Exploring Smart Public Buildings Towards Sustainability

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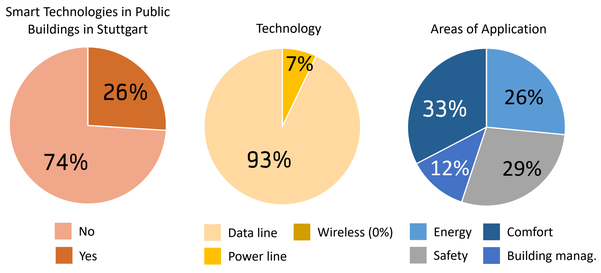
Motivation

This research explores opportunities for retrofitting public buildings with wireless smart (home) technologies and open source software to reduce energy consumption and CO2 emissions as well as to increase occupancy rate and user comfort.
Research interest aims at special requirements of Smart Public Buildings, the suitability of wireless smart (home) and open technologies for public buildings as well as their impact on data privacy.

Methodology

I. Analysis of requirements and classification of public buildings and smart applications based on literature.
II. Survey of public institutions (sample size = 50) in the region of Stuttgart to determine the dissemination of smart applications in public buildings (cf. figures below).
III. Designing and implementing several use cases within the university buildings (current phase).
IV. Evaluating and documenting the use cases, providing open source for reuse and development.

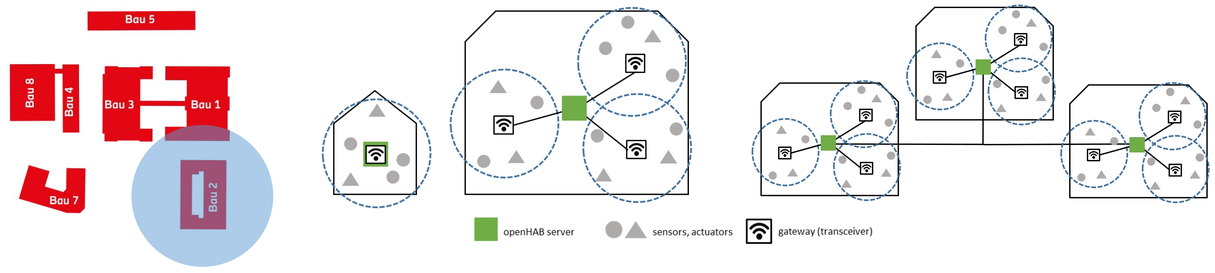


Open Eco System

Recommendations for public institutions point out the importance of striving at vendor and technology independence. Solutions based on open source software are regarded as one way to avoid a vendor lock-in. In this research, the open source software openHAB (open Home Automation Bus) is used to integrate all smart devices, technologies and services into one single platform.
Due to an open and modular approach, openHAB can be adapted to various use cases. Additional open source software components are used for persisting data (MySQL, Influx DB), managing telemetry data (MQTT), adding network security layer (Docker, Nginx) and visualizing data (Grafana). Thus, the entire openHAB stack can be built completely on open source software.

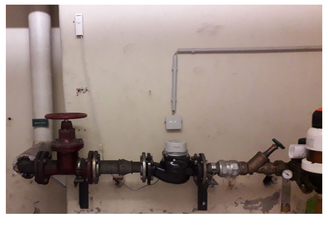
Use Case 1: Distributed Smart Systems

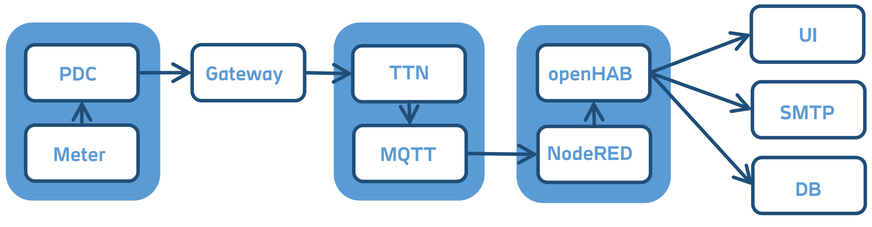
The university campus serves as testbed for the Smart Public Building. A basic installation has been set up to enable the implementation of different use cases. The entire system spreads over five floors in building 2, connecting more than 120 wireless sensors and actuators with a server. Sensors and actuators are distributed in offices, lecture rooms and computer labs, monitoring room conditions and device status. Because a smart home usually is much smaller than a public building, a concept for connecting and managing large buildings as well as multiple buildings has been developed in order to deploy the distributed wireless sensor network. It includes multiple gateways, servers (Docker Swarm) and indirect communication via MQTT.



Use Case 2: Smart Metering

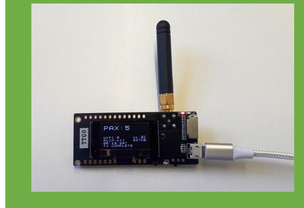
To provide fine-grained remote access to energy and water consumption of building 2, a monitoring system for the utility meters has been installed. The monitoring is based on pulse counting and includes several utility meters in two basement levels, connection is established via LoRaWAN. The respective gateways make use and contribute to an open infrastructure (The Things Network, TTN). The openHAB server subscribes to the MQTT broker of TTN. User interfaces and mail notifications allow technical staff and researchers to read the meters remotely once an hour. Data are furthermore persisted by openHAB in a DB.

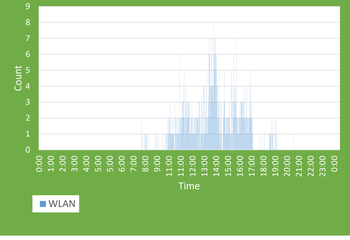


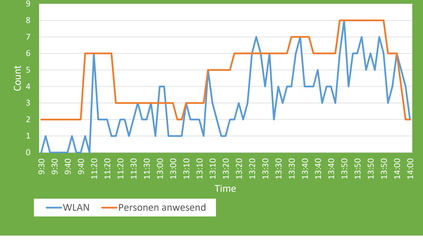


Use Case 3: Smart Lecture Room

The Smart Lecture Room describes a concept for monitoring lecture room conditions to optimize energy consumption and room occupation as well to provide a more healthy learning environment. Several lecture rooms have been retrofitted with different kinds of IoT (electronic-based, software-based, human-based). To estimate occupancy, the Paxcounter has been installed and configured. The Paxcounter is an OSS project for counting mobile devices (WiFi/Bluetooth) in realtime – in a privacy preserving manner. Room and outside data (e.g. luftdaten.info) are used for rule-based automation as well as for control Uis (e.g. tablets).







Discussion

Many public institutions occupy buildings as tenants, thus facing the same limitations regarding installations as tenants of private homes. Other public bodies lack funding to retrofit their building stock with wired automation systems. Open source home automation platforms like openHAB enable interoperability and independency and are adaptable to different needs. Additionally, open networks like TTN, open standards like MQTT, and open data like luftdaten.info may be part of this ecosystem in order to make the public building stock more sustainable in many respects.
On the other hand, the presented use cases for public buildings pose new challenges towards smart home technologies, such as scalability, reliability, security and privacy. Beyond the scope of this project, key indicators for sustainable Smart Public Buildings may be developed.

ICT4S Online Survey

1. Do the proposed technologies have the potential to make public buildings more sustainable?
2. What indicators would you suggest to evaluate the sustainability of a Smart Public Building?
3. What are the main challenges for public buildings to achieve more sustainability?

Survey tool: Surveymonkey. Survey does not ask for personal data.

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