System Modeling with USE (UML-based Specification Environment)

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Abstract: The Unified Modeling Language (UML) is accepted today as an important standard for developing software. UML tools however provide little support for validating and checking models in early development phases. There is also nearly no substantial support for the Object Constraint Language (OCL). Therefore, our group works on an approach for the validation of UML models and OCL constraints based on animation and certification. The USE tool (UML-based Specification Environment) supports analysts, designers and developers in executing UML models and checking OCL constraints and thus enables them to employ model-driven techniques for software production. Our group also applies OCL and USE in concrete projects. OCL and USE are employed in DOL, a joint eGovernment strategy in Germany. The objectives of DOL include standardisation of electronic data exchange between public agencies. DOL is employing UML models, profiles, and tools: Reusable conceptual models are provided, the UN/CEFACT profile for CoreComponents is used to ensure correct derivation of models in concrete projects, and a further UML profile (the XOEV profile) has been developed to attach data transmission details to the conceptual models. The automated creation of data exchange specifications is supported by the MDA tool XGenerator: It allows the validation of UML models against their applied profiles using OCL constraints, and it supports a flexible, MDA-based generation of XML Schema definitions, DocBook-based documentation, and WSDL descriptions.

1. USE (UML-based Specification Environment)

To assure model quality, model verification and model validation have been put forward. Our group concentrates on model validation, i.e., on checking that a model meets informal requirements a developer has in mind. Checking also involves that the model satisfies particular properties, for example, that certain consequences can be proved or at least certified by a model inspection process.

In order to assist developers in model-driven techniques, our group puts forward the tool USE (UML-based Specification Environment). USE basically is an interpreter for a subset of UML and OCL. An OCL constraint is either an invariant or a pre- or postcondition. Work around USE combined efforts to define the formal semantics of OCL hand in hand with a Java implementation based on an OCL metamodel. Early USE versions were developed further by practical projects. The original USE tool was later extended by a snapshot generator and the support of class diagram visualization.

Model validation through exploring properties of models is a significant task within model-based software development. The USE system supports developers in analyzing the model structure (classes, associations, attributes, and invariants) and the model behavior (operations and pre- and postconditions) by generating typical snapshots (system states) and by executing typical operation sequences (scenarios). Developers can formally check constraints (invariants and pre- and postconditions) against their expectations and can, to a certain extent, derive formal model properties. The following screenshot gives an impression of the USE functionality.

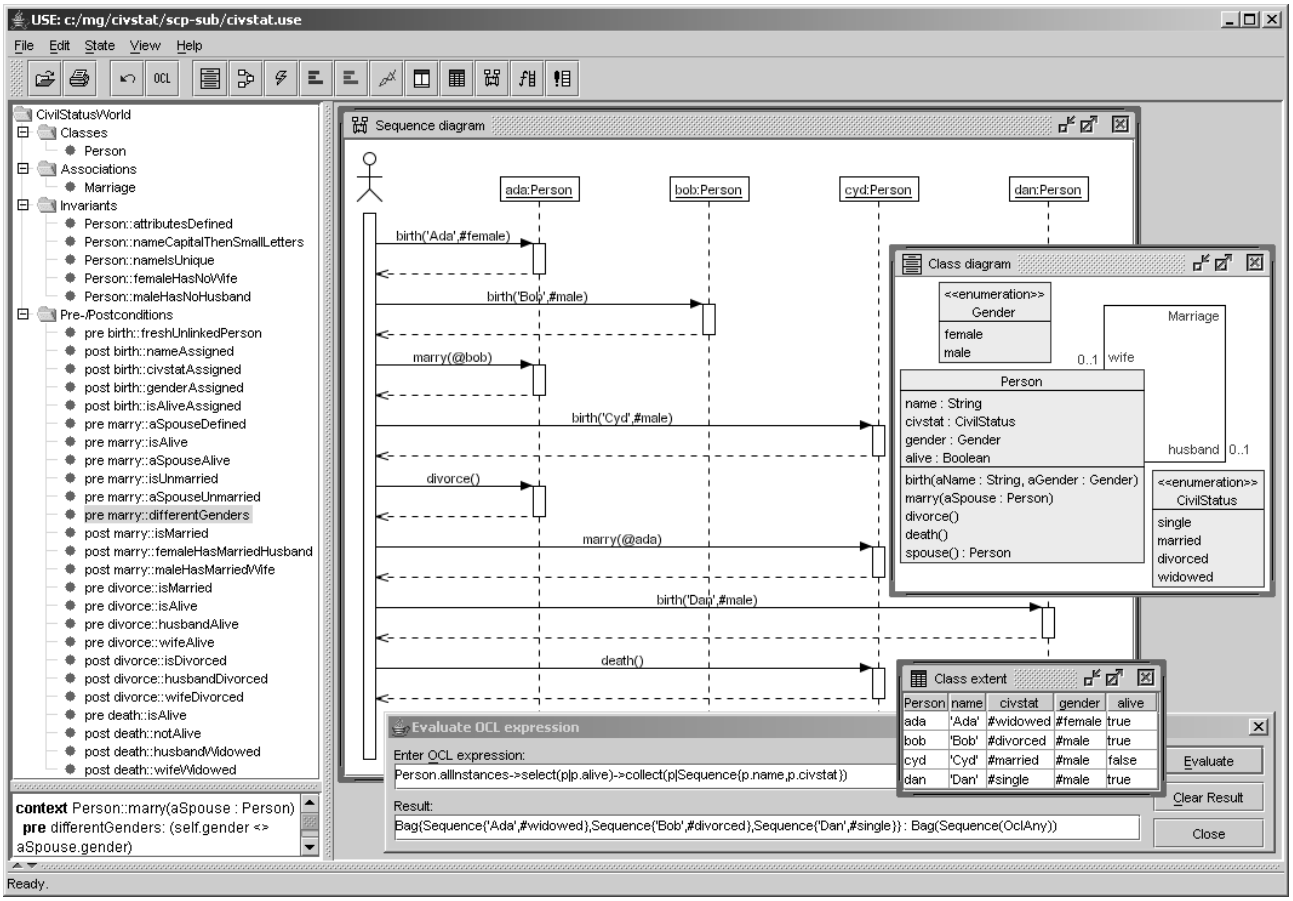

Figure 1: Overview on the Functionality of USE

2. DOL and XGenerator

DOL (Deutschland OnLine, Germany online) is a joint eGovernment strategy by the federal government, federal-state governments, and municipalities in Germany. Its objectives include the provision of a standardisation infrastructure to support the development and deployment of semantic standards for electronic data exchange between and with public authorities, so-called XOEV standards (XML in der OEffentlichen Verwaltung, XML in public authorities). Several concrete ongoing XOEV projects (including civil status registration, data exchange for immigration offices, data exchange in the judiciary domain, and vehicle registration) are currently realised as DOL projects on top of this infrastructure. The pioneer project XMELD (XML im MELDewesen, XML for municipal citizens registration) has been successfully finished in time and budget thanks to extensive use of model-driven techniques. As indicated in the following diagram, several similar projects have been started under the roof of DOL as well.

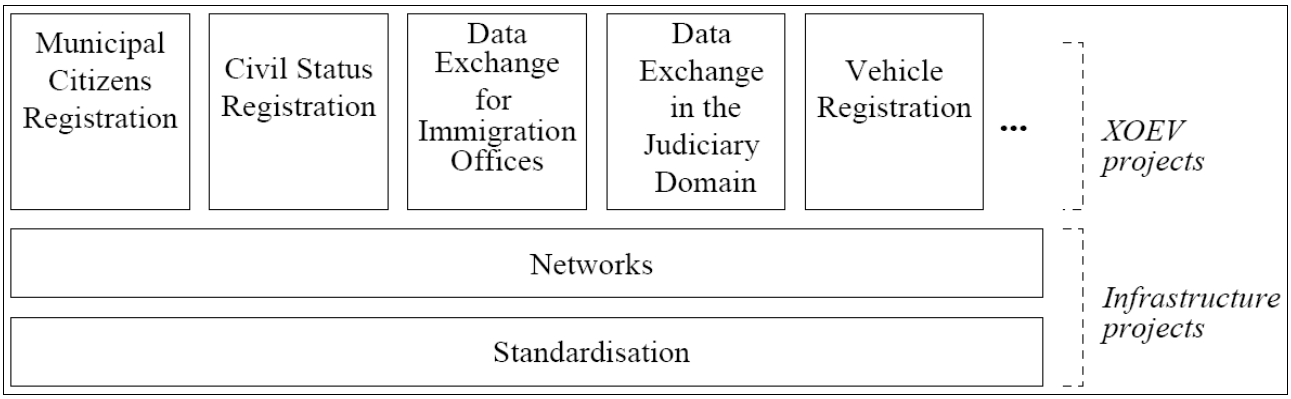

Figure 2: Overview on DOL (Deutschland OnLine)

The model-driven standardisation infrastructure of DOL employs UML models, profiles, and tools to provide a unifying production chain for XOEV standards: A core components model is being developed which collects basic information entities that are common in several areas of the public administration (e.g., entities like Name or Address), enabling interoperable processes across administrative domains. This reusable conceptual model is based on the concepts of the UN/CEFACT Core Components specification, aligning the standardisation approach of DOL with standardisation efforts in other European countries, such as France.

Automated profile validation is used to ensure correct usage of core components in the domain models of XOEV projects. The MDA tool XGenerator has been developed in DOL to perform this profile validation in addition to the transformation into XOEV standards: These XOEV standards (currently consisting of documentation, XML Schema files, and, in some projects, WSDL files) are generated from domain models in an MDA-based way. A DOL specific UML profile, the XOEV UML profile, has been developed to attach platform-specific information to the platform-independent domain models. This additional information is used by the tool XGenerator to produce the various parts of an XOEV specification from an annotated UML model in a configurable way. This means that the XGenerator is both a profile validator and a flexible model transformation tool. OCL is a central ingredient in this production chain. It is employed to describe the well-formedness rules in both profiles and as a model query language within the transformation language of the XGenerator. The XGenerator employs USE as its OCL evaluation engines. The following diagram gives an overview on how the XGenerator is applied.

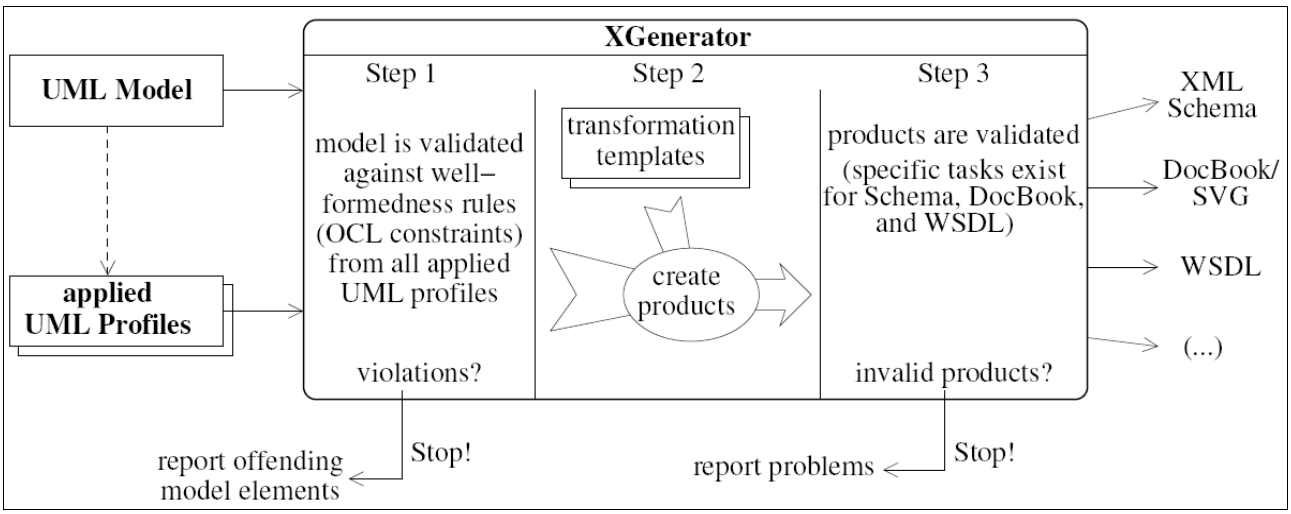

Figure 3: Applying the XGenerator

References

[1] Martin Gogolla, Fabian Büttner, and Mark Richters. USE: A UML-Based Specification Environment for Validating UML and OCL. *Science of Computer Programming*, 69:27-34, 2007.

[2] Fabian Büttner, Mirco Kuhlmann, Martin Gogolla, Jens Dietrich, Frank Steimke, Andre Pankratz, Alina Stosiek, Alexander Salomon. MDA Employed in a Joint eGovernment Strategy. *Project Report*. http://www.db.informatik.uni-bremen.de/. 2008.