![ITEA3 logo]

Project Results

PRO-HEAL

An immune system for healing IoT networks

EXECUTIVE SUMMARY

Systems that can easily adapt at runtime in response to changes in their user preferences, requirements, computing infrastructure and surrounding physical environment – this was the challenge faced by the ITEA project PRO-HEAL. The result was a platform for self-management functionalities that not only reduces the need for manual interventions to keep services functioning and reliable but also increases their lifetime.

PROJECT ORIGINS

Self-management capabilities are expected to not only extend the lifetime of services and systems but also noticeably reduce operational and maintenance costs, and boost reliability and trustworthiness from an end-user perspective. However, for this to become a real and practicable proposition, a platform is needed in which individual devices can play their own roles, free of hierarchy, and come together in response to the needs of the system, controlling the complexity of the networks or systems in a way that mitigates the problem of a device malfunctioning or breaking down. A kind of immune system, as in nature, that can heal such problems. Enter PRO-HEAL.


TECHNOLOGY APPLIED

Wireless networks are still highly complex to program, install, deploy, maintain and replace. In smart buildings, for instance, low-capacity sensor and actuator nodes tend to be small, wireless, battery-powered nodes that can be prone to faults due to internal and external influences like low battery and memory, poor calibration, hardware/software faults, environmental interferences and sensor ageing. But given that these nodes play an important role in bridging the digital world and the physical world, it is vital to detect and recover faults at run-time to minimise manual interventions. By controlling the complexity at source, as it were, the IoT dilemma of cost of deployment and maintenance, which threatens to be a showstopper to widespread adoption, can be controlled.

The project overcame two key hurdles in developing the self-healing solution. Firstly, PRO-HEAL used data analytics to identify faulty behaviour, irrespective of the application. Secondly, it solved the subsequent issue of mitigating the effect of faulty behaviour if it occurs so that when a few of the parts break down, the system continues to function because of its ability to adapt to changing circumstances. When a sensor detects that its trust value falls below a certain threshold, it can remove itself and request maintenance, so the system can still continue to function. And this community of smart individual sensors communicates to confirm behaviour and trust, whether positive or negative. In buildings the norm that sensors recognise and by which

they operate will not change whatever the building type, so the devices can be released with the software and they will work in every kind of building all over the world. Whether it's twelve or twelve thousand nodes, the principle is the same.

MAKING THE DIFFERENCE

While it was not originally the purpose of the project to deliver an actual product but to generate knowledge and insights that can be adopted by industry, there has been an encouraging uptake of the results into products. Dissemination via academic papers and promotions at conferences and exhibitions in both Europe and Asia has created great potential
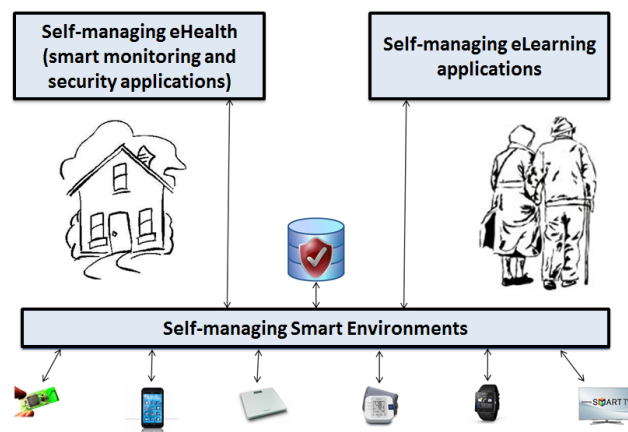
for commercialisation among and with the support of industrial companies and partners.

Using the results of PRO-HEAL, Chess Wise, a founding partner of project coordinator DevLab, produced the first smart lighting solution for chemical environments at a fertiliser plant at the DSM chemical campus in Heerlen, the Netherlands, in June 2017. With savings of around 40,000 lumens or more possible, this solution will significantly reduce energy costs. Not only is this solution applicable to the chemical and petro-chemical industry but also to retrofit offices, school buildings, shops and warehouses. With the Dutch energy company Eneco, along with emerging international partners, sales in street lighting applications are expected to rise above 200,000 Euros.

A similar pattern of rising sales is also expected in the industrial domain (Dietal, Sitech partners in France and the Netherlands as well as the first new international customers in the pipeline) and the office domain (LGG for Western Europe, others under negotiation) over the next two to three years. In Asia, Korean partner WareValley has delivered the ChakraMax product that includes self-protection to several customers at a total revenue of nearly 700,000 Euros.

Other examples of the project results being exploited include the development by Almende of a self-configuring IoT network solution for indoor localisation and building automation, Crownstone smart plugs, with pre-orders by 100 households. This consumer-oriented product has been available from the MediaMarkt chain of stores since June 2017.

Furthermore, an open source software package, SLAC, which simultaneously localises both the user and the devices of a system deployed in an indoor environment, is available. Together with the partners Enervalis and Open Remote, the Van Mierlo intelligent electronics engineering firm has developed a prototype for smart lighting and has installed a 24/7 sensor network that is easy to install at low costs. The wireless network also enables scaling up to more apartments (currently 14) and number of sensors (current total of 140).

MAJOR PROJECT OUTCOMES

Dissemination
- 11 scientific publications, e.g. several IEEE conference papers and other relevant conference papers
- More than 20 presentations at conferences/fairs, e.g. IEEE conferences, ICT Open, Smart Lighting Conferences, LED events, and Green Building Events, Security and Safety Exhibition, IT Week Tokyo, etc.

Exploitation (so far)
- SLAC open source software, SLACs simultaneously localizes both the user and the devices of a system deployed in an indoor environment
- Crownstone open source software, a self configuring IoT Network# names new systems + one-liner explanation
- Dietal active lighting control for ATEX plants
- Erasmus/Stenden/Enexis active presence and lighting control systems for offices, school buildings and warehouses
- Blok61, a 24x7 sensor network with self learning capabilities for interactive indoor control systems
- ChakraMax, database security system with self-protection capabilities

PRO-HEAL
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Partners

The Netherlands
Development Laboratories (DevLab)
Eindhoven University of Technology

Republic of Korea
WareValley

Project start
January 2014

Project end
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