Eyeing the future of ubiquitous computing

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A future in which computers become pervasive, unobtrusive and almost invisible is being brought a step closer by EYES, an IST programme-funded project addressing many of the challenges of creating the sensor networks needed to make ubiquitous computing an everyday reality. Primarily a research initiative, EYES has designed a demonstrator and prototype sensor network that marks an important step forward in the cutting-edge field. The six project partners plan to showcase their work at the IST 2004 conference in The Hague, providing a glimpse at what many believe will be the future of computer systems.

Described as “the calm technology that recedes into the background of our lives,” ubiquitous computing relies on the use of tiny devices embedded in everyday objects and environments, collecting and delivering information and communicating wirelessly, and intelligently, between themselves. Such virtually imperceptible sensor networks could, for example, be used to control room temperatures in houses, to provide security in office buildings, to monitor pollution or locate people or animals - potentially revolutionising the way we work and live.

For ubiquitous computing to become a reality, however, several obstacles must first be overcome, not least regarding the efficiency of the sensor nodes themselves and the overall architecture in which they operate.

Due to conclude in February next year, EYES is addressing many of those challenges.

“The project will result in new protocols, frameworks and architectures for use in sensor networks,” explains project coordinator Paul Havinga at the University of Twente in The Netherlands. “We are looking at network protocols, system support for small devices, communication methods, data processing and above all energy efficiency.”

The need for low energy consumption
According to Havinga, the principal obstacle to the pervasive use of sensor networks is the need to ensure the sensor nodes consume as little energy as possible, and therefore continue to function for as long as possible.

“Sensor nodes have to be able to operate for at least six months and in some instances several years depending on where and how they are applied. Therefore they need to consume as little battery power as possible to make them cost effective,” the project coordinator says. “Energy efficiency has to do with time: there’s no point using a low-powered device if it has to function for long periods, when a high-powered device would complete the task faster and consume less energy.”

The way the EYES partners addressed the energy efficiency issue was to design protocols that turn sensor nodes off when they are not in use, but which would allow them to reawaken when they are needed. “The sensors only operate when they are required to communicate with other sensors or when there is some activity or change in what they are monitoring,” Havinga notes. “It is an important step forward in creating efficient networks.”

Equally important is the ability of the sensors to adapt to their operating environment and reconfigure themselves, allowing the network to continue to function even if one or more nodes are inoperable or if the number of sensors in a particular area changes.

Demonstrated in the dairy sector

The potential for the EYES' protocols and architecture to be used in everyday life was proven by a demonstrator developed for use in the agricultural sector. The system consists of a series of sensors attached to dairy cows to monitor their location and movement, and thereby determine their state of health. Other sensors were also introduced into dairy plants to monitor the temperature and density of milk.

"We chose the application area because it demonstrates the many possibilities for sensor networks, given that in this instance the sensors had to be dynamic, mobile and robust, they had to provide location information and had to constantly adapt to their environment," Havinga explains.

In addition to the demonstrator, the project partners are in the process of developing a prototype sensor network based on the architecture, protocols and algorithms they designed. The prototype network will be generic in the sense that it can be reconfigured and adapted for use in many application areas. Some of the network elements are currently being used in systems developed by project partner Nedap, while a spin-off company, Ambient Systems, has been created based on the project's work.

"In the short term I foresee small wireless networks increasing in use and within 15 years I expect sensor networks to become widespread," Havinga says. "A sensor could be attached to a prison guard for example to monitor where they are and whether they are okay, or sensors could be used to manage heating and air conditioning in buildings, and there are also possibilities to use them for environmental monitoring to take measurements of atmospheric and water pollution."

Expanding the use of small networks will be a crucial step toward the implementation of larger and even more pervasive systems Havinga

believes, pointing to a future in which computers become part of everyday objects and environments, rather than objects in themselves.

Source: IST Results