4th International Workshop on Requirements Engineering for Self-Adaptive, Collaborative, and Cyber Physical Systems (RESACS)

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I. Introduction

Over the last ten years, first research on self-adaptive systems (SAS), then research on cyber physical systems (CPS) and just in the last few years, research on collaborative systems has attracted the attention of the academic and industrial community. Self-adaptiveness, collaboration, and cyber physicality represent novel characteristics of software-intensive systems insofar that such systems possess significantly different properties than traditional information systems or embedded systems. For example, their highly connected and context-aware nature gives rise systems constantly changing their runtime behavior, stressing the need for runtime adaptation and reorganization, which must be considered during the requirements phase. This implies new and unforeseen challenges for requirements engineering to systematically engineer self-adaptiveness, collaboration, and cyber physicality into these systems.

Specifically, in order to develop adaptive, context-aware systems like SAS, CPS, or trustworthy social media systems, the requirements engineering process must adapt as well to allow for the development of systems that support self-adaptation to the individual end-user needs. For example, in the automotive domain, a self-adaptive vehicle needs to consider individual user preferences and support the driver in the best possible way.

In the past three editions of RESACS, submitted papers and workshop discussions have proven useful to presenting authors and attending audience alike, resulting in new impulses in shaping this still novel and wide-spread field. For the fourth edition of RESACS, the tradition of RESACS was continued. In a highly interactive workshop the arising challenges in the emergent field of self-adaptive, collaborative, and cyber physical systems were discussed, positioned, and addressed. Thought-provoking and highly constructive discussions among a broader audience and presenters jointly identified properties of these types of system, what their properties entail, which challenges emerge due to these properties, and how traditional, contemporary, and novel approaches might address these challenges for requirements engineering in particular, but also software engineering in general. We hope that the results of the RESACS workshop will spawn research ideas, and standardization of terminology in SAS and CPS research, validate existing research avenues, foster empirical studies, and facilitate collaboration between industry and academia for software engineering as a whole.

II. A Brief History of the RESACS Workshop Series

This is the fourth workshop on this specific set of topics. The previous editions took place 2015 and 2017 in Essen, Germany, and 2016 in Gothenburg, Sweden.

In its first edition in 2015, RESACS identified context-awareness and trustworthiness as central issues that pose new challenges for the requirements engineering of cyber-physical and self-adaptive systems. These and other properties cannot simply be added on to SAS nor CPS, but must be inherently built into them, from requirements to code. These topics continued to be a central concern in RESACS's second edition in 2016, where the topic of trustworthiness was extended to requirements for social media systems and context-awareness for the development process of self-adaptive and cyber-physical systems. In its third edition in 2017, emphasis in presentations and discussions was on the emerging topic of autonomous driving. In particular, a central point of discussion was the ability of developers to reduce uncertainty due to potentially infinite possible interaction scenarios of autonomous vehicles with the real world.

While RESACS started with a strong emphasis on requirements engineering for self-adaptive and cyber-physical systems, especially the latest installment showed a particularly strong interest of participants in the topic "autonomous driving." New impulses generated in 2017 show that self-adaptive,

collaborative, and cyber physical systems are a key solution driver for autonomous driving cars. Challenges for SAS and CPS such as uncertainty management, context modeling, planning for adaptation, coping with the complexity, and safety-criticality as well as trustworthiness of systems can be uniquely demonstrated in autonomous vehicles.

III. Summary of RESACS 2018

In this year's edition of RESACS, contributions pertained to the entire spectrum of the requirements engineering research. For example, in [1], *Daniel Aceituna, Kaushik Madala, and Hyunsook* present an approach to elicit safety requirements based on undesired combinations of component and context states. By making use of constrained natural language, where detrimental state combinations can be found and recovered from. While [1] focuses on safety requirements, the work by *Ahmed Saeed and Seok-Won Lee* [2] takes a broader scope and presents an approach that allows the requirements engineer to investigate trade-offs in the satisfaction of system qualities for SAS. Saeed and Lee argue that when the behavior of SAS changes, the system's performance may be impacted. Knowing in which way the system will behave at the earliest possible state during development is of course within the scope of requirements engineering. Similarly, *Kaushik Madala, Hyunsook Do, and Daniel Aceituna* present an approach in [3], which allows identifying and analyzing off-nominal behavior, e.g., behavior after adaptation of a self-adaptive and safety-critical system. Specifically, the approach in [3] allows analyzing behavior specified in natural-language requirements. In [4], *Natalia Mannov, Clara Marie Lüders, and Alexey Kaznin* present an approach that deals with NL-requirements as well. The contribution of their short paper is a mobile device application that improves note taking through self-adaptive text recognition. A tool-based approach is also taken by *Rüdiger Pryss, Johannes Schobel, and Manfred Reichert* in [5]. In their mobile application intended for symptom tracking of medical conditions, an adaptable API to dynamically change the questions asked to patients is used. Another tool is presented by *William Cook, Andrew Driscoll, and Bastian Tenbergen*: AirborneCPS is presented in [6], which is a simulator that aids identifying undesired functional interactions between CPS. Another approach intended for CPS development is presented by *Klaus Kammerer, Rüdiger Pryss, Kevin Sommer, and Manfred Reichert* [7]. In this contribution, the authors suggest using augmented reality to guide the maintenance process of industrial CPS.

This year RESACS had the extraordinary pleasure to also welcome a guest paper, brought to us by the First International Workshop on Requirements for Internet of Things (RIOT). Edited by *Sepideh Ghanavati* and *Aaron Massey*, the authors *A. Omar Portillo-Dominguez and Vanessa Ayala-Rivera* presents an requirements-based approach to systematically validate the adequacy of emulated IoT systems within a common environment. Moreover, in addition to the peer-reviewed papers, *Hausi Müller*, University of Victoria, gave an interesting and detailed talk, in which he makes the argument that the engineering of adaptive CPS requires a wholistic engineering approach with developers being familiar with a wide scope of application domains [9].

IV. Workshop Technicalities

Continuing its tradition from previous years, each paper was reviewed by at least three members of the program committee. The reviews focused on the soundness of the presented ideas, the technical quality of the manuscripts, and their suitability with regard to the scope of the workshop. We, the organizers, would like to place particular emphasis on the extraordinarily high quality of the reviews, which were critical, yet constructive, and lead to accepting a total of seven papers. We are indebted to the program committee members:

- Raian Ali – *Bournemouth Univ., UK*
- Ottmar Bender – *Airbus Defence and Space, Germany*
- Jennifer Brings – *Univ. of Duisburg-Essen, Germany*
- Fabiano Dalpiaz – *Utrecht Univ., The Netherlands*
- Maya Daneva – *Univ. of Twente, The Netherlands*
- Ilias Gerostathopoulos – *Technische Univ., München,Germany*
- Sarah Gregory – *Intel, USA*
- Frank Houdek – *Daimler AG, Germany*
- Zhi Jin – *Peking Univ., China*
- Kai Petersen – *Blekinge Univ., Sweden*
- Matt Primrose – *Intel, USA*
- Carme Quer – *Univ. Politècn. de Catalunya, Spain*
- Nauman Qureshi – *NUST, Pakistan*
- Rick Rabiser – *Johannes Keppler Univ., Austria*
- Vítor E. Silva Souza – *Fed. Univ. of Espírito Santo, Brazil*

References

[1] D. Aceituna, K. Madala, and H. Do, "Deriving Functional Safety Requirements using Undesired Combination State Templates," Full Paper.

[2] A. Saeed and S.-W. Lee, "Non-Functional Requirements Trade-Off in Self-Adaptive Systems," Full Paper.

[3] K. Madala, H. Do, and D. Aceituna, "A Knowledge Acquisition Approach for Off-Nominal Behaviors," Full Paper.

[4] N. Mannov, C. Lüders, and A. Kaznin, "Reqvision: Digitizing Your Analog Notes into Readable and Editable Data," Short Paper.

[5] R. Pryss, J. Schobel, and M. Reichert, "Requirements for a Flexible and Generic API Enabling Mobile Crowdsensing mHealth Applications," Full Paper.

[6] W. Cook; A. Driscoll, and B. Tenbergen, "AirborneCPS: A Simulator for Functional Dependencies in Cyber Physical Systems - A Traffic Collision Avoidance System Implementation," Short Paper.

[7] K. Kammerer, R. Pryss, K. Sommer, and M. Reichert, "Towards Context- Aware Process Guidance in Cyber Physical Systems with Augmented Reality," Short Paper.

[8] A. O. Portillo-Dominguez and V. Ayala-Rivera, "A Requirements-based Approach for the Evaluation of Emulated IoT Systems," Guest Paper from the 1st Intl. Workshop on Requirements for the Internet of Things, edited by A. Massey and S. Ghanavati.

[9] H. Müller, "Engineering Adaptive Cyber Physical Systems," Keynote Paper.