CHARLES UNIVERSITY PRAGUE
faculty of mathematics and physics

The Board of Doctoral Studies
Faculty of Mathematics and Physics
Charles University Prague
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Prague, April 13th, 2016

Re: Michal Kit, Doctoral Thesis – Advisor's Reference

The submitted PhD thesis concentrates on modeling, realization and simulation of Smart Cyber-Physical Systems (SCPS for short), i.e., large-scale distributed systems, often closely bound to the real world, that provide dependability despite operating in dynamic, open-ended, and unpredictable environments. The characteristics of SCPS (distribution on a large scale and open-endedness in particular) and their environment (i.e., recurrent dynamism and unpredictability) make the development and deployment process a problematic task, when considering contemporary architecture models, abstractions and tools.

In this context, the thesis targets the following goals: (1) to propose architecture abstractions that are specifically tailored for building dynamic software architectures of SCPS, (2) to complement these architecture abstractions with a prototype framework supporting both development and deployment of SCPS, and (3) to simulate the system.

With respect to the above goals, the major scientific contributions of the thesis lie in:

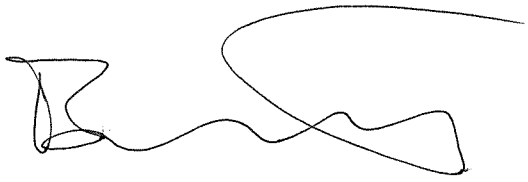
- The *DEECo component model* (Dependable Emergent Ensembles of Components), which brings novel architecture abstractions that are centered on the concept of component ensembles – dynamic, self-organizing groups of autonomous components. The architecture abstractions of DEECo are particularly tailored for building dynamic software architectures of RDS. The thesis also presents a rigorous computational model of DEECo.
- The *jDEECo execution environment prototype*, which maps the DEECo abstractions, their semantics, and the computational model to the Java programming language. This includes proof of concept for the DEECo-tailored communication model suitable for distributed deployment of SCPS.
- The *jDEECoSim simulation platform,* which allows prototyping and early testing of CPS using simulation-based techniques.

As to the contents, the thesis is structured as a commented collection of papers. The thesis starts with an overview with identification of goals and challenges (Chapter 1) and an extensive discussion of the state-of-the-art approaches in the areas of software architecture abstractions, communication paradigms for distributed systems, and co-simulation based methods for system verification (Chapter 2). Then, the above contributions are summarized and briefly described

(Chapter 3). Following, the contribution presented in terms of a commented collection of co-authored publications (Chapter 4), which includes 6 publications (all of them published in at top-notch peer reviewed conferences and a journal with IF) as well as one technical report consisting formal description of the DEECo model. The thesis is concluded with the author's vision of the promising research directions and open challenges stemming from the results of the thesis (Chapter 5).

The thesis thus maps the work of Michal Kit during his PhD. In total, he has co-authored 11 peer-reviewed papers published at international conferences and workshops, as well as in a journal with impact factor. These include the Microprocessors and Microsystem journal (IF: 0.512), CBSE 2015 and 2013 (core A, proceedings by ACM), SEAMS 2015 Workshop (proceedings by IEEE), ECSA 2014 (proceedings by Springer), EUROMICRO 2014 (core A, proceedings by IEEE) and WICSA 2012 (core A, proceedings by IEEE CS). The thesis is based on 6 of these papers. The intermediate results of the thesis were applied in a number of research projects, most importantly the EU FP7 project ASCENS and EU FP7 RELATE, several bilateral research projects of the department with Volkswagen AG, and the department research project DEECo.

In my view, Michal Kit has proved the ability to make substantial, high-quality research contributions in the field of software engineering, especially in the area of software engineering of cyber-physical systems. The research was done systematically and according to sound scientific principles with strong emphasis on evaluation based on prototypes and use-cases. Considering all these facts, I strongly recommend to accept the thesis for defense and to grant a PhD degree to Michal Kit.



Doc. RNDr. Tomáš Bureš, Ph.D.
Advisor