The Business Informatics Group together with the Faculty of Informatics at TU Wien invites to the talk

**Model-Driven Architecture and Behavior of Cyber-Physical Systems**

**Dr. Andreas Wortmann**  
Tenured research associate at the Chair for Software Engineering at RWTH Aachen University

**When?**  
November 12th, 2020  
10 a.m.

*via* GoToMeeting  
https://global.gotomeeting.com/join/165860453  
code for entry: 165-860-453

**Abstract**

Systems engineering has produced striking results in many domains. Researchers and practitioners have devised concepts, methods, tools that autonomously move vehicles, enable doctors to conduct remote surgeries across continents, and sent astronauts into space. All of these cyber-physical systems are driven by software whose complexity increases tremendously. Overcompensating this growth in software and systems complexity demands novel methods that increase the abstraction in systems engineering, advance automation, and facilitate the integration of domain expert solutions. Model-based systems engineering aims to address this complexity by advancing systems engineering from its contemporary document-based processes to sophisticated model-based processes. In the latter, abstract models serve as means for systems design, communication, documentation, and basis for implementation. But to overcompensate the growth in complexity, using models as secondary artifacts is insufficient.

Comprehensive research in software engineering has led to recognizing that model-driven processes, in which models are the primary engineering artifacts, can significantly improve abstraction, automation, and domain-specific modeling to address the increasing complexity in systems engineering. Yet, model-based systems engineering focuses on informal models that are hardly accessible to meaningful automation and overly generic.

This thesis summarizes 14 selected publications of a research program towards a model-driven systems engineering that operates on domain-specific modeling languages, supports sophisticated modeling methods, and enables the systematic operation of cyber-physical systems. The results of this research program cover four substantial challenges towards the model-driven engineering of cyber-physical systems: First, it contributes to understanding the use of models and modeling languages for cyber-physical systems through two comprehensive literature studies on modeling for cyber-physical systems in Industry 4.0 and mobile robotics. The studies surveyed over 3,000 publications each and produced insights into requirements for the efficient model-driven engineering and operations of cyber-physical systems in both
domains. Second, it conduces novel foundations for the efficient engineering of domain-specific modeling languages based on the requirements identified in both studies. These foundations introduce innovative notions of language components and their composition upon which families of domain-specific modeling languages can be created systematically efficiently. Third, it leverages these foundations to produce modeling languages to describe functional architectures and geometric-physical architectures of cyber-physical systems that support unprecedented automated modeling methods, including tracing, decomposition, and semantic differencing, to facilitate modeling, maintaining, and evolving these architectures. Fourth, it exploits the novel language engineering foundations and the unprecedented automated modeling methods to alleviate the systematic operation of cyber-physical systems with digital twins that represent and optimize the observed systems. Hence, this research program forges a bridge from observations on modeling cyber-physical systems, over software language engineering and modeling methods, to their operation that supports researchers and practitioners to advance from the contemporary document-based engineering of cyber-physical systems to their systematic model-driven engineering.

Bio
Andreas Wortmann is a tenured research associate at the Chair for Software Engineering at RWTH Aachen University. There, he leads a team on model-driven systems engineering, coordinates a workstream of the Internet of Production excellence cluster, and advises the Center for Systems Engineering. He conducts research in model-driven software and systems engineering, formal methods in software engineering, and software language engineering, which is documented in over 70 publications. Moreover, he has chaired and organized various international conferences and workshops, serves on the board of the European Association for Programming Languages and Systems (EAPLS), and co-chairs the working group on model-based systems engineering of the German INCOSE chapter GfSE. For more information, please visit www.wortmann.ac.

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