

### INTO-CPS PROJECT FACTS



**Title:**

Integrated Tool Chain for Model-based Design of Cyber-Physical Systems

**Project Partners:**

Aarhus University, Denmark  
 Newcastle University, UK  
 University of York, UK  
 Linköping University, Sweden  
 Verified Systems International, Germany  
 Controllab Products, Netherlands  
 Clersy, France  
 TWT GmbH - Science & Innovation, Germany  
 Agro Intelligence, Denmark  
 United Technologies, UK  
 Softteam, France

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**Project Website:** [www.into-cps.au.dk](http://www.into-cps.au.dk)

**Duration:** 36 months (2015-2017)

### What is INTO-CPS

Systems composed of closely coupled computing and physical elements are increasingly important in the modern world. Such Cyber-Physical Systems (CPSs) are characterized by a complex architecture and a design process involving different science and engineering disciplines. At this interface between disciplines, different formalisms and technical cultures meet, and the traditional approaches for designing systems vary significantly among the relevant fields. The developer of a CPS faces a large design space that is hard to

cover with hardware prototypes due to the high cost of their implementation. A common workflow for the model-based design of CPS – and the necessary tools – is currently missing.

To address these challenges, INTO-CPS seeks to create an integrated “tool chain” for comprehensive model-based design of CPSs. The tool chain will support multidisciplinary, collaborative modelling of CPSs from requirements, through simulation of multiple heterogeneous models that represent the physical elements as well as the computational parts of the system, down to realisation in hardware and software, enabling traceability at all stages of the development.

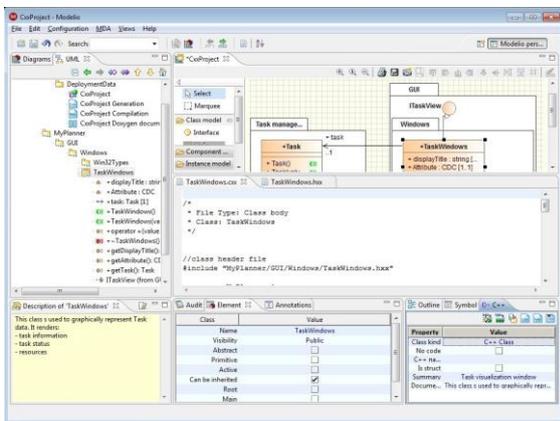
### Changes in the project consortium: Agro Intelligence ApS spun off Kongskilde Industries.

Following a restructuring of Kongskilde, a new spin-off company called Agro Intelligence ApS was created at the end of July 2015. The new company is located in Aarhus, Denmark, and will be responsible for research projects that have been conducted by Kongskilde until the restructuring. As a consequence, Agro Intelligence will replace Kongskilde in the INTO-CPS consortium. For INTO-CPS nothing will change as all the involved employees from Kongskilde have transferred to Agro Intelligence. For any questions, feel free to contact the CEO of Agro Intelligence, Ole Green ([olg@agrointelli.com](mailto:olg@agrointelli.com))



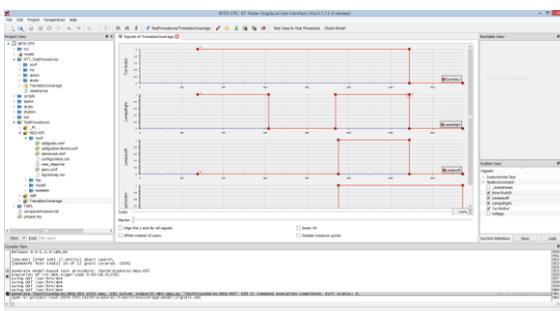
### Project progress: Integration of Modelio and RT Tester completed

At the first stage of the INTO-CPS project, the teams from SOFTEAM and Verified Systems integrated their tools with the goal of providing a single co-modelling and co-simulation environment for end-users. Modelio is a UML and SysML workbench for system architects and developers of CPS provided in open source.



**Figure 1: The Modelio tool**

The RT-Tester Model-Based Test Case Generator (RTT-MBT) is a tool suite which supports the generation of test cases directly from UML and SysML models.



**Figure 2: The RT-Tester Model-Based Test Case Generator tool**

RTT-MBT will benefit from the Modelio functionalities in addressing users' needs in system modelling, requirements

management, documentation generation and code synthesis. In return, RTT-MBT opens up new features in test case generation and smart testing to Modelio. Both tools are used in conjunction in the INTO-CPS project and thus the INTO-CPS project has reached the first important milestone.

In the next newsletter, other milestones that have been reached will be presented.

### Spotlight on a Case study: Agriculture

The agricultural case study is provided by the Danish company Agro Intelligence and it is focused on the modelling, design and analysis of an autonomous robot: the Robotti platform. The robot can be seen in Figure 3. Robotti is differentially driven by tracks or wheel modules mounted on both sides. The navigation is controlled by GPS and Kinematic models. The platform can navigate pre-loaded routes and apply different kinds of treatment to the soil through the implements mounted in the central frame. In the Robotti configuration that can be seen in Figure 3, the platform features two implements. Depending on how and when the soil has to be treated, these can be lifted or lowered.



**Figure 3: The Robotti agricultural platform.**

The system presents many technical challenges both from the methodological and the technical point of view. The application of the INTO-CPS tool chain will help address:

- The systems engineering challenge present during the engineering lifecycle of such a Cyber-Physical System.
- The safety requirements behind the agricultural robot. Safety during operation must be ensured, making safety sub-systems a key aspect to take into consideration from the beginning of the design process.
- The need for lower prototyping costs. Modelling and simulation will help at exploring the design space in a cost effective manner and reduce the number of prototypes that have to be built.

In the coming newsletters, we will present the other case studies in the railways, building automation and automotive domains.

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### Survey results

In the summer 2015, a first online survey among the IFG members was conducted. The main results are presented here.

It became clear that the level of experience with CPS design among the IFG members varies from those with little or no experience to those who are experts. The application areas are also very diverse including automotive, aerospace, medical technology and energy technology. This reflects the heterogeneity of the IFG, meaning that the IFG addresses a broad audience.

Regarding the expected benefits of model-based CPS design, all respondents expect to have increased trust in the design, and many respondents see gains in productivity (reduced development time and costs). On the other hand, most respondents see the lack of know-how and the high complexity of CPS as potential obstacles in the development of CPS. Focusing on INTO-CPS, all respondents expect guidelines for CPS design as a key result of the INTO-CPS project together with standards and theoretical foundations.

With respect to the INTO-CPS tools, exchangeability of components and use of standards, in other words interoperability, are seen as key properties together with formal validity of the simulation results. The feature of the INTO-CPS tools that was seen as most important is system modelling while other features such as design space exploration or test automation were also seen as relevant.

INTO-CPS aims at addressing these concerns and expectations by delivering comprehensive guidelines for CPS design and an interoperable toolchain that is based on standards (e.g. the Functional Mock-up Interface, FMI) and a solid formal foundation. System modelling will be based on SysML, and test automation will be connected to the requirements in Modelio as described above.

For these reasons, we believe that INTO-CPS is well-aligned with the users' expectations and ideas, and we invite you to learn more about INTO-CPS on one of the events where we will present the current status of the project.

### Upcoming events

**Artemis Technology Conference**, Turin (Italy), October 6 – 7 2015: INTO-CPS will be presented at the Artemis Technology Conference along with other major European ICT research projects. For more details, see <https://artemis-ia.eu/technologyconference2015/index.html>

**ICT 2015**, Lisbon (Portugal), October 20 – 22 2015: INTO-CPS will host a stand at this major ICT event. Along with the previous projects, Destecs and Compass, INTO-CPS will be presented in the “Transform Area”. For more information, see <https://ec.europa.eu/digital-agenda/events/cf/ict2015/item-display.cfm?id=15106>

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### Recent Publications

J. Fitzgerald, C. Gamble, P. G. Larsen, K. Pierce, J. Woodcock. *Cyber-Physical Systems Design: Formal Foundations, Methods and Integrated Tool Chains*. In Proc. 2015 IEEE/ACM 3rd FME Workshop on Formal Methods in Software Engineering at ICSE 2015. DOI 10.1109/FormaliSE.2015.14

INTO-CPS Poster at HiPEAC 2015 European Projects Poster Session (Softeam). 19th - 23rd January 2015

A.Bagnato (Softeam) *The INTO-CPS Project in the Spotlight*. HiPEAC Newsletter #42, May 2015,

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For more updates, visit our website:

<http://into-cps.au.dk/>