# Demo Abstract: Energy Management in Buildings with Sensor Networks

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## ABSTRACT
Energy has become one of the main cost drivers in our society. Therefore technical systems and solutions that save energy and keep the costs down gain in importance. In buildings, equipment like air-condition and heating consume high amounts of energy. Even small adjustments can therefore lead to significant lowering of costs. With the help of sensor networks, the monitoring and controlling of facilities can be simplified and improved. In this demo, we present a fine granular and long-term operating system for monitoring the relevant physical parameters of a building both indoors and outdoors.

## Keywords
µPart Particle, energy & facility management, sensor facade.

## 1. INTRODUCTION
Our built environment is one of our society's largest investments, e.g. all buildings in Switzerland are worth 2400 billions CHF [1]. Each year, 40 billion CHF are invested in Switzerland in maintenance or in new buildings. The total number of buildings affected exceeds the figure of 2 million. All buildings must provide comfortable space for humans. In order to achieve this goal, an enormous energy flow is needed, resulting in large costs. Saving energy during building operation has therefore both ecological and economical impact.

## 2. STATE OF THE ART
To optimize the parameters for the HVAC (heat, ventilation & air conditioning) equipment, engineers need precise measurements of sunlight irradiation, temperature and air quality. Normally, during the first operating year of a newly constructed building, these measurements are monthly taken to form the basis for the standard adjustment of these energy demanding equipments of the building. This manual process has two main disadvantages:

- It is very cost intensive due to labor costs and its associated transportation costs. The fully burdened (van, tools, fuel, parts, labor, hardware and software) cost of field engineers accounts for $1,000 per visit [2].
- Taking a single sample per month doesn't provide enough information to fully optimize the HVAC systems.

## 3. MOTIVATION
Wireless sensor networks have the potential to play a significant role in the facility management business. Deploying sensor nodes with the appropriate sensor equipment in each room enables continuous remote monitoring of temperature, sunlight irradiation and air quality. Due to the wireless nature of these networks deployment is not complicated since no cabling must be accomplished. Sensor networks solve the two problems facility management companies face today.

## 4. DEMO DESCRIPTION
The system architecture is depicted in Figure 1. For the demo-system, µPart sensors nodes are deployed inside and outside the building to gather periodic measurements. Over wireless links these values are forwarded to the bridges and routers to collect the data for the back-end application supporting the energy engineers to optimize the setup of the building.

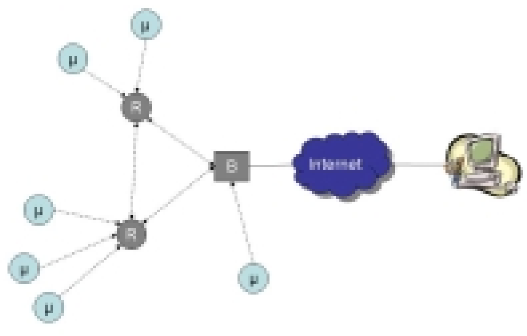


**Figure 1. System Architecture with uPart end nodes (µ), router nodes (R) and bridge nodes (B) .**

### 4.1 HW Platform
The µPart system is a sensor network built on a minimum hardware and software basis. The small and cost-efficient design enables large-scale settings with high sensor density, but without the need of a high monetary investment. The µPart sensor node comprises a micro controller and ISM-band radio interface and can include light, tilt, temperature, motion and acceleration

sensors. With a CR1632 coin-cell battery the life-time can easily exceed one year with a still high measurement period of several minutes. The overall outline is very small (down to 10x10x5mm including coin cell) and therefore ideally supports the embedding in walls, doors or similar parts of a building.

**Figure 2. µPart sensor node.**

The routers implement the communication for data transport and self-organizing overlay functionalities. They act like a traditional sensor network with outsourced sensors. The µParts as well as the routers encode data as strictly typed tuples using the ConCom [3] data description language. This guarantees a consistent view in all parts of the system.

### 4.2 SW Back-End

The software tool being presented during the demonstration will show the variation of temperature and brightness in both time and space axis in the building.

### 4.3 Installation during EWSN 2006

A µPart sensor network with a graphical visualization software tool will be installed at the building hosting the EWSN 2006 conference already in January 2006 to gather data over a long period of time.

The whole range of spatial typologies will prove the climatic diversity of a building: ETZ building offers small and large volumetric spaces with each sun illuminated and permanently shaded areas, doors, gathering spaces, etc.

## 5. CONCLUSSIONS

This demonstration illustrates a novel way to optimise the climatic settings of a building.

The conventional method of optimising building climate equipment is expensive and inefficient, since the optimization measures are based on punctual and manual samplings. Using sensor networks to continuously monitor local temperature and sunlight irradiation enables a more efficient use of energy and HVAC machinery. On top of that, sensor networks enable remote access to sensor data, which reduces the costs of the data gathering process.

With large scale sensor networks, the density of data both in space and time can be dramatically improved. This includes monitoring building's behaviour at night, during special events and exceptional climatic events. Data can be then analyzed for future trends in building control, e.g. a building dynamically reacts to weather forecasts and special events.

## 6. REFERENCES


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[3] A. Krohn, M. Beigl, C. Decker, P. Robinson, T. Zimmer, ConCom – A language and Protocol for Communication of Context, Technical Report ISSN 1432-7864 2004/19.