Enabling Business Analysts to implement CPS solutions using a Model-Based approach

A PhD research activity project developed with AISE contributions

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- Dr. G. Telleschi, Chief Systems Engineer, MBDA;
- Prof. Andrea D’Ambrogio, Tor Vergata University.
Mission
The AISE-INCOSE MBSE Working Group would like to become, in the next 6 years, the primary reference for the Italian SE that would like to adopt the MBSE approach.

Main Topic
The WG MBSE will deal with:
• MBSE approach adoption,
• Metamodeling for a specific context (e.g. sector, project phases, etc.),
• Effective usage of the modelling language,
• Benchmarking of MBSE Tools,
• Digital continuity
AISE-INCOSE MBSE WG

Numbers

- Officially started end of 2020
- 11 Active Members belonging to 6 different Companies spread over 5 Sectors
- 3 meetings organized in the 2021
- 8 activities currently ongoing
- 12 different type of deliverable
AISE and Tor Vergata cooperation in the PhD research project

The project is framed as part of a PhD research activity carried out at the Tor Vergata University, Department of Enterprise Engineering (PhD candidate T. Panetti, Tutor Prof. A. D'Ambrogio) and takes advantage of AISE activities.

In particular, AISE enables the PhD research activity to validate the resulting model and to contribute to the results dissemination.
The reference context analysis

The industry 4.0 plan defined by the MISE in the 2018 aimed at getting the following benefits from the adoption of enabling IoT technologies by the industry:

- Greater flexibility
- Greater speed
- Greater productivity
- Better quality
- Greater competitiveness
The reference context analysis

From personal experience as Innovation Manager and by reviewing related works in literature, it is perceived that Cyber-Physical Systems (CPS) solutions still have to provide their peak in terms of social and market benefits.

In addition, market available solutions do not allow business analysts evaluate easy-to-understand process descriptions at design time, before committing the resources for process implementation.

In this context our vision consists in enabling Business Analysts to implement CPS solutions using a Model-Based approach and increase the level of automation through model transformations.
Background

In **CPS** the computer system continuously interacts with the reference physical system.

The project research generates a new paradigm where **processes**, containing both cyber actors and humans, are integrated and **collaborative**. In this new paradigm, the **business process models** can be directly mapped to the corresponding CPS implementation using transformation rules.

**Business process modeling** is an activity devoted to make process description easy-to-understand to both Business Analysts, from a process-centric viewpoint, and IT developers, from a technology-based viewpoint.
Main research guidelines

- To place the logic of execution of CPS solutions at process layer, in a process-centric organization;
- To use an ontology for abstracting the process layer from the physical layer;
- To introduce Digital Twin (DT) technology, in order to get a quick set-up of the solution before physical implementation;
- To enable a new low-code approach, based on model transformations, where the solutions can be easily implemented starting from the design level.
Research question areas

We focused our effort on the following main research objectives:

1. To define an innovative methodology for enabling new solutions implementation in the CPS field

2. To define a formal language complete with transformation rules for the automated mapping of Business Processes models to IoT-solutions

3. To define a reference architecture for solutions in the CPS domain devoted to ensuring a new life cycle of process-driven CPS solutions
// Receive input from requestor.

portType="client:BPELProcess" operation="initiate"
variable="inputVariable" creaseline="yes"/>

query="/client:BPELProcessProcessRequest/client:input"/>

query="/client:BPELProcessProcessResponse/client:result"/>
Research project highlights

The research project contains the following pillars:

• A non-technology expert must be able to design the CPS solution on a diagrammatic form (modeling);
• The CPS solution is expressed by the analyst at Business Process Management (BPM) layer, thus obtaining process-centric solution;
• During the modeling phase, it is not required to know the technical aspects of the physical layer;
• A set of automated model transformation rules generate the implementation level;
• A CPS ontology is used for decoupling the conceptual level and the physical level, and to gain compatibility with a wide variety of sensors and actuators.

The research project is still in progress. Results will be published in the short-term.
Expected benefits

• The possibility to easily **share the advantages of the designed CPS solutions**, using Business Process modeling
• The possibility to **reuse** CPS solutions using solution patterns available as libraries of Business Process models
• The **low-code approach** and the run-time auto-generation of syntactic and semantic links between the business process and IoT components
• The Digital Twin introduction in emulation mode, so to enable system integrators to **simulate** the process before building the physical layer
• The system integrator **focused on the business solution** rather than on technical aspects
• The Business Process execution engine continuously **monitoring and optimizing** the developed IoT solution
• The Business Process centric view used to **address disruptive technologies** such as IoT, M2M and AI.
An example application
An example application

Predictive Maintenance scenario

The business analyst builds a Business Process maintenance model containing IoT components, onboard sensors, and human operators, the "Maintenance team". The maintenance model is then used in a predictive way, in order to avoid uncontrolled machine downs and start maintenance activities before failures occurrence. The model is finally used, along with a set of transformation rules, to automate the generation of the corresponding implementation. The transformation rules are executed on a technology enabler layer that is developed as part of the research project.
Thanks for the attention!

MBSE Linkedin Group

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