

INNOVATION REPORT

Accelerating the use of standardised wireless technologies for systems monitoring and management



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Use of autonomous wireless devices for monitoring and management is relatively recent. The most important limitation has been the absence of a wireless technology deployed at low-cost and with low-consumption devices. However, development of the IEEE 802.15.4 standard and use of open software for its implementation have resulted in an important evolution in the potential use of these technologies in different market areas such as industry, smart homes (domotics) and smart buildings, energy consumption/production and environmental monitoring.

Although Wireless Sensor Networks (WSNs) are now becoming well accepted in different application markets, there are several aspects that must be improved to enable future growth and consolidation such as the convergence of standardisation and technologies to offer wider and open solutions. With energy-efficient communications protocols integrated data processing and, in general, scalable solutions essential for WSN evolution, the ITEA 2 Interoperable Sensor Networks project, or ISN, sought to create a WSN-based open platform and to test and

validate it in a selected set of vertical applications. The protocols already deployed are Constrained Application Protocol (CoAP), 6LowPAN and several Duty Cycled Medium Access control protocols. CoAP is an adaptation of HTTP application protocol and 6LowPAN is an adaptation of IPV6 internetworking protocol for constrained devices; MAC protocols for WSNs operate in a duty-cycled way and put the communication unit to sleep when no communication is needed.

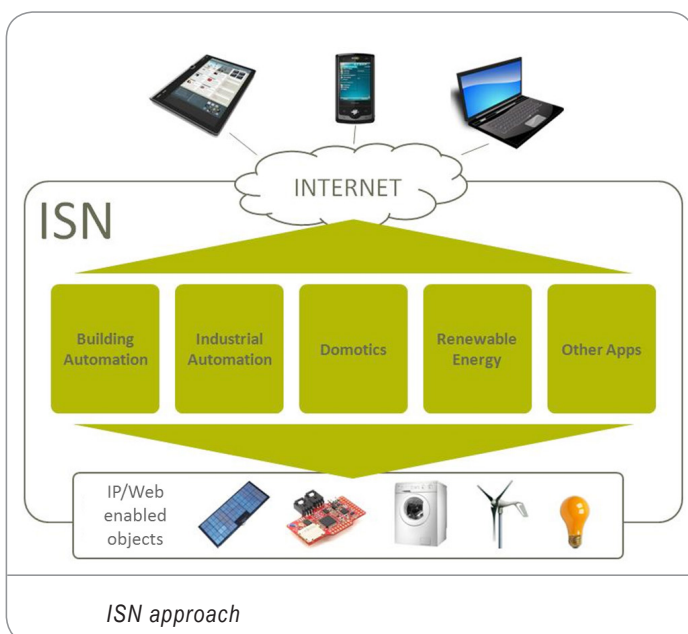
Despite being a very small project in ITEA 2 terms – about a tenth of the normal project size – the ISN project has not only successfully created this first commercial co-application platform based on embedded IP/web technologies for constrained devices but it also provides the opportunity for the results to be deployed and exploited.

Challenges ...

Based on experience developed in the ITEA ESNA project and emerging communications standards, ISN addressed a set of new, relevant technical challenges for sensor network application domains, such as interoperation with other systems and devices, improved co-existence mechanisms and management of data within and across networks, as well as quantitative performance-measurement techniques. The strong international consortium in the ISN involved high-tech industry with strong research support.

A major challenge for the deployment of systems lies in the multitude of proprietary communication protocols although the success of recent standards such as 6LoWPAN and CoAP pave the way for faster market growth. However, evolution in this field is dependent on technology being able to support and coexist with a number of communication protocols. This is why ISN focused on the development, use and evaluation of emerging WSN standards, addressing four specific objectives in the lifecycle of a wireless sensor network:

1. Simplifying applications development by refining and developing important building blocks such as communications stacks, operating systems, management tools and simulators;



INNOVATION REPORT

2. Simplifying deployment and integration by implementing emerging WSN standards, mechanisms for testing network quality, creating integration tools and establishing interoperability with related architectures;
3. Simplifying monitoring and management by developing energy-efficient network performance monitoring mechanisms, monitoring and management protocols, and network-management tools;
4. Enabling efficient use of data within and outside WSN applications, including management of WSN systems and specific applications needs.

... and innovative solutions

The results of this project now mean that it becomes easier and more cost-effective to construct standards-based WSN applications in high-value contexts, which contributes to improved effectiveness and efficiency in society at large. Specifically, the open platform that is based on embedded IP/Web technologies (6LowPAN/CoAP) with monitoring and control functionalities enables decoupling of application, middleware and sensors/actuators. Furthermore, the project developed several exploitable building blocks along with multi-standard sensor motes (MTP, Edosoft) and sensor boards with multiple standard communication interfaces, a hardware/software box (Freemind-VUB), an application (MAIS) and a management tool (MTP).

Real-world pilots served as the validation environments for the ISN project results. For instance, this enabled the first hotel management platform based on CoAP and the first building and renewable energy monitoring platform based on embedded IP/Web technologies. A crucial outcome, and an innovative one, is that the ISN platform speaks with multi-vendor sensors/actuators and with multi-vendor applications.

In terms of standardisation, ISN actively participated in the IETF CoRE standardisation group that involved monthly teleconferences, interoperability plug tests and the IETF #83 meeting. The consortium established contacts with the IP for Smart Objects Alliance (IPSO), including Sensinode in Finland, Watteco in France and the Swedish Institute of Computer Science.

From dissemination ...

A key part of the ISN project came in the form of dissemination to get the ISN body of work to a wider audience. Some examples of this are the paper Integrating Wireless Sensor Networks with the Web, presented at the Extending the Internet to Low power and Lossy Networks workshop, which took place in Chicago, USA, in 2011 and which was co-located with the renowned international conference Cyber Physical Week (CPS) Week

2011. Another important paper published by the ISN consortium is entitled Evaluation of Constrained Application Protocol for Wireless Sensor Networks. The paper, presented at IEEE International Workshop of Local and Metropolitan Area Networks (LanMan), in October 2011, at Chapel Hill, USA, demonstrated the energy savings of CoAP compared to HTTP. The ISN project also actively participated in the 9th European Conference on Wireless Sensor Networks (EWSN), in Trento, Italy, 2012, with a demo entitled Enabling Transparent WSN Resource Access via RESTful Web Services. The demo showed how the use of embedded Web technologies simplifies the overall network architecture.

... to demo ...

The results of the project have been demonstrated in the MAIS fidelity application with control functionality in the domain of hotel management, in a customised calendar application with control functionality and in the Freemind monitoring application that collects data from heterogeneous devices in the renewable energy and building monitoring domains. As for the single building blocks developed in the project, these saw tangible application in a management tool (sniffer), the GAIA3 sensor board and sensor motes with multiple communication interfaces. In fact, these demos provide the basis for the commercial exploitation prospects as Freemind expands its gateway box with WSN open standards that will be used in energy management systems and exercises control via these standards (HVAC optimisation). MAIS is using the ISN platform in hotel management systems and MTP will commercialise both the sensor motes with multiple communication interfaces and WSN management tools while Edosoft aims to commercialise the GAIA3 sensor board.

... and exploitation

Within a short period of time, new products have made it to market: sensor motes with multiple communication interface (IEEE 802.15.4 and WiFi), hardware platform GAIA3 wireless sensor and actuator networks based on open standards, a sniffer tool for IEEE 802.15.4 and 802.11, and a 6LowPAN/CoAP based gateway box. Also twenty Flemish companies have shown an interest in the ISN project results and participate in the TETRA project "6LowPan: towards zero configuration building automation" that will run for two years in which the important issue of security is also taken into consideration. In terms of new services, the deployment of customised monitoring and control systems based on open standards can be cited while the newly developed systems include a commercial platform based on embedded IP/Web technologies, a hotel management application based on enabled monitoring and control, and a renewable energy and building monitoring application. An active participation and contribution have been made to facilitate the Internet of Things. An agreement has also been made with the

INNOVATION REPORT

Spanish company Inetsis to sell wireless solutions. With more than ten scientific publications, good standardisation progress and dissemination successes, new products in the market and the good synergy that has been achieved among several project partners, the ISN project can be proud of its achievements.

European industry stands to gain a competitive edge in the use of WSN technology in critical sectors of industry and society,

sectors where global demand has a huge growth potential. The dissemination of the results to the rest of the world can exert an influence on both the pace and direction of related technical R&D work outside the project and in standards committees. It is also necessary to spread this influence to the user sectors of society and industry to help accelerate the uptake of modern technology and methodology as well as the wide deployment of WSN in large-scale integrated applications.