



Aalto University
School of Engineering

Room Systems as a Service Platform for Smart Buildings

11th International Conference on Improving Energy Efficiency in
Commercial Buildings and Smart Communities (IEECB&SC'20)

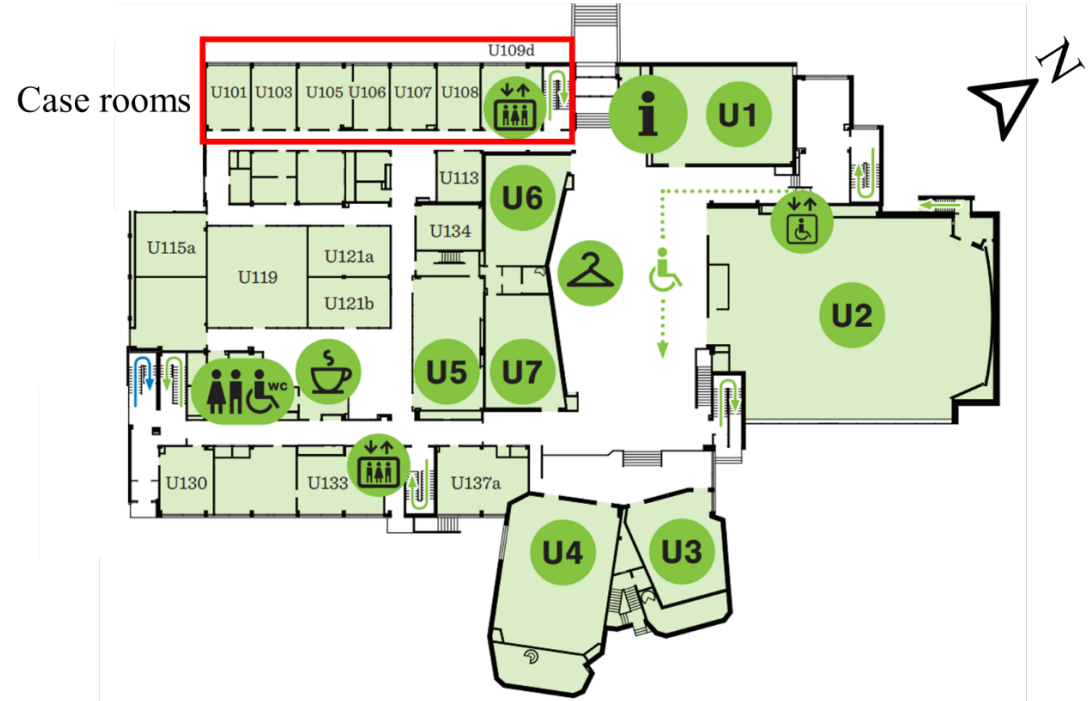
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Research objectives

- How smart HVAC-technologies can be incorporated in retrofitted buildings
- Evaluate how to integrate different systems including building automation, HVAC and Aalto space mobile application
- Evaluate how ICT-technology and services can be used in buildings through case examples

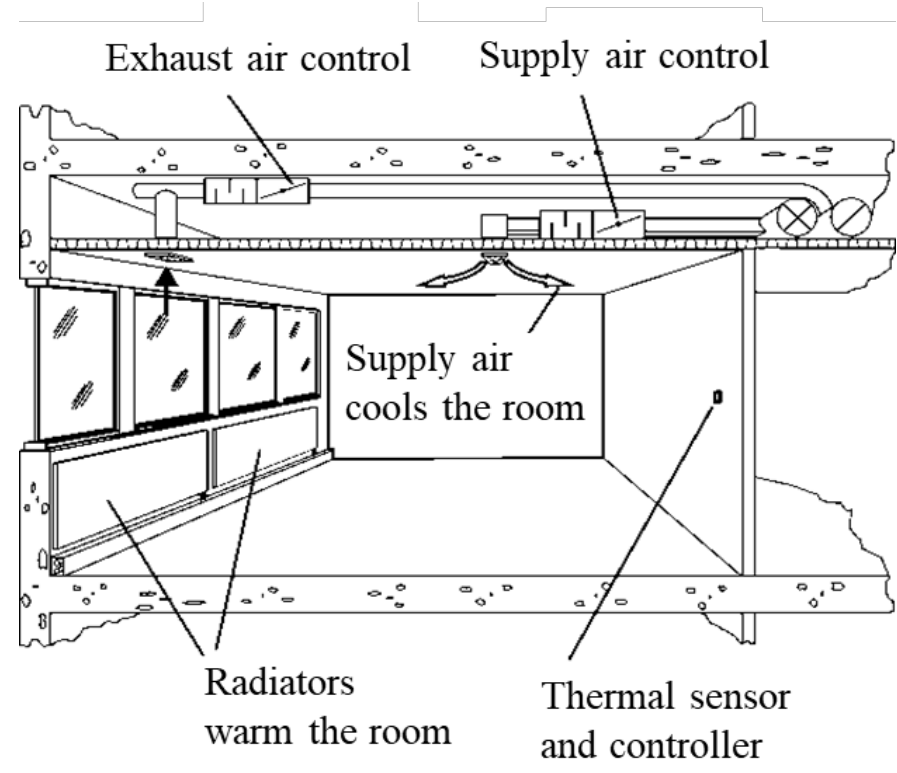
Case rooms in Undergraduate center

- Smart room systems studied in seven group working rooms of Otakaari 1
- Rooms are used as group working spaces for students



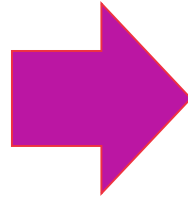
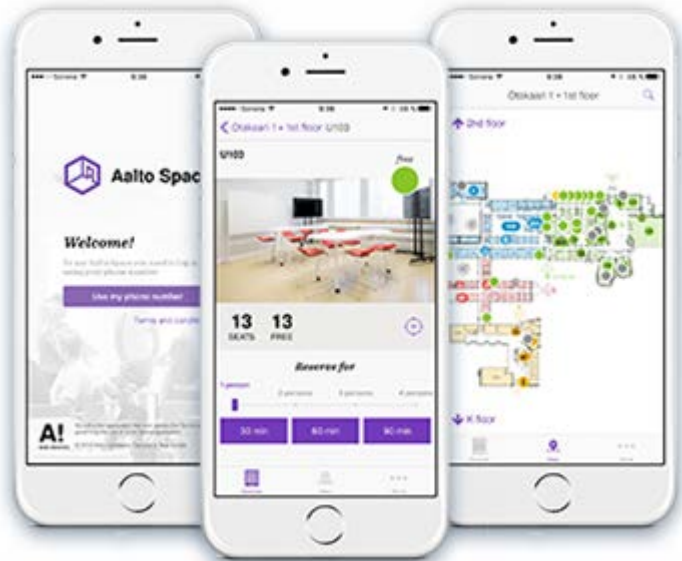
HVAC system of the case rooms

- Ventilation by a VAV ventilation system with T + CO₂ control
- Each room has two supply and exhaust air terminals
- Terminals are equipped with on/off dampers
- Heating by water radiators equipped with manual thermostatic radiator valves



We let the users to adjust the ventilation and temperature

Aalto Space mobile app for room reservations (iOS + Android)



Space heating:

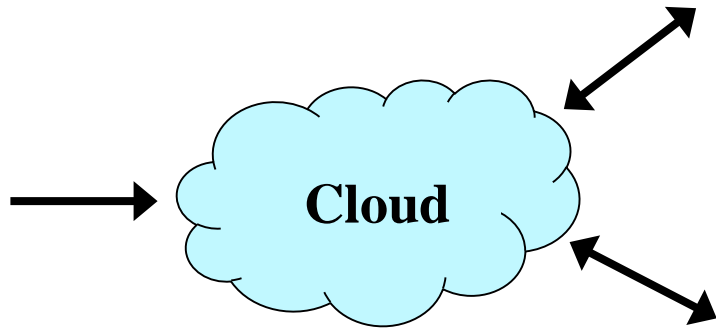
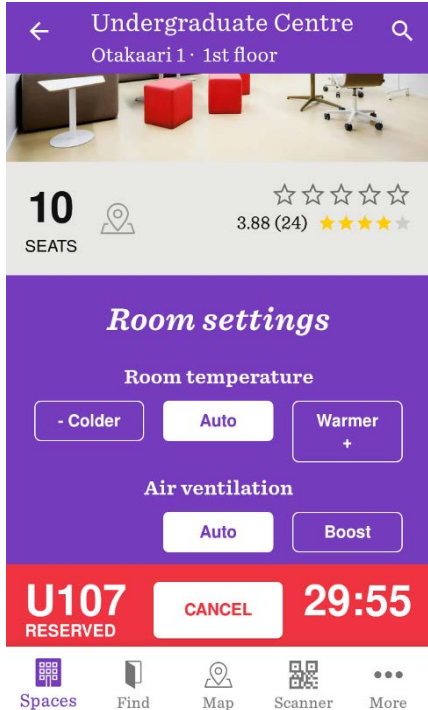
- Users can adjust set point of heating during the reservation
- Electronic IoT thermostats are needed

Ventilation:

- Users can override the settings of the automation system of Fidelix oy during the reservations

Principle of the Aalto Space control

Aalto space



Heating/Smart
thermostats



Ventilation/ Automation system



Integration of Aalto Space, real estate IT services and Building Management systems together

AALTO SPACE APP & KISKO LABS MIDDLEWARE

Aalto Space Front

iOS and Android OS:s

User interface for using the service

- Delivers space reservation and service requests to Aalto Space Middleware

Aalto Space Middleware

Provides data connection for Aalto Space Front

- Delivers space reservation & service requests forward
- Communicates with Smart Campus through Integration Service and confirms that the indoor climate service is available in the space
- Delivers service confirmations to Aalto Space Front

AALTO IT LOCAL & CLOUD SERVICES

AZURE AD

Database of external Aalto users

AALTO AD

Database of internal Aalto users

ASIO Cache

Caches selected ASIO data

Reduces data traffic to ASIO

ASIO

Central space and asset database

- Space & asset management
- Reservation management

Aalto Integration Service

Integrates services to Aalto IT infrastructure

- Connects Aalto Space Middleware to ASIO, which keeps track of spaces, assets and reservations
- Authenticates external/internal users using Aalto AD and Azure AD

SmartCampus

Service for building automation integration

- Checks if the Indoor Climate Service is available in the space.
- Piloting phase spaces: "U101, U103, U105, U106, U108, U109".

Indoor Climate Service functionalities:

- Air Conditioning: current → 100%
- Temperature: current → +2/-2 °C
- Delivers service requests to building automation
- Delivers service confirmation to Integration Service

BUILDING MANAGEMENT AND RELATED CLOUD SERVICES

Fourdeg Cloud Service

Fourdeg service for remote thermostats

Receives service requests and delivers them to Fourdeg thermostats

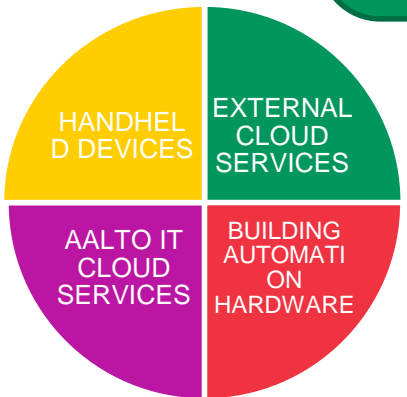
Fourdeg Thermostats

Adjust radiator temperatures

Fidelix Building Automation

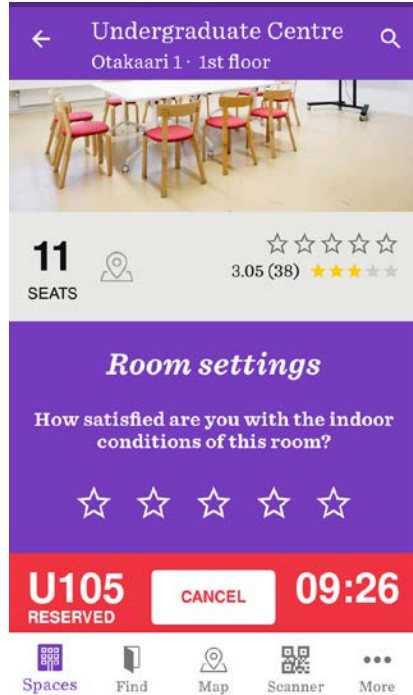
Adjusts AC settings (room specific ventilation sheets)

LEGEND

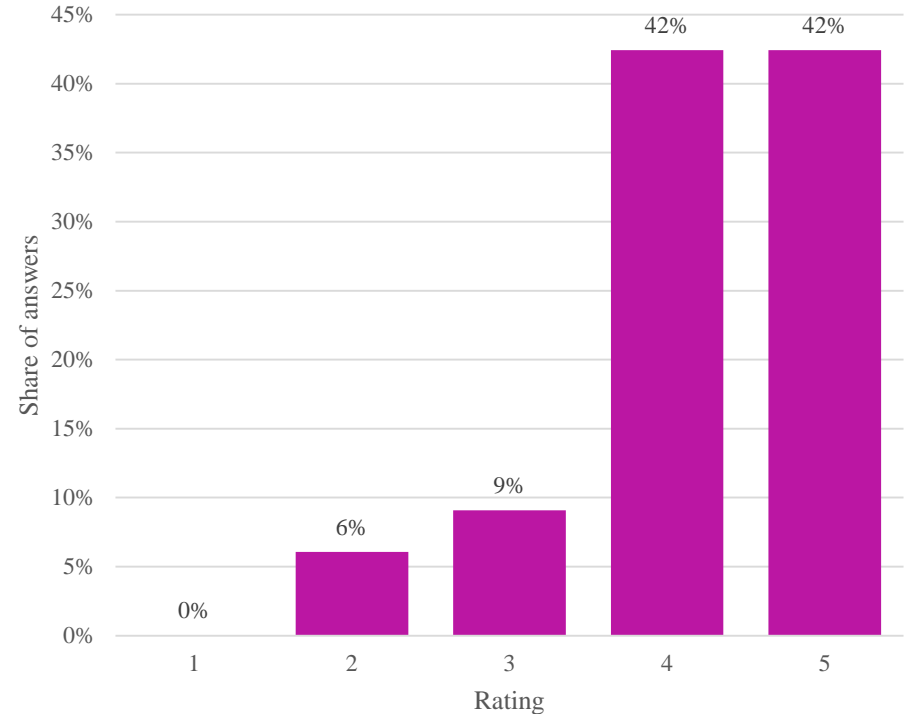


User satisfaction?

“How satisfied are you with the indoor conditions of this room?”

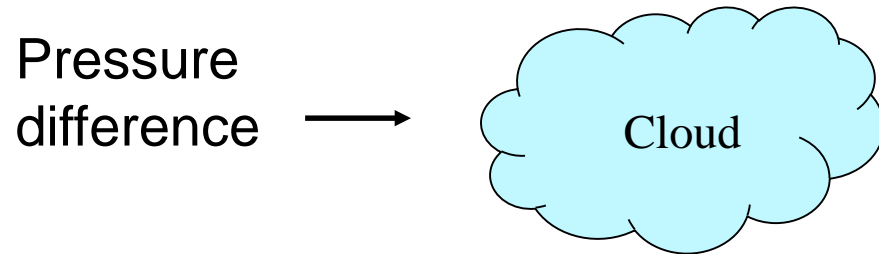


User feedback



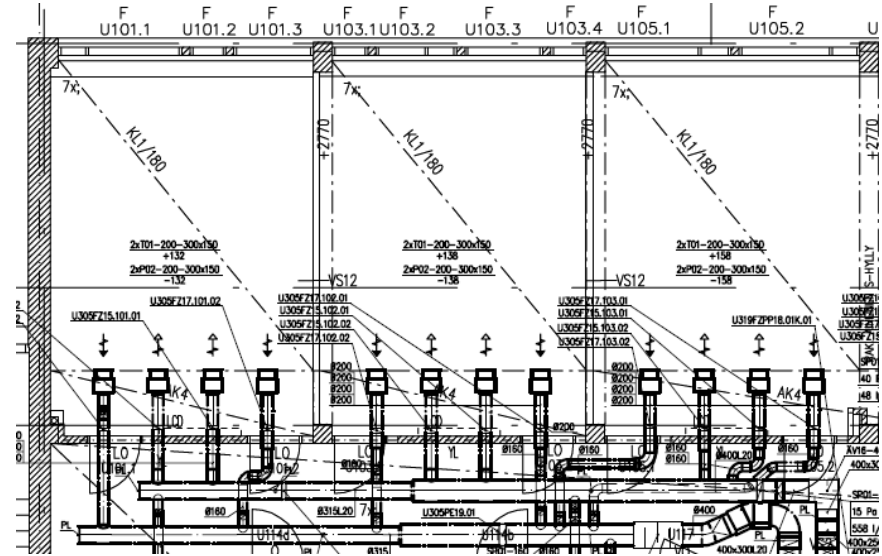
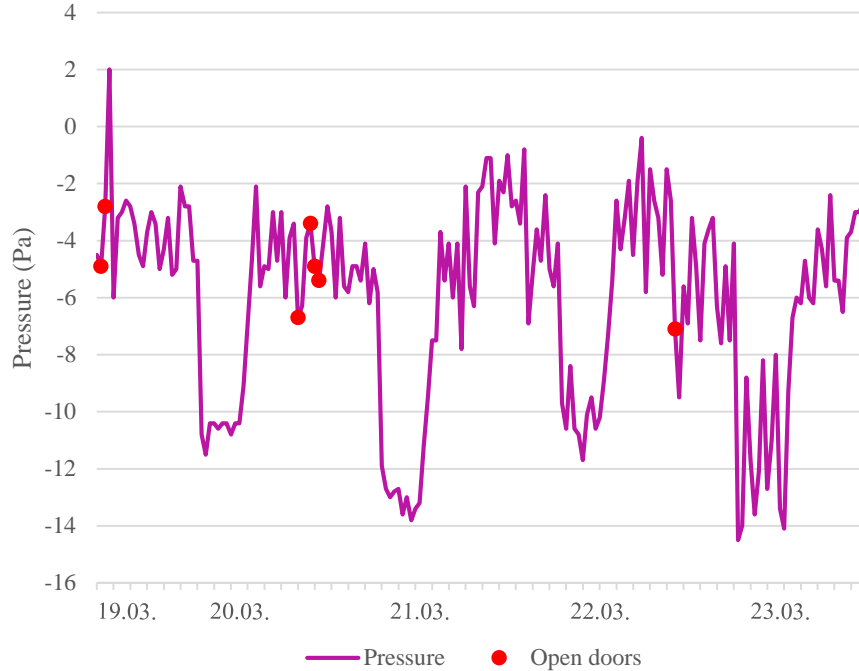
Monitoring of the pressure difference over the envelope

- Wireless data collection by Integral IoT service
- Data is transferred to the cloud by Sigfox radio network
- Pressure sensors: Sensirion, sensor model SDP816-125PA
- (accuracy 3 % of reading)
- Time step of the measurement 30 min



Pressure difference over the building envelope

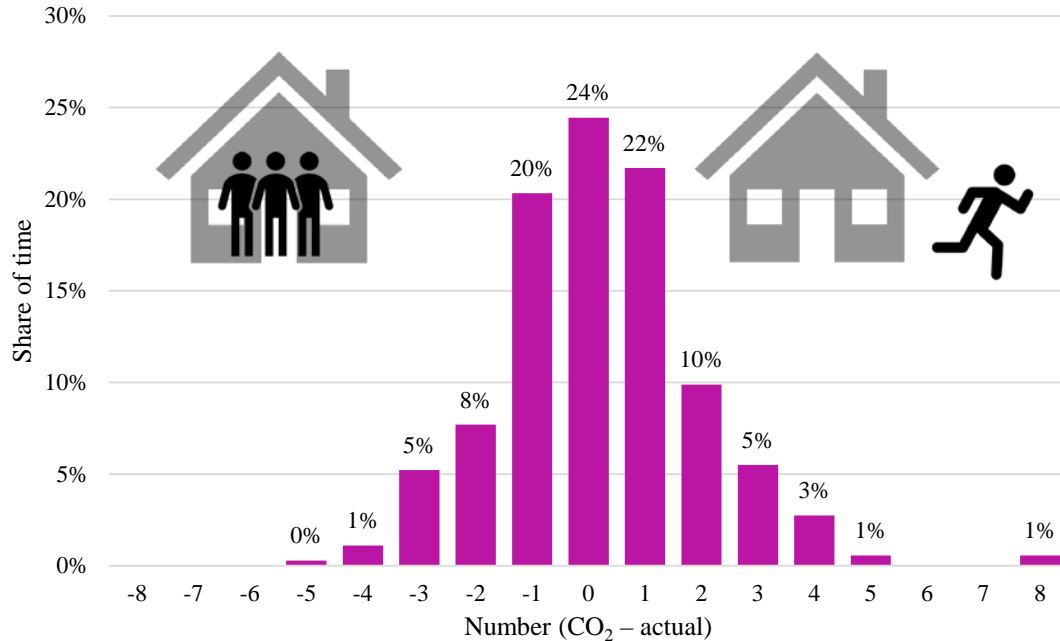
Room U101



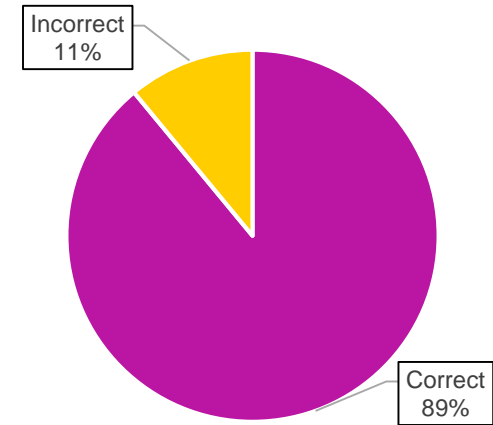
Even though, the rooms are connected by the same ducts, the neighboring rooms do not have a major effect on the pressures in the rooms.

Room occupancy – CO₂ concentration

Difference between CO₂ concentration-based calculation and actual occupancy



CO₂ concentration-based room occupancy compared with actual occupancy



Conclusions

The main benefits of the novel system compared the standard ones are:

- 1) the monitoring of the ventilation system performance is improved and possible risk of damages in building envelope could be reduced,**
- 2) the controllability of indoor climate is enhanced in energy efficient manner, and**
- 3) finally users' perception on the indoor climate is improved.**

A large, modern building with a green roof and red facade, surrounded by lush green trees and a grassy lawn with people walking. The building has a distinctive angular design with a prominent red section on the right side. The foreground is a well-maintained lawn with several people walking and sitting. The sky is blue with scattered white clouds.

Thank you!