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EDITORIAL

Reference models: how can we leverage them?

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This editorial reflects some observations from discussions at the MODELS 2021 conference and its workshops, which were held virtually in Japan during the period of October 10–15, 2021. As the Editors-in-Chief of the journal most associated with the interest of MODELS, we are very much appreciative of all the deep efforts of the organizers and their continued interest in collaborating with SoSyM. A large number (34) of members from the modeling community were involved in the general organization of MODELS 2021. Our deepest gratitude goes to the General Chairs, Zhenjiang Hu (Peking University), Tomoji Kishi (Waseda University), and Naoyasu Ubayashi (Kyushu University), as well as the PC chairs, Shiva Nejati (University of Ottawa) and Daniel Varro (McGill University as well as Budapest University of Technology and Economics). The organization was superb, and the success of the conference suggests that topics related to software and systems modeling continue to grow in interest each year. The diversity of topics around the idea of modeling in development and understanding of software and systems becomes broader with each conference edition. We were also very excited to extend the collaboration with MODELS through the Journal First option (a record 30 SoSyM papers were presented in MODELS sessions) and the continuation of the Most Impactful Papers (MIP) from the past decade (a list of the MIP awards from the current and past years can be found at https://www.sosym.org/awards).

During the informal period in one of the sessions, there was a discussion on the definition of "reference models" and what purposes they serve in general use. To prime this discussion, we provide below the definition from Wikipedia:

> A reference model—in systems, enterprise, and software engineering—is an abstract framework or domain-specific ontology consisting of an interlinked set of clearly defined concepts produced by an expert or body of experts to encourage clear communication. A reference model can represent the component parts of any consistent idea, from business functions to system components, as long as it represents a complete set. This frame of reference can then be used to communicate ideas clearly among members of the same community.

In full consideration, we are only partly satisfied with this definition. Firstly, even a reference model is a "model." According to our understanding of the general definition of "model" (which is based on Stachowiak [1]), (1) there should be an original and real system/entity that is being modeled, (2) the model should be an abstraction of the original, and (3) the model has something to do with the original system. As a consequence, a model can be used as a substitution for the real system: The Principle of Substitution states that a subset of questions can be answered about the original by querying the model. This seems to fit the definition of a reference model because such a model should be a reference for many (similar) systems, even though there is typically a concretization development step between the definition of the reference model and the finalization of the system.

Furthermore, models are usually made explicit in appropriate modeling languages. For example, if we design a reference model for some data standard, we can use class diagrams as a language for its expression. Correspondingly, it is often feasible to use a similar language for both reference and concrete models, even though sometimes specific language constructs may only be used in the reference, respectively, the concrete model. It is often not easy to recognize a reference model from the concrete realizations that are possible.

Given a concrete model that is used for realization within a concrete system, it is not always very clear whether and how far the concrete model actually conforms to the reference model. This is not necessarily a problem when the reference model serves an educational or informal need. However, when there is tool assistance available, the question on whether a concrete model conforms to its reference becomes more critical. When the reference model is defined

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from a legal or standards context, the same conformance question may also apply.

While the word "reference model" is used quite frequently to our understanding many domains and their communities have different and mostly informal understandings of the significance of a reference model, and consequently, different approaches to using reference models in a particular domain. We posit that a more concise and formal understanding of the concept of a reference model is needed. This would also improve the tool-assistable relationship between a general "reference model" and the set of concrete realizations that conform to that reference model. We pose the following research question:

> How can the notion of a reference model, explicitly denoted in a given modeling language, be formalized together with a precisely defined and tool-assisted notion of a conformance relation that would enable concrete realizations of the reference model?

Furthermore, it may be that when encoding a reference model within a given modeling language, we actually define some kind of ontology (e.g., including a set of terms and their relations) within that modeling language. This would enable an interesting connection between modeling languages and ontologies. Such a connection is obvious for class diagrams, but we also give two additional examples: (1) Encoding a reference model for the behavior of smartphone apps using a StateChart, and realizing specific app definitions using a variable number of states in a concrete StateChart, and (2) providing a reference model for production and billing processes using BPMN within a car manufacturer, and then defining individual concrete factories of that manufacturer around the world.

Wikipedia also mentions several uses of reference models, such as: (1) Creating standards, (2) education, (3) improving communication between stakeholders, and (4) facilitating comparison. A tool-based approach, however, with a clear relationship between reference and concrete realization model is not (yet) included in the Wikipedia definition.

We are aware that there is already much scientific work on this topic and we hope that as a community, we can develop a useful approach that helps developers in their everyday work tasks regarding the importance of reference models.

1 Content of this Issue

We also point your attention to the really interesting expert voice article by Dorina C. Petriu. She gives an overview of the current state on how to assess Cyber-Physical-Systems (CPS), which are the kinds of systems that combine physical parts with software in intensive and manifold forms, using models that are dedicated for various types of non-functional properties.

And we are of course proud to host the MODELS 2019 Special Section defined by our guest editors: Tao Yue, Silvia Abrahao, and Man Zhang.

1. *Expert Voice*
   - "Integrating the analysis of multiple non-functional properties in model-driven engineering" by Dorina C. Petriu
2. *MODELS 2019 Special Section*
   Guest editors: Tao Yue, Silvia Abrahao, and Man Zhang
3. *Regular Papers*
   - "CMMN evaluation: The modelers' perceptions of the main notation elements" by Ioannis Routis, Cleopatra Bardaki, Georgia Dede, Mara Nikolaidou, Thomas Kamalakis, and Dimosthenis Anagnostopoulos
   - "Characteristics, potentials, and limitations of open-source Simulink projects for empirical research" by Timo Boll, Florian Brokhausen, Tiago Amorim, Timo Kehrer, and Andreas Vogelsang
   - "Unleashing textual descriptions of business processes" by Josep Sànchez-Ferreres, Andrea Burattin, Josep Carmona, Marco Montali, Lluís Padró, and Luís Quishpi
   - "Conceptualization, measurement, and application of semantic transparency in visual notations—A systematic literature review" by Saša Kuhar and Gregor Polancic

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1. Stachowiak, H.: Allgemeine Modelltheorie. Springer, Wien (1973)