PREFACE

The development trends of modern information technologies, steadily increasing demands for fast, accurate and just-in-time processing of big volumes of data, on the one hand lead to the constant growth of the complexity of Information Systems (ISs), and on the other call for their high performance. Numerous questions that need to be addressed when one designs or redesigns high performance ISs increase the associated implementation risks. One of the ways to control them is using suitable modelling and simulation methods as well as tools which facilitate better understanding of the system as a whole and help achieving its integrity properties.

A comprehensive analysis of so many existing mathematical and simulation methodologies of high performance ISs is a challenging task. In this special section we present seven papers reporting the most recent research, developments and solution techniques related to selected aspects of ISs such as input flow modelling, discrete/continuous stationary/transient analysis of systems' behaviour, load control mechanisms, scheduling and optimisation. In all papers related to scheduling and optimization problems, the authors propose new simulation-based methodologies, while in the remaining papers, the authors develop new analytical methods and implement them as new high performance algorithms.

In order to carry out adequate analysis of ISs, there is a need to capture a lot of traffic traces of flows traversing the system and then apply efficient analytic models capturing their nature. Mészáros *et al.* present their recent research results on the canonical representation of discrete phase type distributions and Markov arrival processes in highly distributed ISs. Motivated by practical applicability of results, they define the mathematical formulas and strict procedures for parameter matching and trace fitting. The authors demonstrate that fitting with canonical forms leads to substantially better performance of the IS than when using general Markovian forms, in the sense of the main performance measures, chiefly running time and fitting quality of traffic traces.

Another example of discrete time modelling application is an approximation of continuous-time models by time quantization, which is the topic of the paper by Atencia. The author presents a new model of intelligent computational nodes with various destabilization effects and flexible service. He uses Markov chain models for stationary analysis under general assumptions on processes governing systems' behaviour.

Kim *et al.* discuss the importance of possible dependencies and correlations in flows and processes in high performance ISs. They study a generic model of ISs, in which fast and QoS-aware processing (contact center, mobile network subsystems, etc.) operating in a random environment is required. Whenever the random environment alternates its states, the key parameters of systems' processes are changed correspondingly. Based on matrix-analytic results for Markov processes, they developed a new methodology for stability analysis of system performance, which is defined as an NP-hard global optimization problem. They demonstrate through the experiments the interrelation between systems' processes and the resulting characteristics.

An important extension of the ideas related to the dependence of systems' characteristics on the nature of internal processes and time period of their operation is presented by Zeifman *et al*. The authors developed a special truncation methodology, which can be easily utilized for complex analysis of the stability and homogeneity of ISs. That methodology allows for the characteristics of the system in terms of non-stationary (non-homogeneous in time) birth and death process as well as calculation of its termination probability characteristics with uniform (in time) error bounds of truncation.

Gaidamaka *et al.* discuss another crucial aspect of modern high performance ISs related to overload control and protection of essential components. They study the efficiency of two hysteretic control policies by applying a queueing-theoretic approach. They developed a new methodology for treating systems with hysteretic mechanisms (but operating already in stationary regimes), which leads to fast performance calculation algorithms.

Probably the topics most actively discussed nowadays in scientific periodicals are presented by Zhao *et al.* and Dębski. The first paper is devoted to the scheduling problem in big ISs equipped with several hundred thousand physical machines. It is of major interest to develop an efficient scheduling algorithm to host incoming requests (in the case considered, requests are virtual machines). The chosen criterion is minimal energy consumption. For global optimization problems arising in this context, the authors theoretically prove that their algorithm works correctly and converges fast. Experimental results also clearly illustrate the benefits of their approach. In the last paper, the author studies trajectory optimization problems and focuses on a black-box represented performance measure. New simulation-based trajectory optimization algorithms are developed. The key idea behind these algorithms is a grid-based discretization scheme used for the transformation of the continuous optimization problem into a search problem over a specially constructed finite graph. The dynamic programming method is used for the approximation of the global solution.

Most of the authors contributing to this special section participated in the 27th European Conference on *Modelling and Simulation*, which was held at Aalesund University College (Norway) in May 2013. We would like to take this oppor-

tunity to thank the authors for their effort and contribution. Significant attention was given to all parts of the contributions by reviewers, who helped us to ensure the quality of this special section and to whom we hereby express our gratitude.

We believe that this collection of papers will serve as a good review and provide up-to-date research agenda for current and future developments in the area of high performance ISs, and will appeal to a broad audience, from scientists engaged in theoretical and practical research areas to advanced students interested in this topic.

Pavel Abaev
Department of Applied Informatics and Probability Theory
Peoples' Friendship University of Russia, Russia

Rostislav Razumchik
Institute of Informatics Problems
Russian Academy of Sciences, Russia

Joanna Kołodziej
Department of Computer Science
Cracow University of Technology, Poland

September 2014

Pavel Abaev graduated in applied mathematics and informatics from the Peoples' Friendship University of Russia in Moscow in 2008, where he also received a Ph.D. in computer science in 2011. He works as an associate professor at the same university. He has served and is currently serving as the PC co-chair and an IPC member for several international workshops, including *ECMS 2013, 2014* as well as *ICUMT 2014*. His research is currently focused on software defined networking with OpenFlow and NFV solutions, QoS analysis of SIP, and mathematical modeling of communication networks.

Rostislav Razumchik graduated in applied mathematics and informatics from the Peoples' Friendship University of Russia in Moscow in 2008. In 2011 he obtained a Ph.D. in probability and statistics at the Moscow Institute of Electronics and Mathematics (Technical University). Since then he has worked as a senior researcher at the Institute of Informatics Problems of the Russian Academy of Sciences and holds the position of an assistant professor at the Peoples' Friendship University of Russia. He has served and is currently serving as an IPC member for several international conferences and workshops, including *ECMS 2013, 2014*, XXXI *ISSPSM*, and *ICUMT 2014*. Doctor Razumchik also serves as guest reviewer for several peer-reviewed international and Russian journals.

Joanna Kołodziej graduated in mathematics from Jagiellonian University in Cracow in 1992, where she also received a Ph.D. in computer science in 2004. She works as an assistant professor at the Cracow University of Technology. She has served and is currently serving as a PC co-chair, the general co-chair and and IPC member for several international conferences and workshops including *PPSN 2010, ECMS 2011, CISIS 2011, 3PGCIC 2011, CISSE 2006, CEC 2008, IACS 2008, 2009,* and *ICAART 2009,2010*. Doctor Kołodziej is an EB member and a guest editor of several peer-reviewed international journals, as well as an author and co-author of many publications in high quality peer reviewed international journals. For more information, please visit www.joannakolodziej.org.