**ESNA**
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# Developing effective business applications for wireless sensor networks

Results of the ESNA project have enabled effective development of business-oriented wireless sensor network applications with a standard architecture, technology and application-development guidelines, and proof-of-concept implementations. The open-source sensor network system architecture provides support for off-the-shelf sensor network nodes, including applications, software development kits and middleware services, based on documented interoperability specifications. And guidelines have been developed for dimensioning of networks, and type of nodes to use for different application domains, as well for requirements analysis and design at a systems level.

Wireless sensor networks involve the interconnection of matchbox-sized devices using radio communications. Such devices are becoming widely available as low-cost off-the-shelf elements and open up many new systems opportunities. They are battery powered and so very flexible as no power cabling is needed; they can be positioned where required and not where power happens to be available.

Moreover, the devices are multifunctional – nodes can be equipped with many different sensor capabilities, such as temperature, humidity, movement, radiation, gases and light. So each of these nodes can be a platform for many different uses – opening up a very broad spectrum of applications.

In addition, as they interoperate wirelessly, these devices establish their network dynamically. This means that if a node disappears, the system does not collapse. Instead, the rest of the nodes reconfigure themselves and continue. Such robustness is an important advantage.

**CREATING FUNCTIONAL SYSTEMS**

While such devices are becoming available in bulk quantities, mainly from Asia, the added value comes from the software that creates the system out of the individual components. The Swedish Institute of Computer Science (SICS) realised the need for Europe to master this sector and found like-minded partners at the ITEA brokerage event in Barcelona in 2005.

The project was set up in ITEA as EUREKA encourages fast exploitation of project results. This enabled the ESNA consortium to develop solid technology with cross-border co-operation and push it to new levels to be able to satisfy concrete application needs subsequently.

ESNA had two different objectives:

1. To provide a strong and multifunctional advanced software platform which supports very flexible needs in applications from a technology push point of view; and
2. To create the application frameworks and architectures that support the needs in sectors such as:
   - *Industrial applications*, mainly in the process industry, to monitor equipment wear for example as an unplanned stop in an industrial process can be very costly;
   - *Monitoring physical space for safety* – for example detecting intruders in an enclosed space;
   - *Next-generation home devices* – enabling consumer devices to interact wirelessly such as a fridge talking to a temperature-management system;
   - *Construction/building automation* to control energy costs for heating, ventilation and air conditioning, providing a green approach to maintaining comfort;
   - *Agricultural monitoring* for precision agriculture to manage irrigation, pesticides and fertilizers for optimum production without waste of resources; and
   - *High voltage electricity transmission network* – proactively monitor the state of critical components in 110 kV and above networks to avoid disruption.

**ENSURING STANDARDS COMPLIANCE**

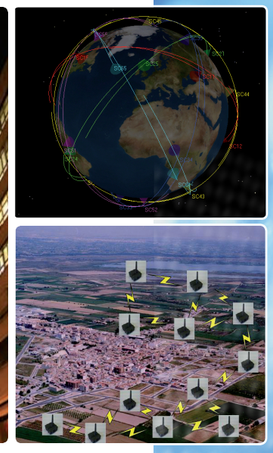
ESNA chose to be innovative in carefully selected technology areas. For instance, it looked at developing the basic generic platform – corresponding to the operating system in a computer – based on 'protocol' stacks for IPv6, which is the new Internet protocol standard. Above all, the ITEA project focused on being standards compliant but with innovative implementations – such as developing the world's smallest implementation of IPv6, ported to many different platforms.

A particular effort on innovation was made to reduce energy use. Wireless network devices are normally powered by AA batteries; ESNA looked at where electrical energy is in used practice, and how use of energy can be optimised, so that the cost of changing batteries can be kept low.

The result was new software-controlled technology for very low power use to enable the devices to operate as long as possible on one set of batteries. This mainly involved optimisation of the radio communication between devices as radio transmission is much more demanding than computing. New methods were developed that are the most energy efficient currently available.

ESNA also worked on market-oriented frameworks for a series of specific areas. The project developed methods for interoperation with other IP environments as wireless sensor networks are not intended to operate as separate, stand-alone islands but rather as part of enterprise-wide IT environments. The ESNA system can now interoperate with a range of different environments and the devices fit smoothly into those environments.

This involved supporting industrial standards in various application areas – such as the WirelessHART open-standard networking protocol widely applied in industrial automation – and in building automation where stakeholders have yet another set of communications standards. All in all, at platform level, ESNA provided solutions that are innovative in terms of integrating other technologies and systems.





**BUILDING EUROPEAN LEADERSHIP**

A major achievement has been the development of a strong European lead in wireless sensor networks while this field is still emerging globally. On the basic software side, ESNA consolidated the open-source Contiki software. This highly portable, multi-tasking operating system is designed for microcontrollers with small amounts of memory and enables the development of memory-efficient networked embedded systems and wireless sensor networks. A typical Contiki configuration requires 2 kb of RAM and 40 kb of ROM.

The software was created using a set of tiny light-weight elements – much like Norwegian explorer Thor Heyerdahl's original Kon-Tiki expedition raft. What was a nice demonstration system when the ITEA project started has now been consolidated and the open-source outcome is already being used by commercial actors who have picked up this as a very useful system for small devices.

On the applications side, the GAIA sensor node for precision agriculture was launched in Spain in 2009. And a spin-off – Ingeniería de Sistemas Intensivos en Software – also emerged in Spain using the technology developed in the ESNA project to target energy monitoring and management in the construction industry. The company involved is also looking at other new business areas based on the same technology toolbox.

In addition, several purely industrial components have been developed based on work in the project. ABB for example now has sensors for use in process control that contain software solutions developed in this project. So ESNA has been highly successful from a concrete point of view in delivering things that are either being used as open source or are being marketed by specific partners.

Several members of the consortium are now working with new partners in a follow-up project which will reuse results and knowhow from ESNA. And SICS itself is heavily involved in other European projects that will take the software results further to validate them in different areas and develop the functionalities of the system.

*More information: www.sics.se/esna*