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Contemporary Complex Systems and Their Dependability

Proceedings of the Thirteenth International Conference on Dependability and Complex Systems DepCoS-RELCOMEX, July 2–6, 2018, Brunów, Poland

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Preface

In this volume, we would like to present the reader with proceedings of the Thirteenth International Conference on Dependability and Complex Systems *DepCoS-RELCOMEX*, which took place in the Brunów Palace in Poland from 2 to 6 July 2018.

DepCoS-RELCOMEX is an annual conference series organized since 2006 at the Faculty of Electronics, Wrocław University of Science and Technology, initially by Institute of Computer Engineering, Control and Robotics (CECR) and now by Department of Computer Engineering. Its idea came from the heritage of the other two cycles of events: RELCOMEX (1977–1989) and Microcomputer School (1985–1995) which were organized by the Institute of Engineering Cybernetics (the previous name of CECR) under the leadership of Prof. Wojciech Zamojski, now also the DepCoS chairman. In this volume of "Advances in Intelligent Systems and Computing", we would like to include results of studies on selected problems of contemporary complex systems and their dependability. Proceedings of the previous DepCoS events were published (in historical order) by the IEEE Computer Society (2006–2009), by Wrocław University of Technology Publishing House (2010–2012) and recently by Springer in AISC volumes no. 97 (2011), 170 (2012), 224 (2013), 286 (2014), 365 (2015), 479 (2016) and 582 (2017).

Published by Springer Nature, one of the largest and most prestigious scientific publishers, the AISC series is one of the fastest growing book series in their programme. Its volumes are submitted for indexing in ISI Conference Proceedings Citation Index (now run by Clarivate), Ei Compendex, DBLP, SCOPUS, Google Scholar and SpringerLink, and many other indexing services around the world.

The selection of papers in these proceedings illustrates a broad variety of topics which are investigated in dependability analyses of today's complex systems. Dependability came naturally as a contemporary answer to new challenges in their reliability evaluation. This kind of systems cannot be interpreted only as (however complex and distributed) structures built on the base of technical resources (hardware), but their analysis must take into account a unique blend of interacting people (their needs and behaviours), networks (together with mobile properties, iCloud organization) and a large number of users dispersed geographically and producing

an unimaginable number of applications (working online). A growing number of research methods apply the newest results of artificial intelligence (AI) and computational intelligence (CI). Today's complex systems are *really* complex and are applied in many different fields of contemporary life.

Dependability approach in theory and engineering of complex systems (not only computer systems and networks) is based on multidisciplinary approach to system theory, technology and maintenance of the systems working in real (and very often unfriendly) environment. Dependability concentrates on efficient realization of tasks, services and jobs by a system considered as a unity of technical, information and human assets, in contrast to "classical" reliability which is more restrained to the analysis of technical resources (components and structures built from them). This difference has shaped natural evolution in topical range of subsequent DepCoS conferences which can be seen over recent years.

The Programme Committee of the 13th International DepCoS-RELCOMEX Conference, its organizers and the editors of these proceedings would like to gratefully acknowledge participation of all reviewers who evaluated conference submissions and in this way helped to refine the contents of this volume. The list includes, in alphabetic order, Andrzej Białas, Ilona Bluemke, Eugene Brezhniev, Dejiu Chen, Frank Coolen, Mieczysław Drabowski, Francesco Flammini, Manuel Gil Perez, Zbigniew Gomółka, Zbigniew Huzar, Igor Kabashkin, Vyacheslav Kharchenko, Wojciech Kordecki, Alexey Lastovetsky, Jan Magott, István Majzik, Jacek Mazurkiewicz, Marek Młyńczak, Yiannis Papadopoulos, Krzysztof Sacha, Rafał Scherer, Mirosław Siergiejczyk, Robert Sobolewski, Janusz Sosnowski, Jarosław Sugier, Victor Toporkov, Tomasz Walkowiak, Bernd E. Wolfinger, Wojciech Zamojski and Wlodek Zuberek.

Expressing our thanks to all the authors who have chosen DepCoS as the publication platform of their research, we would like to stress our desire that their papers will help in further developments in design, analysis and engineering of dependability aspects of complex systems, creating a valuable source material for scientists, researchers, practitioners and students who work in these areas.

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Tomasz Walkowiak
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Thirteenth International Conference on Dependability and Complex Systems DepCoS-RELCOMEX

Organized by Department of Computer Engineering, Wrocław University of Science and Technology, Brunów Palace, Poland, July 2–6, 2018

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Contents

Monte-Carlo Simulation and Availability Assessment of the Smart Building Automation Systems Considering Component Failures and Attacks on Vulnerabilities

Vyacheslav Kharchenko[1,2], Yuriy Ponochovnyi[3(✉)], Artem Boyarchuk[1], Eugene Brezhnev[1,2], and Anton Andrashov[2]

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Abstract. The information and control system of smart building is considered as a set of subsystems including a building automation system (BAS) which has three-level structure (automation/control, communication, data base, cloud/management). BAS security and availability during its life cycle are assessed using the Markov models and Monte-Carlo simulation. Markov model is used to calculate BAS availability considering the possibility of recovery and different kinds of the faults. The Monte-Carlo simulation is applied to investigate any flow of intrusions into the BAS by analyzing system availability of a fault/vulnerability to occur during time depending on failure rate of its subsystems. The results of analytical and simulation modeling are compared to assure trustworthiness of availability assessment taking into account attacks on vulnerabilities.

Keywords: Simulation models · Building automation systems
Availability functions · Probability distribution function

1 Introduction

A set of smart buildings subsystems which performs information and control functions is considered as a building automation system (BAS), in other words the automation system of a dwelling, office or public institution [1]. The structure of the BAS of a smart building [2] includes the levels of control functions implemented on the CPU/FPGA, wireless communications and databases located on local servers or cloud data centers (Fig. 1).

Failures of the BAS component can be caused by physical and design defects (reliability factor); attacks on vulnerabilities (information security factor) [3]. Given the

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criticality of the consequences of failures, it is necessary to justify strategies and parameters for servicing and restoring systems. During the life cycle, software components can be modified (updates, patches). One of the key issues in the development of service strategies is their separate or general implementation, taking into account the factors of reliability and safety [4].

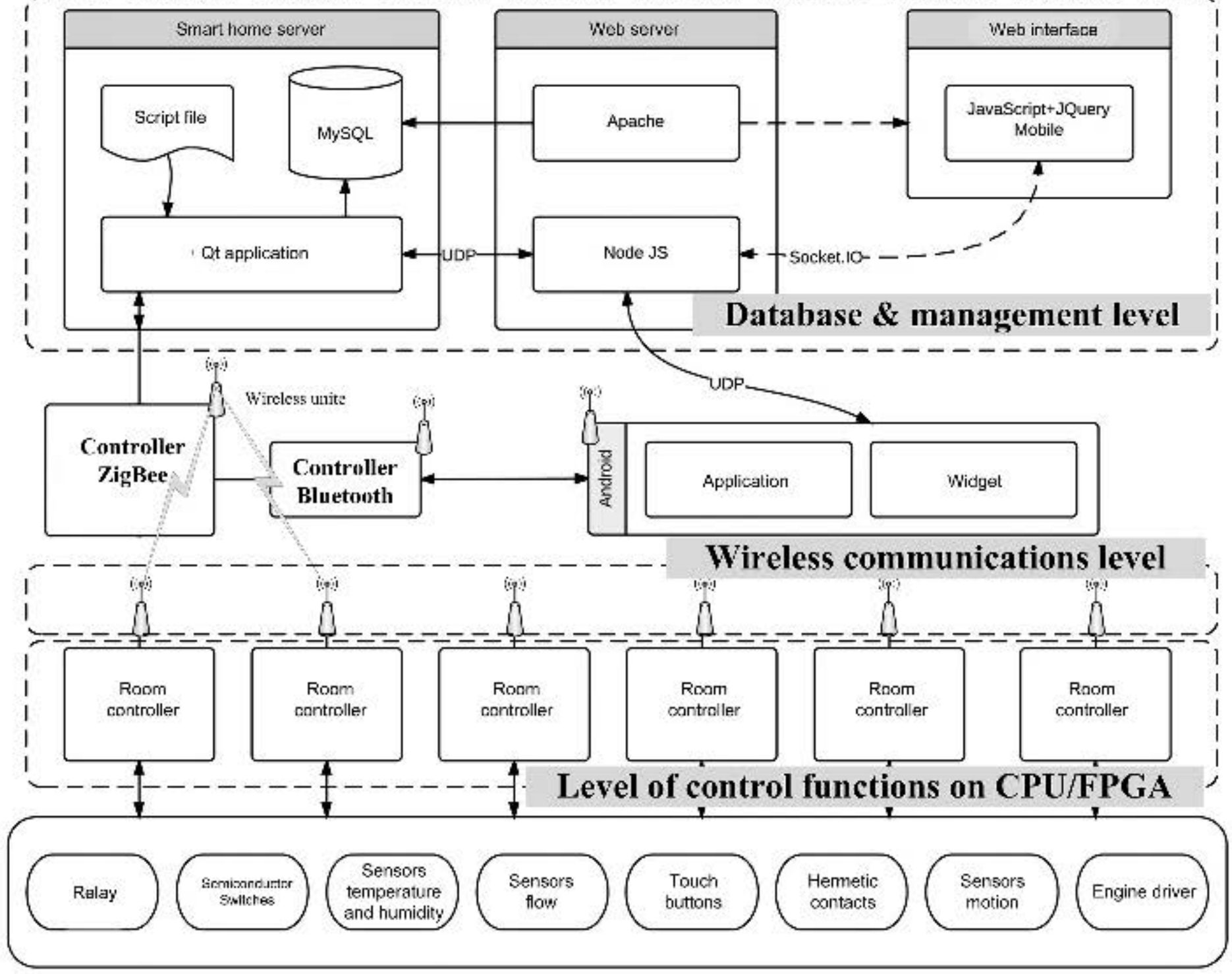

Fig. 1. Levels of architecture BAS [2].

Elimination of design defects and vulnerabilities leads to the changed parameters, in particular, the failure rates. The existing models of systems with variable parameters use full-scale experiment [5], Bayesian methods of investigation [6], Markov and semi-Markov processes [7]. The well-known Markov (semi-Markov) processes are based on the formation of a set of system states, transitions between them, and determination of the transition intensities. This set is more preferable in the case of evaluating the readiness of BAS with regard to various types of failures. In the case when the construction of the Markov model becomes more complicated with the increased number of states, the Monte Carlo method is used [8, 9]. The application of the Monte Carlo method is justified for complex systems with a large number of elements; in which random factors are interrelated in a certain way [10]. In addition, the simulation of random phenomena by the Monte Carlo method is carried out in order to verify the reliability of the results of the analytical Markov model.

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