Decentralized MCT

Design of a decentralized measurement
and control technology concept for building services
in the context of the Internet of Things

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Summary report

Munich, February 2019

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1 Introduction

The measurement and control technology in buildings usually is managed centrally based on superordinate parameters (Top-down-management) and is mostly unsatisfactory for the user in terms of functionality and interaction. The management of the building technology mainly does not adapt to the user and follows its rigid rules. Additionally these rules are often complicated, inflexible and unable to exploit the energy saving potentials.

2 Objective of the research project

The hypothesis of the research project is to exploit the energy-saving potential by decentralized control strategies of the building technology by means of direct, decentralized networking of the building services components by involving the user.

The aim is to examine, on a conceptual level, how and to what extent such decentralized management is technically feasible and what potential for improvement is possible. In addition to the investigation of the climatic context, the focus is on the development of a prototypical application for controlling selected relevant climatic factors. Finally the integration of the application takes place in a predefined demonstrator room, which is located at the campus of Robert Bosch GmbH in Renningen.

Concept

Access to the control of the decentralized building technology should be generally controlled via a smartphone application. In other words, the user interacts with a smart device that is connected via W-LAN to a database in which the settings desired by the user are stored. This database is connected to the building technology via further interfaces, which finally executes the desired control commands and controls the respective decentralized components.

The application includes the following functions:

- Authentication (user authorization)
- Localization (zone assignment of the user)
- Operation mode (degree of influence of the user)

After the authentication and localization of the user, the application assigns a specific operating mode. In the "single-mode", the user is authorized to control independently the system and to adapt the conditions to his individual, personal comfort requirements. If the user leaves the room (zone), the system switches to a predefined basic state (default values). In the "multi-mode", it is no longer entirely possible for the individual user to set individual settings on its own. This means that the application adapts the personal settings of each user within a common room (zone) and determines a weighted compromise value per occupancy zone, which is passed on to the building technology.

The general flow chart of the application is shown in Figure 2.1.

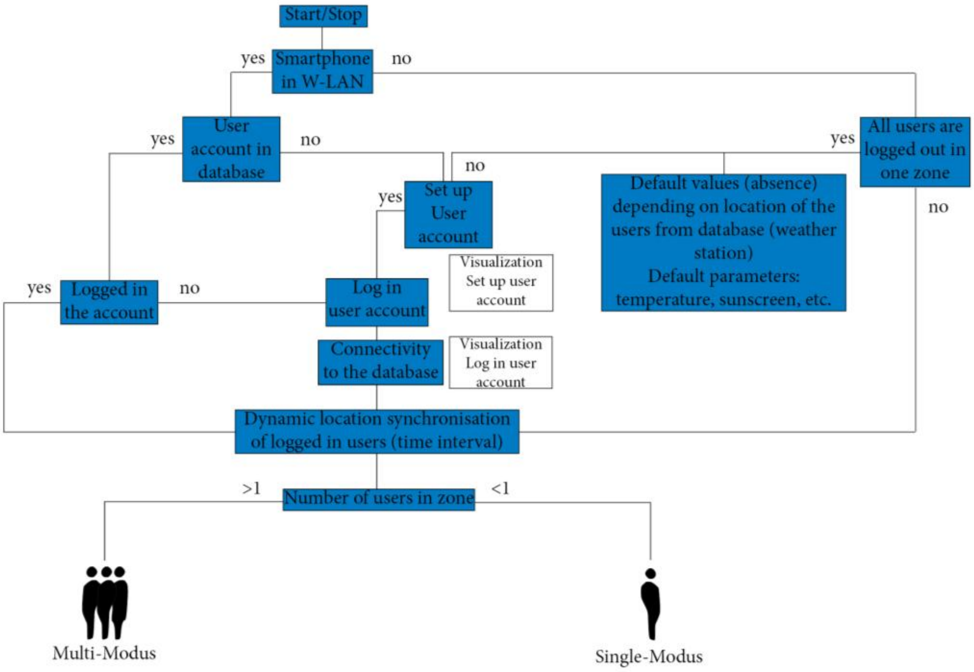

Figure 2.1 **General flowchart (functional scheme) of the decision processes of the application**

Implementation

The used communication scheme is based on a hybrid, decentralized peer-to-peer (P2P) connection. The main goal is to reduce the reliance on external servers. The application is able to send different preferences to other users in the same room (zone) and to calculate an optimal solution for the building services component in the room (zone). The role of the server in the planned system is to perform operations and data management, as this would be too costly for a mobile device (storing the ownership of the transfer systems to a zone, specific communication schemes for the various air conditioners, etc.) (Figure 2.2).

Figure 2.3 illustrates the prototypical user interface of the application.

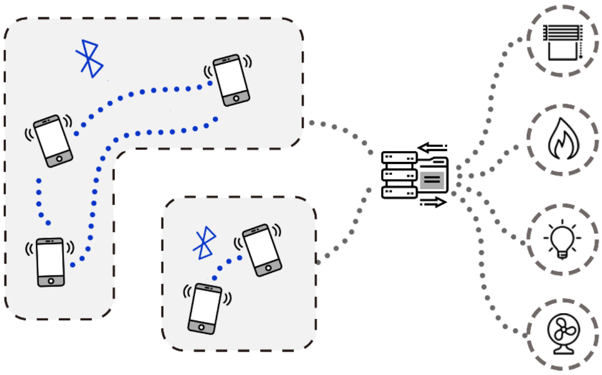

Figure 2.2 Scheme of the communication process

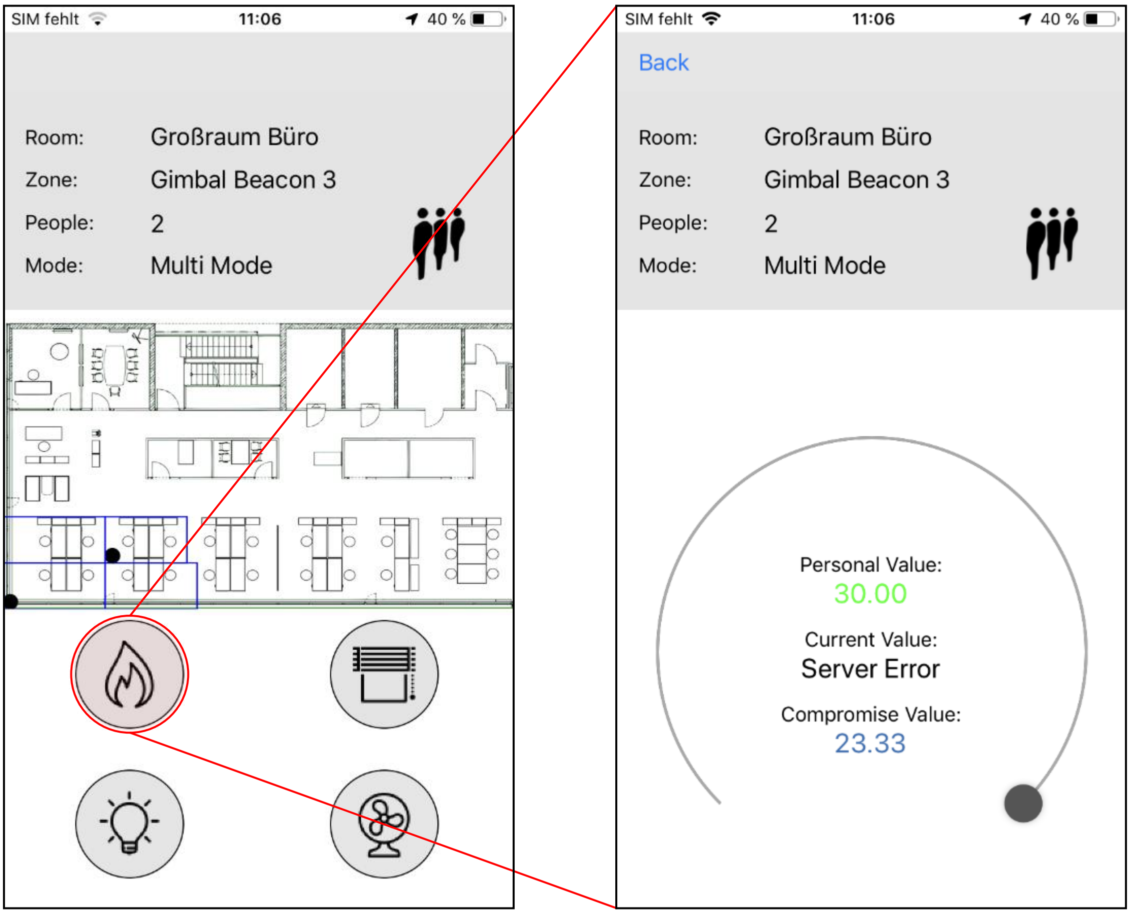

Figure 2.3 Prototypical user interface of the application with main page and exemplary detail view (Left: Main-ViewController [Source (original map): Robert Bosch GmbH], Right: Sensor-ViewController)

Simulation

The simulation models refer to a predefined simulation area within the demonstrator room. Figure 2.5 provides an overview of the different input parameters.

The simulation results show that the decentralized variant with a central control element represents the thermally most comfortable and energetically most efficient solution. Numerically, compared to the base variant, this means that the comfort in the form of the total deviation degree hours decreases by 18.5 % to 31 Kh (in this case 57 Kh are permissible) and at the same time the primary energy demand is reduced by 47 % from 124.5 kWh/(m^2a) to 65.8 kWh/(m^2a). Completely decentralized behavior reduces the energy demand by only 31 % compared to the base case; thermal comfort in terms of total deviation degree hours increases by as much as 6 % to 54 Kh (Figure 2.4).

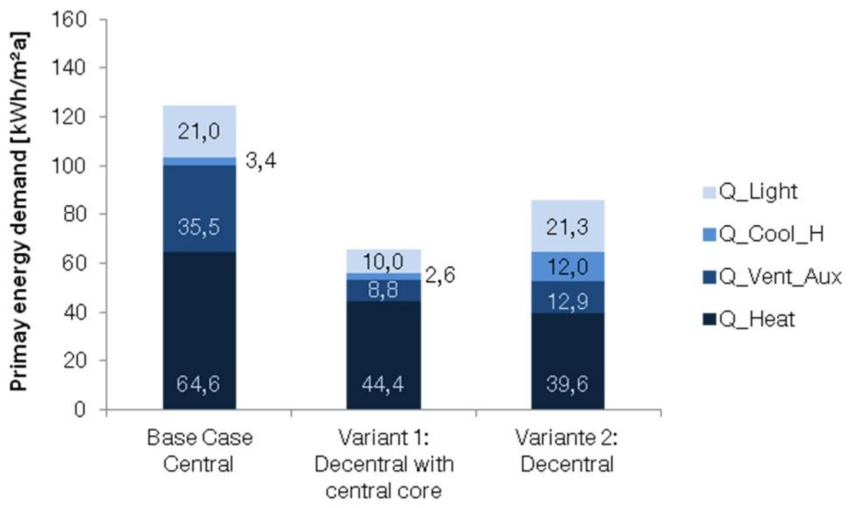

Figure 2.4 **Comparison of the primary energy demand per m^2**

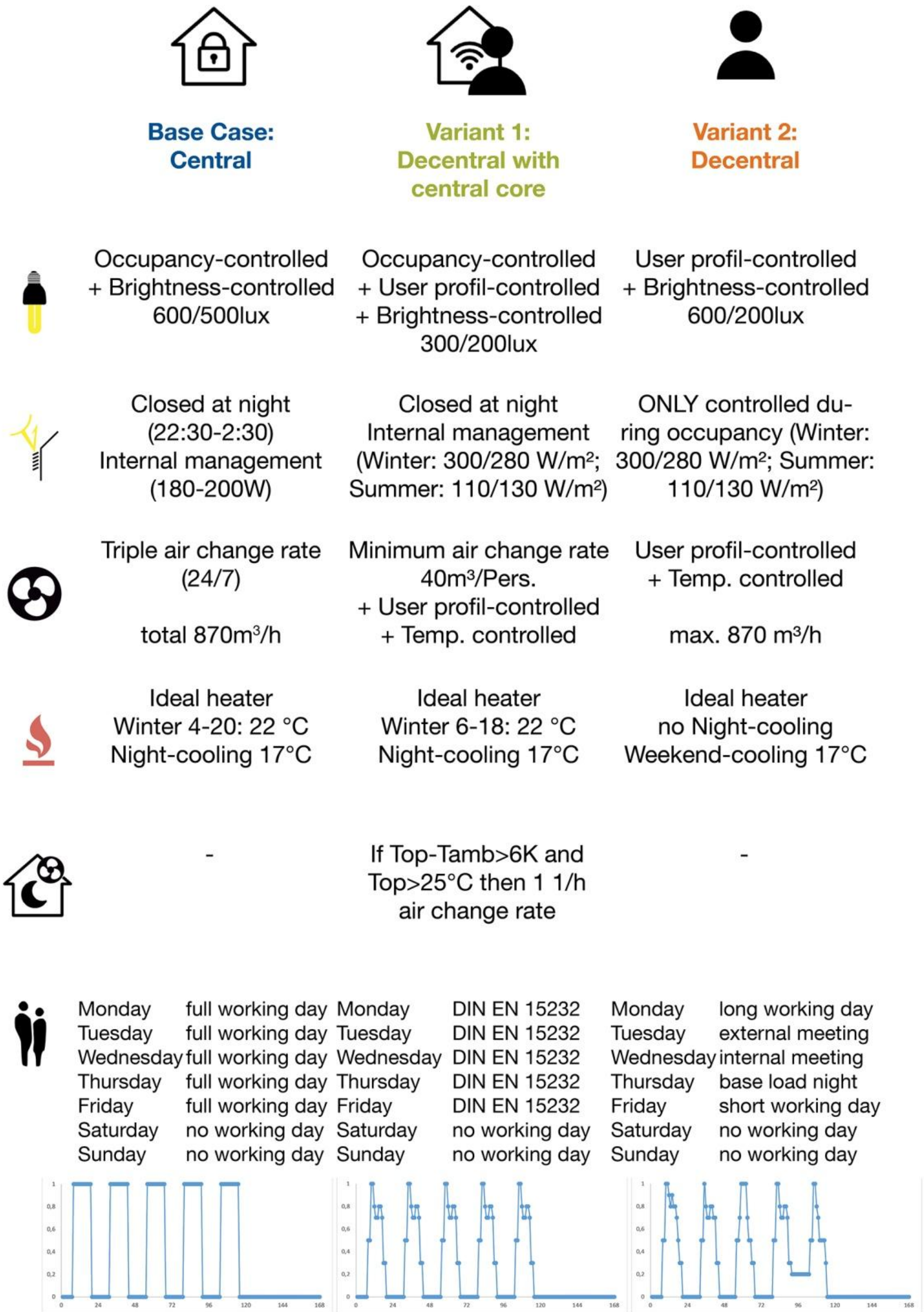

Figure 2.5 **Input parameters of the simulation variants**

3 Summary

The hypothesis that a decentralized building management system would be more energy efficient and thermally more comfortable for the user compared to a top-down managed system can be confirmed. In general, a decentralized control is nowadays in theory feasible. All required sensors and control elements are available on the market and a corresponding implementation is possible. However, the simulation results also show that a completely decentralized behavior without a central control element is not ideal, because the user does not always behave correctly and thus the thermal comfort decreases and energy is needed.

4 Key data

Title: Decentralized MCT

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