Systemanalyse und Modellierung
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An Extension of the Eclipse Modeling Framework for Global Model Management

Background and Motivation

Developing complex systems such as nowadays aircrafts involve the collaboration of engineers from a multitude of domains (e.g., system engineering, control engineering, mechanical engineering, electrical engineering, software engineering). It has been shown that errors during the system design are often due to inconsistencies between the models developed for the various domains. Model-Based Engineering (MBE) promotes the use of Domain-Specific Modeling Languages (DSML) to represent the design aspects of each domain with dedicated model so that it can be processed by computer tools for automated consistency checks and quality assurance. Therefore, many models of various DSMLs (physical structure, software and hardware architectures, behavior, etc.) are employed and combined to specify a system completely and adequately as illustrated in the figure below.[1]

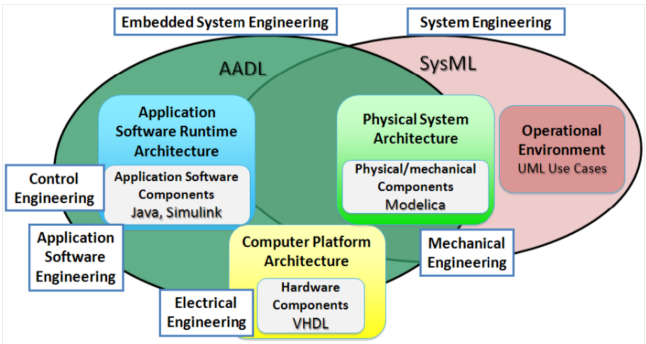

Figure 1: The numerous domains involved in developing complex systems covered by a set of DSMLs

The purpose of *Global Model Management* (GMM) is to ensure that the interplay between the combined models is managed properly in addition to the activities on each model in separation. Such management has to cover the integration of modeling languages, the coordination of all activities on these models, as well as governing all the models and related activities accordingly. In order to scale for large models, this must be achieved with sufficient modularity and incrementality, so that only the impacted model elements are re-computed when models are changed to avoid the cost of re-computing complete large models.

An example where GMM is needed is the integrated development of avionics systems as shown in figure 2. Many models are used to specify for example the aircraft physical systems such as its engines, landing gear, etc. (tier 1), its hardware computing platform (tier 2) and its executed software (tier 3). These models typically depend on each other. For example, the power consumption of the hardware platform (tier 2 model) computed from the individual power consumption of hardware components must be consistent with the available electrical power from the engine as specified in tier 1 model. Furthermore, it must also be possible to specify and manage *integration views* showing predefined and combined aspects of the underlying models for performing specific activities such as verification of the design or code generation. In this context, GMM must guarantee the proper interplay of all the models as they are changed during development and that integration views can be specified and managed properly in a modular and incremental manner for scalability.

[1] From Feiler et al., *System Architecture Virtual Integration: An Industrial Case Study*, 2009

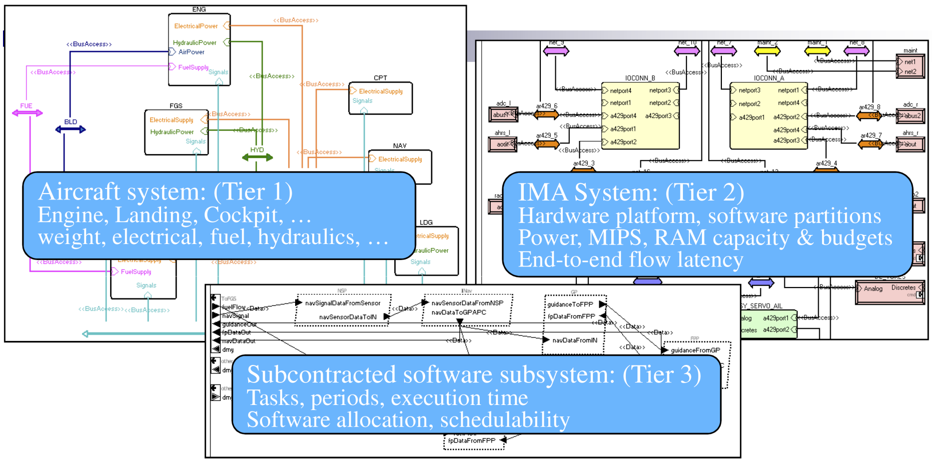

Figure 2: The multiple models used for the specification of an aircraft

Another example is the federation of autonomous robots such as those of our CPS (Cyber-Physical Systems) Lab.[2] To prototype, for example, the behavior of a large group of robots upfront, high-level design models of the robots and the environment may be subject to a coarse-grain simulation. Then, detailed design models for a single robot may be derived from the higher-level ones using synthesis techniques. Furthermore, the detailed behavior of a single robot under idealized conditions may, for example, be tested or coupled with a simulation model of the environment of the robots.

GMM has to enable for all these steps that at first the transition between different models or the required deployment and configuration of the required sets of models for particular activities is done properly and with only minimal manual effort. In this context, it is important that the GMM is able to compose the required set of models and activities in a modular fashion from the already existing building blocks and that the steps can be done incrementally such that they also scale for very large models or sets of models.

Description

The methods and tools for model-based engineering in the System Analysis and Modeling group make intensive use of the Eclipse Modeling Framework (EMF). The goal of the project is to design and develop an extension of EMF to better support modular and incremental GMM. In particular, the EMF meta-modeling language Ecore needs to be adapted to natively support the combination of independent modeling languages and their models and to improve performances when applying model operations. These improvements should be implemented with minimal disruption of existing EMF-based modeling languages and tools to avoid as much as possible recompiling EMF-based existing modeling languages and tools.

The developed extension will be integrated in the MoM (Model Management) framework developed in the System Analysis and Modeling group[3] for large combined system architecture and requirements models. Case studies for the avionics domain from the AVSI (Aerospace Vehicle Systems Institute) SAVI (System Architecture Virtual Integration) program[4] will be used to evaluate the extension. Case studies for the robotics domain from the CPSLab may also be used to evaluate the developed extension.

Contact

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[2] https://www.hpi.uni-potsdam.de/giese/public/cpslab/

[3] http://hpi.de/en/giese/projects/model-management.html

[4] SAVI is a collaboration between aerospace system development stakeholders that aims to advance the state of the art of technologies that enable virtual integration of complex systems. Current members of SAVI include Airbus, Boeing. BAE Systems, U.S. DoD, Embraer, U.S. FAA, Goodrich, Honeywell, U.S. NASA, Rockwell Collins, and Software Engineering Institute/CMU. See http://savi.avsi.aero/