Geospatial Data Modelling and Model-driven Transformation of Geospatial Data based on UML Profiles

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01/2010

Background and Motivation
In the context of current national and international spatial data infrastructure (SDI) initiatives, such as the INSPIRE (Infrastructure for Spatial Information in the European Community) Initiative, conceptual models describing the semantics of geospatial data in a formal and coherent way are being developed.

On the basis of these models geospatial data can be provided in a uniform structure. However, often the necessity exists to integrate geospatial data based on differing models. Generally, the modelling language UML (Unified Modeling Language) is used for defining models. For those SDI initiatives, whose geospatial data are described by UML models, it is theoretically possible to apply the so-called Model Driven Architecture (MDA) approach for integrating the geospatial data.

The MDA approach aims at developing software by defining formal models and transforming between them, thus achieving a separation of platform-independent from platform-specific aspects. MDA supports transformation at the conceptual level, which means that the transformation rules are first defined between source and target models and are then executed automatically by means of transformation tools. The advantage of this approach is that the rules need to be defined only once, afterwards transformations into various formats can be carried out by applying appropriate encoding rules.
Problem Statement
The research project “Model-driven approach for accessing distributed spatial data using web services – demonstrated for cross-border GIS applications (mdWFS)” revealed that the prerequisites for a satisfying use of geospatial data described by UML models are only partially given.

Several problems arising from the way conceptual models are currently defined in the geospatial domain have been identified: (1) The UML models and UML profiles are not machine-interpretable due to semantic modification of the UML specification, i.e. they are not conforming to the UML specification anymore; (2) a discrepancy in the visual and machine-interpretable representation of the UML models exists; and (3) the models involved in the transformation adhere to different UML profiles (AAA UML profile, INTERLIS UML profile, INSPIRE UML profile). The first two problems can be solved by exercising more care when defining the models, whereas the third problem persists and can be considered the most crucial one to be solved by scientific research.

Methodological Approach
Transformation between different UML profiles can be performed without additional difficulties when the UML profiles involved are real UML profiles in terms of being compliant with the UML specification. However, this does not apply to the UML profiles used in the project. The aim of this thesis is to develop a framework for UML-profile-based model transformation in the geospatial domain. This will include the definition of a suitable Core UML profile which represents an intersection of the elements of relevant individual UML profiles, the specification of mapping rules for metamodel transformation between selected UML profiles (AAA UML profile, INTERLIS UML profile, INSPIRE UML profile) and the Core UML profile, as well as the development of a prototype for multi-level model transformation which makes use of the defined Core UML profile and the metamodel transformation rules. The main idea the research focuses on is that the models have to be machine-interpretable; otherwise the potential of the model-driven approach cannot completely be exploited.

References


Stand: 24.11.2015