area of wireless sensor / actuator networks and wireless communication. With its four industrial domains (Aeronautics, Automotive, Rail, and Building) and 21 clearly industry-driven use cases / applications, DEWI aims at providing and demonstrating key solutions for wireless seamless connectivity and interoperability in smart cities and infrastructures, by considering everyday physical environments of citizens in buildings, cars, trains and airplanes.

DEWI, led by the VIRTUAL VEHICLE Research Center in Graz/Austria, currently is one of the largest funded European R&D projects, comprising 58 renowned industrial and research partners from 11 European countries and lasting from 2014 to 2017. It covers 400 person-years with a total budget of €40m.

Currently, the second project year of DEWI has been very successfully finished and DEWI is really well on track: In addition to up to now 200 deliverables (!) comprehensively documenting the work done in DEWI so far, a lot of demonstrators and prototypes across all industrial domains are already available. This includes real rockets, trucks, trains and a lot more (for details see below). Furthermore, DEWI has accomplished a high-level architecture across all domains, which is fully compliant with the ISO/IEC 29182 standard Sensor Network Reference Architecture. Thus, DEWI will add clear cross-domain benefits in terms of re-usability of technological building bricks and architecture, processes and methods.

This article presents selected highlights and achievements since the last ARTEMIS-IA Newsletter on DEWI, published in July 2015.

HIGHLIGHTS FROM THE FIRST TWO YEARS OF DEWI

So far, the DEWI consortium has performed more than 100 dissemination activities, including more than 40 scientific publications. The DEWI Website (www.dewi-project.eu) was fully re-furbished one year ago with focus on technical content to further attract researchers and developers. It provides a comprehensive overview on all the industrial domains and uses cases, and makes numerous deliverables available for public download. There a dedicated DEWI Use Case Booklet can also be found. This booklet aims at presenting all the industry-driven use cases of DEWI to a broader public. Over the next months, at several international conferences DEWI will carry out special sessions such as the “Dependability and Robustness of Wireless Sensor Networks” session at the IEEE ETFA2016, September 6-9, in Berlin, or at the ARTEMIS Technology Conference 2016, October 5-6, in Barcelona.

THE DEWI ASSESSMENT AND MONITORING FRAMEWORK: GAINING AND KEEPING OVERVIEW OF COMPLEX RTDI PROJECTS

Research, technology development and innovation (RTDI) projects like DEWI pursue the fulfillment of high-level objectives (defined by the project itself, but also defined by funding authorities) and strive to increase the technology readiness level (TRL). In general, it is very difficult to measure and quantify such characteristics during the project life cycle due to their rather high level. However, this quantification is very important - for both project partners and funding authorities - to get a measureable assessment of project progress towards the objectives. Within DEWI, we developed the comprehensive DEWI Assessment and Monitoring Framework (“DEWI-Frame”). Based on a consistent mathematical-logical framework, it can be used for the assessment of project progress towards the objectives as well as for monitoring of project innovations. The key mechanism of DEWI-Frame is the consideration of requirements in the assessment process, and bi-directionally linking them with project innovations and high-level objectives. The application of DEWI-Frame in the ARTEMIS JU project DEWI shows that the fulfillment of project objectives can be easily tracked on a continuous basis. By using this method, overview of complex RTDI projects can be gained and kept, and a clear assessment of project progress towards the objectives is available to project partners as well as funding authorities. The methodology of DEWI-Frame can be tailored to be used in RTDI projects of any kind with an easy parameterisation of scaling factors [1].

AERONAUTICS DOMAIN

The aeronautics domain consists of two use cases with the general objective of implementing and designing dependable wireless sensor and actuator networks in two different aerospace scenarios.
Use Case Multilink Telemetry Logger for Rocket Launchers

The first use case focuses on using wireless sensor networks to replace cables and subsystems based on wired interfaces in space crafts. This task faces the challenge of deployment in extreme environmental conditions, such as wide temperature ranges, vibrations and increased electromagnetic exposure. Another major challenge of replacing cables in aircrafts is the highly critical operation of wired industrial interfaces. Therefore, wireless technology must be appropriately adapted to minimize the effects on real-time and highly reliable industrial wired networks. On the other hand, replacing cables of space crafts with wireless links is expected to provide a number of advantages such as flexible design, improved troubleshooting, coverage of parts of the aircraft difficult to reach with wires, and mainly reduced weight. Reduced weight, in turn, translates onto fuel savings as well as improved flight ranges and speed. Currently, the integration of wireless sensor networks and tracking modules into the body of a rocket are completed.

Several flight tests have also been completed, each one with increased functionality of the different modules, thus successfully proving the use of wireless on board a spacecraft.

Use Case Active Flow Control

The second use case of the aeronautic domain focuses on a different aspect: using a dense wireless sensor and actuator network to track the formation of turbulent flows across aircraft surfaces (e.g., wings) and attempt to counteract it with convenient actuation (e.g., synthetic jet actuators). The ultimate objective is to reduce skin drag effects, thus improve lift forces, save fuel consumption as well as improve range and speed of commercial aircrafts. The major challenge of this use case is the design of a highly dense network of nodes with wireless capability and the convenient management of sensor and control information within the aircraft. The current status of this prototype is the full integration of pressure sensors and synthetic jet actuators into a wireless sensor network. Full scalability analysis based on different analytical assumptions and computational fluid dynamics simulations have been achieved. A system level simulator integrating flow turbulent models and simulation results has been produced. The integration with the internal aeronautics network of a commercial aircraft has also been completed.

AUTOMOTIVE DOMAIN

The DEWI automotive domain focuses on the application of wireless technologies in the automotive domain. Being wireless allows for innovative test system solutions that are required for the development and verification of automotive components like engines, transmissions or batteries. Wireless sensors also allow for a much more detailed instrumentation of units under test. In combination with automatic identification, configuration and localisation technologies, such a WSN (wireless sensor network)-based test system can significantly push efficiency of the costly verification phase, and reduce potential sources of errors like miswiring, corroded contacts or misplaced plugs. For certain applications like the measurement of mechanical vibrations in construction vehicles, wireless sensors provide the only useable option to learn about the comfort level of human operators. Overall we expect to see a reduction of wiring efforts for test vehicles by 50% due to replacing temporary wired sensors and interfaces by WSN. First prototype demonstrations have already shown the impact in helping boost efficiency and quality in Europe’s car industry.

Other teams work on innovative new solutions by combining personal mobile devices such as smart phones or tablets wirelessly with cars, allowing new modern applications for vehicle use. Prototypes that were shown to selected users generated high interest and also demonstrated a clear need to provide strong security. This will be a focus of a future phase.

The establishment of wireless sensors in production vehicles (cars, trucks) has
to overcome significant challenges like obstructing metallic structures or multi-path propagation and energy constraints. On the other hand such systems could provide clear weight benefits to car manufacturer and vehicle owners, because the wiring harness still provides a major share of weight and costs of vehicles. The mid-term goal of DEWI’s effort in the automotive domain is to reduce this weight of the signal wirings by 30% by using WSN. An additional advantage comes with the flexibility of potentially mounting wireless sensors on existing mechanical parts, and even the possibility of integrating sensors into them.

DEWI partners demonstrated wireless sensors (e.g.: fuel level sensor, brake lining-wear sensor, etc.) in a real-life truck, showing the feasibility and dependability of wireless technologies like IEEE 802.15.4e in real-life scenarios. A series of campaigns at both RF and network levels have been carried out, accompanied with extensive analyses how to integrate such system in future automotive E/E architecture. The figure below shows some wireless sensor prototypes: Lining-wear sensor, Chassis Level Sensor (ECS), Fuel Level Sensor and Washer Fluid Level Sensor.

**RAIL DOMAIN**

During the second year of the DEWI project the rail domain has been very focused on the development of useful applicable technologies for trains, especially on safety applications and freight monitoring. Once the requirements for the different use cases were gathered and analysed during the first year, the last steps of the task 2 “Define Specifications”, and the achievement of task 3 “Develop and implement” were the main goals for the second year, especially in those work packages (WP) related with the use cases and the demonstrators.

For the WPs on train integrity detection system, train composition detection system, freight monitoring and management system, and demonstrators the following steps were achieved:

- The definition of the variables has been completed.
- The sensors have been selected for each use case.
- The high level architecture for the rail
The following steps were achieved:

- Data fusion and context-aware and reasoning platform prototypes for Industrial Wireless Sensor Networks [5]
- Troubleshooting Wireless Home Networks Using a Portable Testbed [7]

For the WP on centralized on board solution for seamless, safe and reliable WSN integration the following steps were achieved:

- In the first half of the year the definition and prototyping for the DEWI gateway were completed.
- During the second half of the year, the generic application of the DEWI gateway was developed.
- Different tests were applied to check the communication with a simulated WSN (stress, number of nodes, quality of service, etc.) and the behaviour against connection and disconnection of the modules.

The second year of the building domain has been focused on the implementation of the various prototypes, components and sub-systems for the wireless technologies presented in the five building domain use cases. The prototypes and components developed include for example:

- Indoor conditions monitoring WSN and backend SW and HW components based on BLE (Bluetooth low-energy), ZigBee and Wi-Fi
- Indoor positioning solutions for personnel and assets tracking based on RF, optical and imaging technology
- Automated lighting solutions based and study and simulations on dense lighting networks
- Energy management solution for WSN gateways
- Data fusion and context-aware and reasoning platform prototypes for processing WSN sensor data into information
- Heterogeneous WSN components for smart home automation

Progress has been made in facilitating interoperability by specifying a high-level-architecture for the building domain. The final demonstrators for the building domain have also been specified and the results will be presented at several locations around the partner countries.

The building domain has produced several publications during the year. These publications are as follows:

- Broadcast Storm Problem in Dense Wireless Lighting Control Networks [3]
- RLL - Reliable Low Latency Broadcast Data Dissemination in Dense Wireless Lighting Control Networks [4]

The objective of the interoperability domain is to ensure an efficient technical management of all the domains along the DEWI project. Interoperability is defined as the ability of diverse sensor networks or sensor nodes to exchange information and to make mutual use of the information that has been exchanged. DEWI follows the official definitions coming from ISO/IEC 29182-2:2013 (E).

The interoperability domain targets to increase the visibility of the project results by developing generic methods, processes, and tools for resource management and mastering mixed requirements for intra-vehicle / smart environment / smart home / smart cities. The interoperability domain is split into the distinct activities of interoperability,

**BUILDING DOMAIN**

The second year of the building domain has been focused on the implementation of the various prototypes, components and sub-systems for the wireless technologies presented in the five building domain use cases. The prototypes and components developed include for example:
technology item & technology item groups, high-level architecture, know-how transfer and standardization, regulation, and certification.

Nine technology item groups (TIG) are defined within DEWI; they are listed in the table below and described in corresponding deliverables.

<table>
<thead>
<tr>
<th>TIG</th>
<th>TIG Name</th>
</tr>
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<tbody>
<tr>
<td>TIG01</td>
<td>Flexible data acquisition, aggregation &amp; fusion</td>
</tr>
<tr>
<td>TIG02</td>
<td>Smart architecture</td>
</tr>
<tr>
<td>TIG03</td>
<td>HW/SW co-design</td>
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<tr>
<td>TIG04</td>
<td>Security, privacy, authorization</td>
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<tr>
<td>TIG05</td>
<td>Re-/ auto-/ self-configuration</td>
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<tr>
<td>TIG06</td>
<td>Smart energy management and harvesting</td>
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<tr>
<td>TIG07</td>
<td>Dependability, robustness &amp; safety</td>
</tr>
<tr>
<td>TIG08</td>
<td>Wireless sensor / device detection &amp; localization</td>
</tr>
<tr>
<td>TIG09</td>
<td>Wireless standards</td>
</tr>
</tbody>
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**Table 1 Technology Item Groups addressed within DEWI**

Within the interoperability domain we have provided the final details of the definition of the DEWI high-level architecture (HLA), see Figure 8. The HLA gives guidelines for the development of wireless industrial sensor and actuator networks (WSANs) to be compliant with the DEWI Bubble concept and the DEWI HLA.

Cooperation with relevant standardization and regulation bodies is crucial to disseminate the findings from the DEWI project. We have managed to create contact with ISO/IEC JTC1/WG7 “Sensor Networks” and granted a category “C” liaison.

**OUTLOOK**

After two highly successful years of development, the third and final year of DEWI will clearly focus on demonstration. All different parts come together for building various impressive real-life demonstrators showcasing the DEWI results. As one of the highlights of the final year of DEWI, the planned “DEWI Demonstration Week” will present the results of the project to funding authorities, journalists, industry and an interested technical audience but also to the general public in various locations all over Europe. Stay tuned for more information about this event!

**ACKNOWLEDGEMENT**

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References (DEWI publications)

J. Hillebrand, M. Karner, W. Rom, “Gaining and Keeping Overview of Complex RTDI Projects with the DEWI Assessment and Monitoring Framework (DEWI-Frame);” System of Systems Engineering Conference 2016 (accepted for publication)


C. Dandelski, A. Desnoyers, B.-L. Wenning, M. Kuhn, D. Pesch, RLL - Reliable Low Latency Broadcast Data Dissemination in Dense Wireless Lighting Control Networks, International Conference on Embedded Wireless Systems and Networks (accepted publication)


E. Dalipi, V. Sercu, P. Becue, B. Joiris, I. Moerman, J. Hoebeke, “Troubleshooting Wireless Home Networks Using a Portable Testbed” (accepted for publication)

Further publications within the DEWI project:


