Multi-Paradigm Modelling of Cyber-Physical Systems CTiCPS 2020 MPM4CPS Keynote

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Abstract

The networking of multi-physics (mechanical, electrical, hydraulic, biochemical, ...) with computational systems (control systems, signal processing, logical inferencing, planning, ...) processes, interacting with often uncertain environments, with human actors, in a socio-economic context, leads to so-called Cyber-Physical Systems (CPS). The CPS that are engineered today are reaching a hitherto unseen level of complexity.

To date, no unifying theory nor systematic design methods, techniques and tools exist for such systems. Individual (mechanical, electrical, network or software) engineering disciplines only offer partial solutions.

Multi-paradigm Modelling (MPM) proposes to model every part and aspect of such complex systems explicitly, at the most appropriate level(s) of abstraction, using the most appropriate modelling formalism(s). This includes the explicit modelling of the often complex engineering workflows.

Modular modelling language engineering, including model transformation, and the study of modelling language semantics, are used to realize MPM. MPM is seen as an effective answer to the challenges of designing CPS.

This presentation introduces a vision of complex CPS, in particular in the context of Industry 4.0. The causes of complexity of such systems and some of the challenges of their collaborative development are introduced, as well as possible multi-paradigm modelling solutions such as (in-)consistency management and co-simulation.

Keywords: multi-paradigm modelling, co-simulation, cyber-physical systems (CPS)