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Research results of the AdaptiveSense project

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Project summary

Project title:	AdaptiveSense – Adaptive control of distributed ICT systems
BMWi code:	01 ME11023A
Term:	01/01/2011 to 30/09/2013
Consortium:	DREWAG – Stadtwerke Dresden GmbH
	T-Systems Multimedia Solutions GmbH (MMS)
	Dresden University of Technology (TU Dresden)
	Zentrum Mikroelektronik Dresden AG (ZMDI)
Project director:	Anette Frenzel, T-Systems

Website: www.adaptive-sense.org

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Research topics

The AdaptiveSense project develops a technical energy management system for presence-dependent activation and deactivation of ICT and potentially other infrastructure systems in office environments. Research topics in the project are:

- Collection and analysis of ICT usage and corresponding energy consumption in office environments
- Development of a sensor network architecture for monitoring and controlling ICT equipment in offices based on an IP/6LoWPAN stack
- Development of hardware with appropriate communication, including sensors, actuators, gateways and bridges
- Development of a central service platform as an energy manager with applications for data analysis and automated control

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ICT usage and energy consumption in the office

Creating energy transparency and analysing user behaviour and the associated energy consumption are the first tasks in the project. In an exemplary study (field test), basic data was collected.

- Six different types of users were created, whose presence, device usage and load profile (electric power consumption) were recorded using sensors and gauges
- Up to 45% of the available ICT resources are reserved unused, and the energy consumption between the user types varies greatly in part
- A project manager consumes only 6 kWh per week
- In contrast, a developer consumes up to 13 kWh per week, because they are equipped with powerful graphics computers and multiple monitors.
- Information regarding data privacy: The study was carried out with the consent of the users. Among users, however, there is some scepticism about the use of constant monitoring

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Sensory wide area network

In the project, a sensor network for minute-by-minute acquisition and control of energy consumption in office environments was designed and implemented. This includes the following elements:

- Sensors for measurement: Utilisation and electric power consumption (energy)
- Actuators for control: Event-linked switching of devices (on/off)
- Environmental parameters: Detection of presence and device usage (use)
- Infrastructure: The light and temperature could also be detected in the room.

The sensors are connected to the wide area network via specially developed gateways and bridges.

- Network: Data transmission based on an IP/6LoWPAN stack
- Network topology: (a) via a LAN bridge or (b) WLAN gateway

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Hardware devices and enabling software

Data transmission on all network levels is based on IPv6 and 6LoWPAN for communication with the sensors. This makes continuous integration into existing wired or wireless network topologies possible on a logical level. Due to the predominant use of bridges instead of gateways, end-to-end encryption is possible.

- The hardware enabling software was developed by ZMDI and mainly includes the 6LoWPAN stack, incl. driver, operating system and applications for the sensor network.
- The hardware devices were designed by the Technical University of Dresden and mainly include gateways, bridges, sensors and actuators. Design and testing of the hardware prototypes was outsourced to the company In-Circuit GmbH, Dresden.

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Cloud-capable energy management platform

In addition to the hardware and software elements of the sensor network, a third element was developed as a cloud-capable energy management platform with a front-end and back-end developed in-house.

- Function of the platform: Data aggregation, analysis, optimisation and automation within the computing cloud as a “self-learning system”
- System expansion via cloud application(s)
- To demonstrate performance, benchmarks can be created and evaluated for buildings, rooms and equipment groups and types
- In addition to measurement of energy consumption, output and utilisation as well as the presence and usage patterns can be detected
- In all respects, however – regardless of the technical possibilities – the data privacy concerns must be taken into account

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User behaviour controls energy consumption

Savings are achieved through automatic shutdown of devices as well as through providing information to employees and behavioural change. Both solutions are equivalent in the maximum obtainable savings.

- Depending on the form, the energy savings are between 1.2 and 7 kWh (adaptive, not adaptive) per week and workplace. Consumption in periods of absence is thus almost completely avoided.
- The savings are highly dependent on user behaviour. Due to the high periods of presence in support and distribution, the savings there are only 18 to 23%, but in the areas of development and project management, the savings are between 55 and 62%.
- The technical solution is more expensive but more reliable than the solution purely based on behaviour.
- Further development of sensors and actuators is based on the open standards and can be used in many ways, such as for wireless control of streetlights.

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Patents and publications

Patents

- TU Dresden has filed a patent application for sensory wide area networks
- The patent application for the IPv6 sensor network of the TU Dresden is currently in the disclosure phase

There were 11 national and international scientific publications.