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Procedia Computer Science 32 (2014) 979 – 984

Procedia Computer Science

The 4th International Symposium on Frontiers in Ambient and Mobile Systems (FAMS-2014)

On defining information and communication technology requirements and associated challenges for 'energy and comfort active' buildings

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Abstract

The intention of this article is to highlight considerations and ensuing challenges encountered in attempts to define communication requirements for the proposed multi-agent based building energy management systems. This is within the framework of 'TKI-Smart Grid BEMS' project which aims at developing new generation intelligent Building Energy Management Systems having capacity to interact with the utility power systems distribution network. The article identifies the development of comfort and energy active buildings as key to deriving maximum benefits from electrical smart grids for the built environment. These buildings require well specified information and communication technology for operational success. The paper is based on critical literature review. This is followed by a discussion on the challenges associated with specifying ICT infrastructure for multi-agents systems-based energy and comfort active buildings.

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Selection and Peer-review under responsibility of the Program Chairs.

Keywords: ICT, smart grids, buildings, multi-agents system

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Selection and Peer-review under responsibility of the Program Chairs.
doi:10.1016/j.procs.2014.05.521

1. Introduction

The now common Net Zero Energy Buildings (NZEB) policy has consequently introduced the need to integrate building level energy generations to power grids [1]. This has in turn led to emergence of 'smart electrical grid' characterised by multi-directional flow of power at low voltage levels and requirement for an elaborate informational exchange between stakeholders and components. Smart electrical grids is defined as 'electricity network that can cost-efficiently integrate the behavior and actions of all users connected to it in efforts towards economic efficiency, energy sustainability and better service delivery to end users' [2]. Implications of smart grid to buildings are: (i) flexible operations for energy advantage, and (ii) dynamic exchange of information by component subsystems and actors. Informational exchange includes: energy generation and consumption profiles, occupants' comfort profiles and preferences, building behavior, market behavior and activity flows for different environmental scenarios. This leads to a key term used in this paper: 'energy and comfort active buildings'; this term is used to describe buildings that proactively use indoor comfort requirements to define limits of dynamic interactions with electrical grid. General guidelines on indoor comfort requirements for buildings are often described in terms of thermal comfort, indoor air quality and visual comfort [3-5]. Operations in electrical smart grids involve interactive coordination amongst multiple actors, processes and devices, this requires agile and robust controls. Some scholars propose multi-agent systems (MAS) for interactions between buildings and electrical smart grids [6, 7]; this is also important in enabling robust user interactions and real time decision making in buildings [16]. However, these have implications in terms of communication requirement such as need for greater robustness, proactivity and real time dynamics [8]. Little attention has been given towards addressing these new developments. This paper outlines the requirements and challenges associated with defining ICT for multi-agent based energy and comfort active buildings. Discussions are further divided into the following subsections: ICT requirements; the challenges, illustrative cases and conclusion.

2. ICT requirements

Multi-agent based energy and comfort active buildings are essentially knowledge based systems whose operations are characterised by informational flows illustrated in Figure 1. Subsequently their ICT requirements can be categorised as unique to the 4 stages of informational flows (see Figure 1).

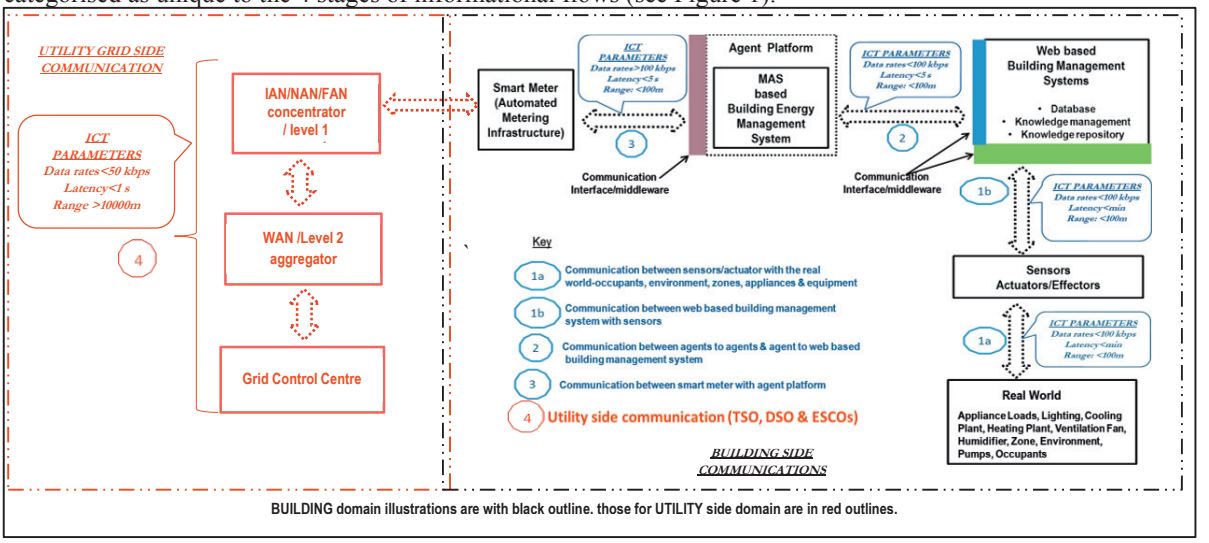

Fig. 1. Figure 1: Informational flows for energy & comfort active buildings in a smart grid.

Further details on the ICT requirements in relation to Figure 1are as discussed below.

Use level communication (stage 1)

This is stage connects the real world with the Building Management System. Information communicated at this stage is modal, singular in objective and is delivered as a signal. There are two categories of communications at this

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