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Formal Aspects of Component Software

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Revised Selected Papers

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Preface

The component-based software development approach has emerged as a promising paradigm to cope with the complexity of present-day software systems by bringing sound engineering principles into software engineering. However, many challenging conceptual and technological issues still remain in this area, theoretically as well as practically. Moreover, the advent of cloud computing, cyber-physical systems, and of the Internet of Things has brought to the fore new dimensions, such as quality of service, reconfiguration, and robustness to withstand inevitable faults, which require established concepts to be revisited and new ones to be developed in order to meet the opportunities offered by those architectures.

That was emphasized by the program of FACS 2016. Several sessions and invited talks were devoted to formal analysis and model-based development, whereas a practical session focused on applications and experience. Security aspects were present, too, in particular at an invited talk. Finally, the last two sessions dealt with operations on components.

A total of 14 papers successfully passed the review process, showing that component-based development is still an active research field.

March 2017

Olga Kouchnarenko
Ramtin Khosravi

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Abstracts of Invited Papers

Formal Models and Analysis for Self-adaptive Cyber-Physical Systems

(Extended Abstract)

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In this extended abstract, we will analyze the current challenges for the envisioned Self-Adaptive Cyber-Physical Systems. In addition, we will outline our results to approach these challenges with SMARTSOS, a generic approach based on extensions of graph transformation systems employing open and adaptive collaborations and models at runtime for trustworthy self-adaptation, self-organization, and evolution of the individual systems and the system-of-systems level taking the independent development, operation, management, and evolution of these systems into account.

From Formal Methods to Software Components: Back to the Future?

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Abstract. Looking back at the past, I believe Formal Methods and Component-based Software Engineering have missed opportunities to synergise. Looking forward to the future, I believe even more strongly that this synergy will be crucial for developing Software Engineering techniques that tackle scale and complexity. In this position paper I outline the fundamentals of my belief, in terms of existing work and future challenges.

From Devices to Data: Testing the IoT

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Abstract. This paper provides an extended abstract of the FACS 2016 invited call on IoT testing.

Introduction

The internet of Things paradigm relies on innovative applications transversally deployed over vertical domains. However, the situation today is still fragmented with the need for an end user to handle different applications to access information from different providers, missing the expected value from transversal deployment. Answering that concern, many standards are developing around the world which now lead to a complex ecosystem in which interoperability of solutions must be ensured [1]. In addition, IoT is handling huge amount of data, threatening users privacy while control capacity of actuators raise the security level requirement. For these reasons, appropriate verification and testing of IoT solutions become a prerequisite to any field deployment. Formal methods such as Model Based Testing (MBT) approach provide an appropriate answer and experiences learnt from on-going European research and standardisation activities have been presented during an invited talk.

Compliance to Standards and Specifications

FIWARE [3] is an ecosystem providing APIs and open-source implementation for lightweight and simple means to gather, publish, query and subscribe context-based, real-time information. This independent community includes more than 60 cities in the OASC alliance who adopt FIWARE NGSI API.

oneM2M [2] was established to develop a single horizontal platform for the exchange and sharing of M2M/IoT data among all applications. oneM2M is creating a distributed software layer which provides a framework for interworking with different technologies.

Both platforms define RESTful interfaces and from their specifications, behavioural models have been made. Such models are typically built using UML modelling with constraints defined with OCL. A commercial tool [4] has been used to generate test suites from the model. Two execution environments were built 1. To demonstrate in the

case of FIWARE, the possible integration of the execution platform, as a webservice, within a Jenkins based continuous integration process and 2. in oneM2M using a normalised execution environment based on the TTCN-3 language [5], popular in the telecom word.

Use of MBT allows increasing both test coverage in comparison with manual approaches and traceability with implemented standards specifications. However, in both projects, the acceptance of functional testing is still to be accepted within the test communities as seen as complex.

Security Test

The ARMOUR project [6] co-funded by the European Commission under the Horizon 2020 program provides duly tested, benchmarked and certified Security and Trust solutions for evaluation of large-scale IoT deployments. It has defined 7 experiments each focused on a different part of an IoT tool chain going from device to data platform. In that project, a methodology based on formal methods has been proposed for security testing. A list of vulnerability patterns has been produced and allowed to derive corresponding test patterns. Here again, a model based testing approach has been chosen allowing testing of security functions by modelling of test purposes related to each experiment. A strong innovation brought by MBT is the integration of the individual models into a meta model allowing end to end security testing of the deployed solution. An offline model driven fuzzing approach is added at that stage to go beyond security functions testing and identify additional vulnerabilities which may arise from faulty implementations. Results from that project are already being contributed to the oneM2M standardisation alliance.

Conclusions and Future Outlook

In addition to compliance and security testing, new challenges are now raised by the need to test interoperability at the semantic layer level. Some initial developments have been made [7] but will require intensified efforts over the coming years. The presented projects take place in a stream of multi-year support from the European Commission toward Internet of Things. This support has been extended in the current H2020 workprogramme which now explicitly asks for verification and testing as part of its open call [8].

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