INTO-CPS: An integrated “tool chain” for comprehensive Model-Based Design of Cyber-Physical Systems

Alessandra Bagnato
SOFTEAM

www.into-cps.au.dk
SOFTEAM

- SOFTEAM (ST), a growing company
  - 25+ Years experience
  - 840 experts
  - Regular growth

- Specialist in OO technologies, new architectures, methodologies

![Graph showing growth from 2005 to 2015](image)

![Map showing locations in France](image)
Modelio for System Engineering

- UML editor with 20 years’ history
  - SysML, MARTE, BPMN
  - Code generation
  - Documentation
  - Available under open source at Modelio.org

Modelio 3
Modelio System Architect Solution

Dedicated to System architects modelling with SysML, UML or BPMN and carrying out Requirements based analysis

- Modelling with UML, SysML and BPMN
- Requirements Modeling
- Tabular editors
- Import/export MS Excel & Word
- Embedded Systems modelling via MARTE
- Traceability Editor
- Impact Analysis
- Document Generation
- Support for Collaborative activities (Constellation, SVN)
- Automatic diagrams creation
- Customisable, interfaces to external tools
Cyber-Physical Challenges

Agricultural Logistics
- Need to model control and planning/re-planning
- Models of locality and mobility
- Real-time behaviour modelling
- Domain-specific reference models

Smarter Building Design
- Models of large-scale, open, diverse data integration
- ... coupled with models of physics
- Need to model learning behaviour
- Possible integration of models of human behaviour
INTO-CPS: A new 8 M€ H2020 Project
INTO CPS Objectives

1. Build an open, well-founded tool chain for multidisciplinary model-based design of CPS that covers the full development life cycle of CPS

2. Provide a sound semantic basis for the tool chain

3. Provide practical methods in the form of guidelines and patterns that support the tool chain

4. Demonstrate in an industrial setting the effectiveness of the methods and tools in a variety of application domains.

5. Form an INTO-CPS Association to ensure that project results extend beyond the life of the project
INTO-CPS

Design Space Exploration
Test Automation

Requirements

Feedback

MiL Co-Simulation

Testing

Heterogeneous Systems Models

SysML - FMI Model Generation

HiL / SiL Simulation

Code / Hardware

Strong Traceability
Configuration Management
CPS co-modelling

requirements

architecture models

automated co-model analysis
design space exploration

models of cyber elements

stub model generation

co-simulation (MiL)

models of physical elements

environment model

co-model

models of elements

code generation

real code

realisation

real plant

lab testing

analysis plug-ins

test automation
model checking

models of physical elements

environment model

realisation

real plant

lab testing

analysis plug-ins

test automation
model checking

models of elements

code generation

real code

lab testing
Tools

Modelio | Overture | 20-sim | OpenModelica | Crescendo | TWT Engine | RT-Tester
SysML modelling | Discrete-event modelling | Continuous-time and physical-systems modelling | Co-simulation solutions | Test automation / model checking
Railways

Agriculture

Building Automation

Automotive

Conventional Inter-crop

crop cleaned soil
Model-driven Design

• Modern systems are complex
• To cope with this, we can build models beforehand
  – To perform analysis (e.g. static analysis, proof, model checking, simulation)
  – Clarify our assumptions
  – Evaluate potential designs
  – Avoid expensive prototypes
• Different modelling paradigms for different aspects
The Initial INTO-CPS Vision

Design Space Exploration
Test Automation

Requirements

Feedback

MiL Co-Simulation

Testing

Heterogeneous Systems Models

SysML - FMI Model Generation

HiL / SiL Simulation

Code / Hardware

Strong Traceability Configuration Management
Requirements Modelling

- **SysML**
  - Use Case diagrams
  - Requirements diagrams
    - Informal (link and traceable)
    - Formal (LTL, Test automation)
The Initial INTO-CPS Vision

Design Space Exploration
Test Automation

Requirements

Feedback

MiL Co-Simulation

Testing

Heterogeneous Systems Models

HiL / SiL Simulation

Code / Hardware

SysML - FMI Model Generation

Strong Traceability
Configuration Management
System Decomposition

• Block Definition Diagram (top level)
System Interface Modelling

• Internal Block Diagram
  – Divide into CT/DE constituent models/systems/components
  – Define interfaces between different components
System Behaviour

- **Parametric Diagram**
  - Define continuous behaviour of CT components
- **State Machines** (DE models generated for tests)
  - Define discrete behaviour of DE components

Diagram of DE components

*alessandra.bagnato@softeam.fr*
INTO-CPS Diagrams and INTO-CPS Blocks
Modelio for INTO-CPS (1/3)
Modelio for INTO-CPS (2/3)
Modelio for INTO-CPS (3/3)
Initial Industrial Follower Group

- AGCO, Denmark
- Alcatel-Lucent, Ireland
- Almende, Netherlands
- Altran, UK
- Bachmann electronic, Netherlands
- Bakker Sliedrecht Electro Industrie, Netherlands
- Carrier, France
- CeTIM, Netherlands
- Chemring TS, UK
- Conpleks Innovation, Denmark
- Dredging International, Belgium
- DSTL, UK
- Goodrich, UK
- Grundfos, Denmark

- GN Resound, Denmark
- HMF, Denmark
- Huisman Equipment, Netherlands
- Irmato Industrial Solutions, Netherlands
- Jaguar Land Rover, UK
- National Institute of Informatics, Japan
- ONERA, France
- Rockwell-Collins, France
- Rolls-Royce, UK
- Seluxit, Denmark
- Siemens, Sweden
- Terma, Denmark
- Thales, France
- UTC Aerospace Systems, UK
- West Consulting, Netherlands
Contacts

Alessandra Bagnato, SOFTEAM
Alessandra.bagnato@softeam.fr

Modelio Web Site:
http://www.modelio.org
http://forge.modelio.org/projects/intocps

INTO-CPS Web Site http://into-cps.au.dk/
@https://twitter.com/IntoCps
https://github.com/into-cps
Thanks!

INTO-CPS

www.into-cps.au.dk