Software and System Engineering for Cyber-Physical Systems: technical challenges and collaboration opportunities

26 January 2016 – IRIT Toulouse
http://www.cpse-labs.eu/news_item6.php

Workshop goals

CPSE-Labs, SysML France **and the** GDR GPL **invite you to attend a free one-day workshop on software and system engineering for Cyber Physical Systems (CPS). This workshop gathers representatives of academia and industries interested in rigorous design of CPS. It aims to clarify the current technical challenges and solutions as well as promoting opportunities for the national and European collaboration offered by the co-organizing entities.**

CPSs are systems that link the physical world (e.g., through sensors or actuators) with the virtual world of information processing. They are composed from diverse constituent parts that collaborate together to create some global behaviour. These constituents will include software systems, communications technology, and sensors/actuators that interact with the real world, often including embedded technologies.

CPSs have been identified as the core enabling and disruptive technology for securing economic leadership in embedded systems/ICT, with enormous social and economic importance. CPSs can make decisive contributions to societal challenges such as coping with an ageing population, addressing climate change, improving issues of health and public safety, supporting the switch renewable energy, planning for megacities and tackling limited resources, sustainability, globalisation, and mobility.

In this context, this workshop will present:

- A forum for exchanging ideas on CPS engineering,
- Information on European funding opportunities managed by CPSE-Labs within the Smart Anything Everywhere initiative
- Presentations on current research and experiments in CPS engineering

The program is also designed to leave space for open discussions between participants.

This workshop is offered as a Satellite Event of the Embedded Real Time Software And Systems (ERTS) Congress 2016.

Organisation

Participation in the workshop is free of charge but registration is mandatory on http://www.cpse-labs.eu/news_item6.php. For more information, contact valerie.cassignol@onera.fr

Registration deadline is 20th January 2016

The workshop is located at:
Université Paul Sabatier, 118 Route de Narbonne, F-31062 Toulouse
Building IRIT- Auditorium Herbrand
Access information: http://www.irit.fr/documentation/plan_irit/planirit_en.html

Program

8.30 – 9.00 Registration

Introduction

9.00 – 9.10 Welcome by Jean-Michel Bruel (IRIT, SysML France), Romain Rouvoy (Université de Lille, GDR-GPL), Sébastien Mosser (I3S, GDR-GPL), Patrick Farail (IRT Saint Exupéry, GDR-GPL), Christel Seguin (ONERA, CPSE-Labs, GDR-GPL)
9.10 – 9.30 Holger Pfeifer (FORTISS) – The European Smart Anything Everywhere initiative and funding opportunities by CPSE-Labs experiments

Session: Models for CPS design (1)

9.30 – 9.50 Holger Pfeifer (FORTISS). CPSE-Labs experiments of Germany South centre: Model-based engineering of industrial automation systems
9.50 – 10.10 Martin Grimheden (KTH) – CPSE-Labs experiments of Sweden centre: Overcoming thresholds for data integration in CPS engineering environments
10.10 – 10.30 Patrick Leserf (ESTACA) - Trade-off analysis with SysML and Papyrus: a drone application

Break

Session: Models for CPS design (2)

11.00 – 11.20 Benoît Combemale (IRISA)- Using models for a broader engagement in smart systems.
11.20 - 11.40 Claire Ingram (Newcastle University) - CPSE-Labs experiments of UK centre: Pragmatic techniques for model-based Engineering of Cyber-Physical Systems
11.40 – 12.00 Michael Siegel OFFIS - CPSE-Labs experiments of Germany North centre: The Maritime Architecture Framework (MAF) and eMaritime Integrated Reference Platform (eMIR)
12.00 - 12.20 André Pierre Mattei (SCA-ITA) - SysML design of an observation satellite for agriculture surveillance in Brazil

Session: Managing data in large CPS

12.20 – 12.40 François Fouquet (SnT, Interdisciplinary Centre for Security, Reliability and Trust)- Models for managing IoT data

12.40 – 13.00 Juan Garbajosa (UPM) - CPSE-Labs experiments of Spain centre: Open CPS platform for building and deploying smart city services

Lunch

Session: Dependable CPS
14.00 – 14.30 Bran Selic (Simula) - Modeling uncertainty in cyber-physical systems
14.30 – 14.50 Fabien Peureux (Femto-st/EGM/Smartesting S&S) - Model-Based Testing for Internet of Things and Cyber-Physical Systems
14.50 – 15.10 Vincent Vidal (ONERA), Hélène Waeselync (LAAS) - CPSE-Labs experiments of France centre: engineering dependable autonomous vehicles

Break

15.40 – 17.00 Discussion of challenges & needs raised by CPSs from the industry view point – Panel moderated by Patrick Farail (IRT Saint Exupéry).

Abstract of presentations

Holger Pfeifer (FORTISS) *– The European Smart Anything Everywhere initiative and funding opportunities by CPSE-Labs experiments*
The European 'Smart Anything Everywhere' (SAE) initiative supports the innovation on smart digital systems thanks to networks of competence centres. The ecosystems built under these initiatives are based on collaboration between researchers, large industries and SMEs which will help to transfer knowledge and resources available to a much wider group of companies. SMEs and middle size companies can experiment with new technologies, try them out in their processes and work together with the suppliers of the technology to adapt it to their specific needs. CPSELabs is one SAE innovation action which provides an open forum for sharing platforms, architectures and SW tools for the engineering of dependable and trustworthy CPS. It provides funding for focussed experiments (3-6 partners) and fast-track (12-18 months) with innovation objective. Next call for experiment will be published in Spring 2016 http://www.cpse-labs.eu/calls.php

Holger Pfeifer (FORTISS) *- CPSE-Labs experiments of Germany South centre: Model-driven engineering for industrial automation systems*
The importance of software in industrial automation is continuously increasing. New approaches to the development and maintenance are needed to cope with the growing complexity of control software for future automation systems. 4DIAC - Framework for Distributed Industrial Automation & Control - is an open source solution for the programming of programmable logic controllers (PLCs) according to the standard IEC 61499. With this standard it provides higher level modelling means and better support for networked control devices. The main components of 4DIAC are the Eclipse-based integrated development environment 4DIAC-IDE and the real-time capable run-time environment FORTE.

Martin Grimheden (KTH) – *CPSE-Labs experiments of Sweden centre: Overcoming thresholds for data integration in CPS engineering environments*
The talk will describe the Kth model-based approach to data integration based on the OSLC interoperability standard.

Patrick Leserf (ESTACA) *- Trade-off analysis with SysML and Papyrus : a drone application*
Obtaining the set of trade-off architectures from a SysML model is an important objective for the system designer. To achieve this goal, we propose a methodology combining SysML with the variability concept and multi-objectives optimization techniques. An initial SysML model is completed with variability information to show up the different alternatives for component redundancy and selection from a library. The constraints and objective functions are also added to the initial SysML model, with an optimization context. Then a representation of a constraint satisfaction problem (CSP) is generated with an algorithm from the optimization context and solved with an existing solver. The presentation will illustrate our methodology by designing an Embedded Cognitive Safety System (ECSS). From a component repository and redundancy alternatives, the best design alternatives are generated in order to minimize the total cost and maximize the estimated system reliability.

Benoît Combemale (IRISA) *- Using models for a broader engagement in smart systems.*
Various disciplines use models for different purposes. While engineering models, including software engineering models, are often developed to guide the construction of a non-existent system, scientific models, in contrast, are created to better understand a natural phenomenon (i.e., an already existing system). An engineering model may incorporate scientific models to build a smart system. This talk proposes a vision promoting an approach that synergistically combines engineering and scientific models to enable broader engagement of end users in smart systems, informed decision-making based on more-accessible scientific models and data, and automated feedback to the engineering models to support dynamic adaptation of smart systems. To support this vision, we identify a number of challenges to be addressed with particular emphasis on the socio-technical benefits of modeling.

Claire Ingram (Newcastle University) *- CPSE-Labs experiments of UK centre: Pragmatic techniques for model-based Engineering of Cyber-Physical Systems*
Newcastle University's Cyber-Physical Systems Lab conducts research into pragmatic techniques for model-based engineering of Cyber-Physical Systems (CPSs). In this talk I will introduce some platforms supported by Newcastle's CPS Lab, including an approach for co-modelling which allows separate design teams working with discrete-event and continuous-time formalisms to develop CPS designs collaboratively. I will also introduce an experiment which has been funded previously under the CPSE Labs initiative.

Michael Siegel (OFFIS) *- CPSE-Labs experiments of Germany North centre: The Maritime Architecture Framework (MAF) and eMaritime Integrated Reference Platform (eMIR)*

The Maritime Architecture Framework (MAF) is a stakeholder-oriented CPS architecture framework for existing and future maritime CPS and services. MAF provides the conceptual basis, methods, tools and technologies to define, document, and align existing or future CPS architectures and architectural reference models for e-navigation and e-maritime applications. The MAF is a key enabler in the maritime domain for system harmonization, interoperability and standardization. The MAF is also a reference for the definition and design of testbeds for e-navigation and e-maritime systems and services. It helps to define the context, to check completeness and provides a semantic basis to discuss the outcome and results. Additionally it offers a semantic basis for integration of testbeds e.g. for larger demonstrators. To support the development of maritime CPS – i.e. the integration of heterogeneous systems of the maritime transportation space - , the Design Centre North provides the eMaritime Integrated Reference Platform (eMIR) for rapid prototyping in simulation environments and testing in real world environments.

This talk gives an overview about the background, context and concepts of the MAF and why testbed environments (e.g. eMIR) for the development, integration testing and demonstration for CPS must take into account and support the design aspects of such an architecture framework.

Andre Pierre Mattei (SCA-ITA) *- SysML Design of an observation satellite for agriculture surveillance in Brazil*

François Fouquet (SnT, Interdisciplinary Centre for Security, Reliability and Trust)*- Models for managing IoT data*

Internet of Things applications analyze our past habits through sensor measurements to anticipate future trends. To yield accurate predictions, intelligent systems not only rely on single numerical values, but also on structured models aggregated from different sensors.

Computation theory, based on the discretization of observable data into timed events, can easily lead to millions of values. Time series and similar database structures can efficiently index the mere data, but quickly reach computation and storage limits when it comes to structuring and processing IoT data.

During this talk, I will present various results presented at Models'15 and SmartGridCom'15 that tackles this complexity by exploiting IoT data characteristics. Notably, I will present a concept of continuous models that can handle high-volatile IoT data by defining a meta type for continuous attributes. In addition to traditional discrete object-oriented modeling APIs, we enable models to represent very large sequences of sensor values by inferring mathematical models that can efficiently replace raw values. We show on various IoT datasets that sequences of polynomials can significantly improve storage and reasoning efficiency.

I will present an application of this IoT model extension for suspicious value detection in the SmartGrid domain. We proposed a method to learn and store a profile of "typical" values and their probability in IoT context models. We show that using such profiles together with a contextual checker we can improve suspicious value detection, both in terms of efficiency and effectiveness.

Juan Garbajosa (UPM) *- Experiments of Spain centre: Open CPS platform for building and deploying smart city services*

Bran Selic (Simula) *- Modeling uncertainty in cyber-physical systems*

For the past year, we have been working on a core model of Uncertainty and its application to requirements specification and system testing in the context of the European Commission's H2020 UTEST project. (More information on this project, which involves a number of industrial and research partners from Europe, can be found at: http://certus-sfi.no/u-test-a-horizon-2020-funding-recipient/).

Fabien Peureux Fabien Peureux (Femto-st/EGM/Smartesting S&S) *- Model-Based Testing for Internet of Things and Cyber-Physical Systems*

Testing Cyber-Physical Systems (CPS) is challenging due to the various uncertainties in their behaviour. The purpose of this talk is to present our ongoing work on a model-based testing framework for automatic generation of executable test cases for CPS in the presence of various uncertainties.

Basically, uncertainties can be described as a lack of certainty about the current state or about the future outcome of the system. Within CPS, it can be due to the stimulus and data sent from the user environment to the physical units (application level), to the interactions between the physical units and the network services (infrastructure level), or a com- bination of the both (integration level). To test such issues, the proposed model-based testing approach is implemented on the EMF framework, and based on the test generation tool Smartesting CertifyIt1. It relies on a UML behavioral model of the system under test, from which abstract test cases are automatically generated by applying dedicated coverage strategies focusing on uncertainty testing. Afterwards, the generated ab- stract test cases are concretized to be executed on the targeted CPS. At this stage, the testing framework gives back testing results by means of behavioural, uncertainty and requirement coverage.

Within this context, the intended specific features and benefits of this model-based testing framework focus on: cost-effectiveness (optimized test generation algorithms minimize the number of generated test cases while enabling high fault-detection), extensible and configurable approach (easily add and adapt testing strategies

regarding the targeted type of uncertainties and requirements), and scalability to support testing of real- life CPS with varied complexity.
This work is mainly supported by the H2020 European project U-Test (http://www.u-test.eu/).

Vincent Vidal (ONERA), Hélène Waeselync (LAAS) - *CPSE-Labs experiments of France centre: engineering dependable autonomous vehicles*
The French design centre of CPSE Labs addresses the dependability of autonomous vehicles, like ground mobile robots, cars with advanced driver systems or unmanned aerial vehicles. The talk will provide an overview of the methods, tools and technologies provided by the design center. They span issues ranging from risk analysis to rigorous development and V&V. The talk will also present two on-going experiments carried out with third-party partners. The first one integrates a robotics development framework (GenoM) and a formal verification framework (BIP). The second one assesses the applicability of the centre's technologies to an industrial system, consisting of mobile maintenance robots deployed on airport runways. A call for additional experiments will soon be issued. Like previously, it will be in direction to both technology suppliers and technology users in the field of autonomous vehicles.