Improvement of Building Automation System

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Abstract. The paper addresses redesign/improvement of a building automation system (BAS). For the sake of simplicity, the field bus technology on KNX example and WSN technologies on IEEE.15.4/Zig.Bee basis are examined. The basic system example consists of four parts: (1) IP/KNX Gateway, (2) IP/WSN 6LoWPAN Gateway, (3) ZigBee Wireless Sensor Network, and (4) KNX Field Bus Infrastructure. A tree-like system model (*and/or morphological tree*) is used. The following system improvement design schemes are examined: (i) upgrade of system components (strategy 1), (ii) extension by adding an additional part (strategy 2), and (iii) combined scheme (strategy 3). Three underlaying problems are used: (a) multicriteria ranking, (b) multicriteria multiple choice problem, and (c) combinatorial synthesis. Numerical examples illustrate the redesign processes.

Keywords: System design, combinatorial optimization, heuristics, multicriteria decision making, building automation, smart home.

1 Introduction

In recent two decades, the significance of reengineering (i.e., issues of systems re-design, rebuilt, improvement, upgrade, transformation, extension) has been increased (e.g., [1], [12], [13], [19]). Building design automation systems (BASs) are increasing in popularity (e.g., [5], [7], [9], [16], [21], [22], [24]). BAS provide managing some building equipments (e.g., monitoring, detection of faults, tracking, minimization of energy usage associated with facility assets, etc.) while taking into account reliability and maintenance cost. The building automation domain is still experiencing intensive growth. Generally, it is quite cumbersome to estimate the advantages and disadvantages of the whole variety of not mature technologies and services. Fig. 1 depicts an architecture of a building automation system ("SAC" corresponds to "sensor, actuator, controller") (e.g., [21]).

For the sake of simplicity, here the field bus technology on KNX example and WSN technologies on IEEE.15.4/Zig.Bee basis are examined. The considered system example consists of four parts (subsystems/components): (1) IP/KNX Gateway, (2) IP/WSN 6LoWPAN Gateway, (3) ZigBee Wireless Sensor Network,

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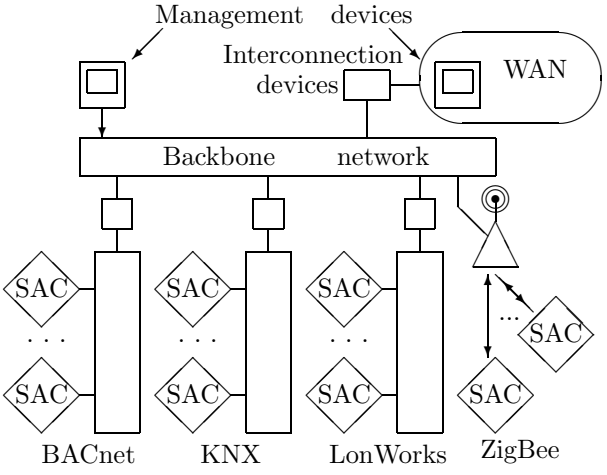

Fig. 1. Architecture of building automation system

and (4) KNX Field Bus Infrastructure. In our paper a tree-like system model (as and/or morphological tree) is used for the system modeling (e.g, [12], [13]).

In the paper three improvement design schemes are examined: (i) bottlenecks-based strategy to improve (upgrade) some system components, (ii) extension of an existing system, and (iii) combined scheme. The following underlaying combinatorial problems are used: (a) multicriteria ranking of alternatives (e.g., system bottlenecks), (b) multicriteria multiple choice problem, and (c) combinatorial synthesis based on Hierarchical Morphological Multicriteria Design (HMMD) approach (morphological clique problem). Realistic numerical examples illustrate the redesign processes for a building automation system.

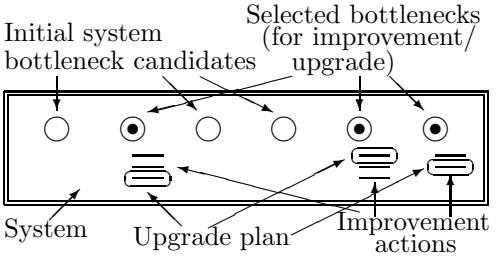

Fig. 2. Bottlenecks-based redesign scheme

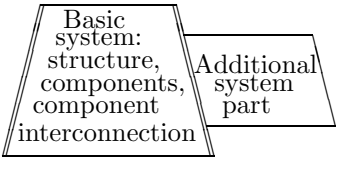

Fig. 3. System extension

2 Systems Modification Issues

In general, system improvement/modification processes are based on the following three action kinds (e.g., [12], [13]): (i) improvement (modification, upgrade, addition) of a system component, (ii) improvement of system components compatibility, (iii) change of a system structure. Evidently, revelation of *system bottlenecks* may be considered as a special preliminary phase. Thus, the following