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

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Extended Abstract

Geospatial data modelling plays an important role in the geospatial domain, not least in the context of current regional, national and international spatial data infrastructure (SDI) initiatives, where more and more conceptual models are being developed using formal modelling languages. In particular, the Unified Modeling Language (UML) is to mention here, which in the geospatial domain is not only popular in research, but also in professional practice and in standardisation. Besides conceptual modelling, the integration of geospatial data is another important task. Especially within the current SDI initiatives the necessity exists to integrate geospatial data based on differing conceptual models into a harmonised data set conforming to one common conceptual model. Provided that the conceptual models are defined using UML, a model-driven transformation approach for integrating the geospatial data can be applied which follows the Model Driven Architecture (MDA) framework.

However, when integrating geospatial data based on different conceptual models, difficulties can arise from the way these models are currently defined within the geospatial domain. Often, the focus is on an informal and graphical representation of the relevant concepts, to the effect that these models contain errors which hinder their successful application in the model-driven transformation approach. Furthermore, the models often adhere to a variety of UML profiles, some of these UML profiles exhibiting deficits which reduce the quality of the models and, thus, also their machine-interpretability. This includes, in particular, UML profiles defined as part of the ISO 191xx series of geographic information standards. For this reason, model-driven transformation of geospatial data is still rarely applied today, in spite of the well-known advantages this approach brings about in general.

The aim of this thesis is to address exactly the problem of the differing and deficient UML profiles and to provide solutions for how to cope with the variety of UML profiles existing in the geospatial domain and with the deficits they exhibit to allow for the creation of high-quality models and the successful integration of geospatial data using the model-driven transformation approach. Starting with a coherent introduction to the most fundamental terms and concepts related to geospatial data modelling and model-driven transformation which also takes into account relevant standards from the standards organisations ISO, OGC and OMG, the state of the art in modelling and model-driven transformation in academia as well as in professional practice is discussed and predominant problems encountered from the way conceptual models are currently defined and used are illustrated.

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Afterwards, a selection of UML profiles currently in use in the geospatial domain is examined. It is discussed, why these UML profiles do not conform to the UML profile definition of the OMG and proposals for how to define these UML profiles in a correct way are provided. Based on these findings, solutions are presented for how to cope with the variety of UML profiles. This includes a generic concept for developing UML profiles in a structured and reusable way, the introduction of a Core UML profile as a universally applicable building block in modelling and model-driven transformation of geospatial data as well as the development of a multi-level information integration framework which allows for transforming between UML models based on differing and deficient UML profiles (cf. figure 1). Finally, the feasibility and applicability of the Core UML profile and of the multi-level information integration framework is demonstrated by applying them to the transformation of geospatial data from Austria, Germany and Switzerland to the European INSPIRE data specifications.

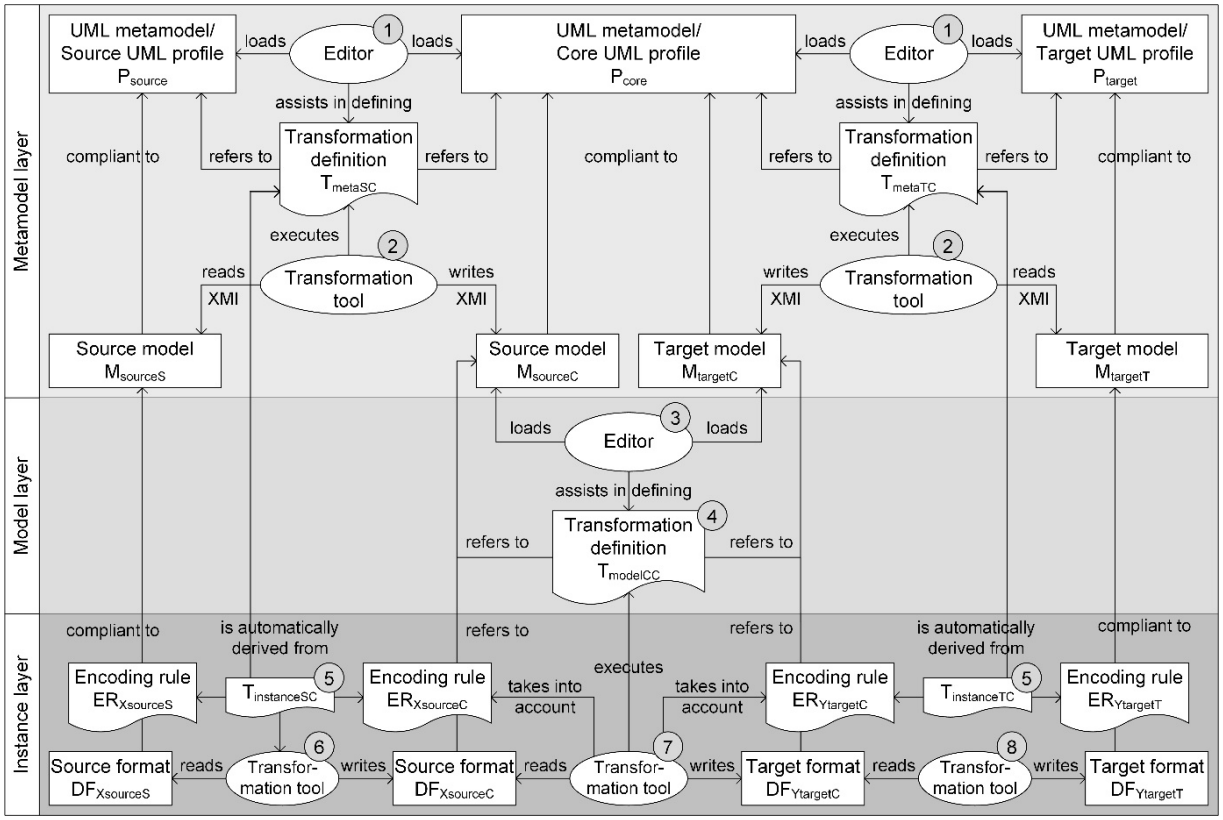

Fig. 1: Framework for multi-level information integration of UML models based on differing and deficient UML profiles

Literature

KUTZNER, T., 2016: Geospatial Data Modelling and Model-driven Transformation of Geospatial Data based on UML Profiles. Dissertation, Technische Universität München.