The LADM Based on INTERLIS

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SUMMARY

Both the conceptual schema language INTERLIS and the land administration domain model (LADM) share the same model driven architecture (MDA) principles. In this paper we explore how INTERLIS and LADM complement each other in actual implementation of land administration system based on the LADM using INTERLIS tools.

In Switzerland, the requirement for a clearly defined data model that can be adapted in flexible ways resulted in a conceptual schema and object oriented language INTERLIS. The cadastral core data model and many other models (i.e. utility services, urban planning, etc.) have been defined with INTERLIS in Switzerland. The concept of the data description language INTERLIS is compatible with international standards like UML or GML/XML. The language is widely used in the country. Constraints for comprehensive data quality checking can be formulated easily. This is one of the main reasons to keep INTERLIS. INTERLIS tools are available for QGIS, FME and other systems. There is also an INTERLIS aware graphic UML editor, GML can be generated, web services (WMS) are supported, etc.

The Land Administration Domain Model (LADM, ISO 19152) has been formulated in INTERLIS now. The result is a layered INTERLIS model description: ISO191xx base model, generic LADM and finally country model specific model expressed in INTERLIS. From this, using INTERLIS tools database schema's (Oracle, PostgreSQL) can be generated and also a foundation for data exchange format (XML) of the specific LADM country profile is available. Specific attention will be paid to expressing the LADM constrains (expressed with pseudo OCL in ISO 19152) into INTERLIS.

The paper first introduces the INTERLIS concepts and supporting documentation. Some examples are included. Then the integration of LADM is expressed. Pro's and con's are analyzed (compared to not using INTERLIS and applying just standard UML, OCL, XML). Finally, future work is presented: support of volumetric 3D primitives, more advanced constraints, etc. Briefly stated, INTERLIS brings one more option to implement LADM (with support from Switzerland) in an efficient manner, and supporting a range of actual target platforms (GIS, DBMS, etc.).

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1. INTRODUCTION

Both the conceptual schema language INTERLIS and the land administration domain model (LADM) share the same model driven architecture (MDA) principles. In this paper we explore how INTERLIS and LADM complement each other in actual implementation of land administration system based on the LADM using INTERLIS and its tools.

This paper now first introduces some INTERLIS concepts in section 2. The concepts are then applied to LADM, as explained in section 3, with special attention to data modelling and constraint formulation. Section 4 compares the LADM/INTERLIS approach with other standards (UML/GML). Finally, future work (section 5) and main conclusions (section 6) are provided.

2. INTERLIS CONCEPTS

2.1 A short history of INTERLIS

The first version of the data modelling language INTERLIS was introduced in Switzerland in the late 1980s (Dorfschmid et al [1]) and has become a Swiss standard in 1998 (SN 612030). The actual version 2.3 of the standard [2] is an object-oriented conceptual schema language (CSL), which is being used to precisely define (spatial) data models in textual form with a rigid computer process able syntax. An important characteristic of the language is that it can easily be understood by application and IT experts, thereby bridging the gap between application and IT domains.

While INTERLIS was originally designed and used mainly for land administration, it is not restricted to land administration data modelling. In fact INTERLIS is a general purpose modelling language. Due to its flexibility it has become part of the Swiss Act on Geoinformation [3] and is currently being used to describe the 160+ data models of the Swiss National Data Infrastructure (NSDI).

2.2 INTERLIS Key Features

INTERLIS has a unique set of features which sets it well apart from other modelling standards (i.e. UML or XML-Schema):

- INTERLIS schemas are defined as easy to read text files. The rigid syntax can directly processed by computer programs;
- the language has built-in geometric data types (point, poly-line, polygon), making it especially suitable for models in the geoinformation domain. Note that at the moment there is not yet a data type of a 3D volumetric solid, such as a polyhedron;
- each INTERLIS data model automatically defines a system neutral XML based data exchange format and there are also tools to generate a database schema (SQL DDL);

An interesting aspect of the language is that it is possible to quality check INTERLIS data against INTERLIS data models (including constraints for valid data), thereby enabling fully automated quality control of spatial data.

2.3 INTERLIS Tool Chain

The intense use of INTERLIS in Switzerland would not be possible, if the language would not be supported by a wide range of tools. The following list gives a brief overview by naming the most important tools (free and commercial):

- the INTERLIS compiler checks the syntactical correctness of an INTERLIS data model (free);
- the INTERLIS checker can quality check INTERLIS XML data against INTERLIS data models (free);
- the INTERLIS UML editor is used to create INTERLIS models from UML diagrams or to visualize existing INTERLIS data models as UML diagrams (free);
- data translators can convert data sets from many GIS systems / databases to and from INTERLIS XML (free and commercial);
- schema tools can generate database schemata directly from INTERLIS data models (free and commercial);

More information about the INTERLIS language and its tools is available at the official INTERLIS web site at www.interlis.ch.

3. INTEGRATION WITH LADM

After the introduction of INTERLIS, it should be obvious that LADM and INTERLIS is a perfect match. By applying the INTERLIS data modelling language to the LADM, ISO 19152:2012 [5, 6] standard, we get computer processable model descriptions, which can be used to initialize databases or transfer LADM data via XML. Using INTERLIS for LADM also means that all free available INTERLIS tools such as compiler, checker, UML editor, etc. can be directly applied to LADM derived country profiles.

3.1 Model Descriptions

To test the feasibility of a LADM INTERLIS implementation, the Swiss Land Management foundation (SLM) started to describe the LADM ISO 19152 standard with INTERLIS. The core work was completed in February 2014 and the full model can be downloaded freely from the SLM web site www.swisslm.ch. The following figure shows an example LADM-UML diagram translated to INTERLIS:

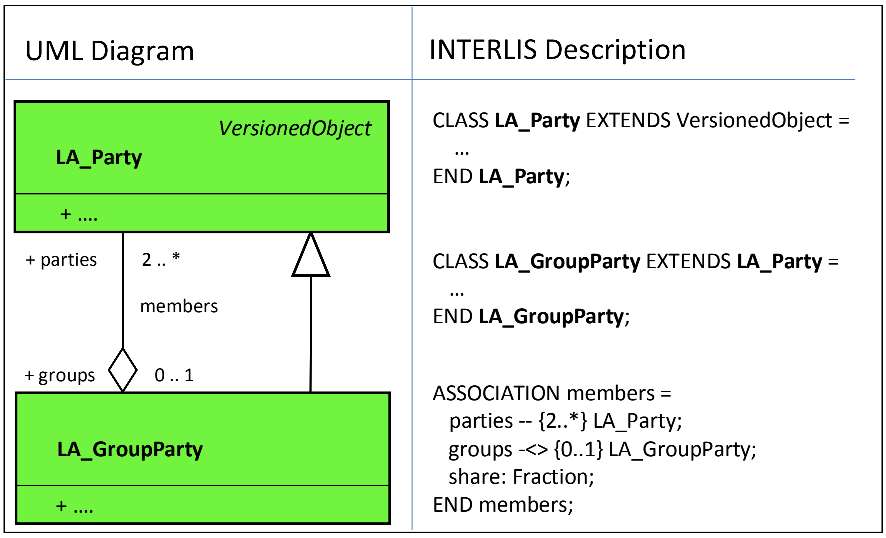

Figure 1: Example of LADM UML diagram translated to INTERLIS (note in the UML Diagram the association class LA_PartyMember is not depicted, but this is included in the INTERLIS description).

3.2 Constraints

The INTERLIS standard includes an OCL like constraint language. Constraints can be defined on object level (`MANDATORY CONSTRAINT`) or class level (`SET CONSTRAINT`, `UNIQUE CONSTRAINT`). Some of the constraints / invariants of the LADM model can be directly expressed by the INTERLIS constraint language, as the following example shows (the UML pseudo OCL invariant ‘if dimension=2D then volume not specified’):

```
CLASS LA_SpatialUnit EXTENDS VersionedObject =
   area: LIST {0..*} LA_AreaValue;
   dimension: LA_DimensionType;
   extAddressID: LIST {0..*} LADM_Base.External.ExtAddress;
   label: CharacterString;
   referencePoint: GM_Point;
   suID: MANDATORY Oid;
   surfaceRelation: LA_SurfaceRelationType;
   volume: LIST {0..*} OF LA_VolumeValue;
MANDATORY CONSTAINT
```

```
   !! if dimension=2D then volume not specified
   NOT (
      dimension == #2D
   )
   AND (
      DEFINED(volume)
   )
END LA_SpatialUnit;
```

The current version of the INTERLIS checker can process such constraints without additional configuration.

4. COMPARISION WITH OTHER STANDARDS

After the introduction to the INTERLIS language and its application to ISO 19152 LADM the reader might ask him/herself what makes the INTERLIS/LADM approach so special. After all there are other well established standards that could do the same with another set of tools. In this section we try to answer this legitimate question from our point of view.

4.1 Reduced Complexity

INTERLIS was designed from the very beginning to model LIS systems and to exchange data between LIS in a system neutral format. The concentration on the two most important tasks, model LIS system and exchange format, in our application domain leads to significant complexity reductions. The INTERLIS 2.3 reference manual consists of only 160 pages, describing the language and also the data exchange format. The reference manual is self-containing making no references to other standards except XML. This reduced complexity makes it much easier for software developers to create powerful tools (compiler, checker, translators, etc.).

4.2 Comparison to UML

UML is a standard mainly intended to document all phases of modern software development (design, development, deployment, maintenance). UML provides many diagram types to support those activities including class, state and behavior diagrams. As UML has no direct relation to Land Administration or Land Information System in general, applying UML to LIS is sometimes difficult as concepts for even the most basic geometric types (point, line and polygon) are missing in UML. Note that within ISC TC211 there is a family of standards providing both generic base types (e.g. the geometry primitives in ISO 19107), domain models (e.g. LADM in ISO 19152) and many other aspects in between (e.g. temporal type, reference systems, metadata, quality). INTERLIS uses UML class diagrams for visualization of data model structures. There is even a free tool to support the UML / INTERLIS integration (UML-Editor).

4.3 Comparison to GML

While GML was originally designed as a data exchange standard it is used today also as a modelling language. While it is possible to use GML for modelling it is somewhat inconvenient as the resulting XML-Schemas are not easily readable by humans without additional tools. Therefore GML should be used as a flexible and model-driven transfer standard only, but not as a modelling language.

The GML standard supports many geometric primitives, making it difficult for software vendors to implement all those types consistently. The Swiss eCH-0118 specification [4] therefore defines an INTERLIS / GML mapping to use a subset of GML as an alternative INTERLIS transfer mechanism.

5. FUTURE WORK

5.1 Swiss LADM Country Profile

As a next logic step it was decided to implement the Swiss LADM country profile in INTERLIS. This work is sponsored by the Swiss government (swisstopo) and was started in February 2015. The project will also make LADM compatible data from Canton Solothurn available on a public webserver. All provided data will be quality checked (based on more explicit constraints for valid data) by an automatic LADM check service.

5.2 INTERLIS 2.4

The LADM/INTERLIS implementation work has directly inspired some additional work on the actual INTERLIS 2.3 language to even better support the LADM standard (i.e. improved constraint formulation, LIST and BAG with basic types). The upcoming INTERLIS 2.4 standard will be published by mid-2015.

5.3 Complete LADM described in INTERLIS

After describing the core of LADM in INTERLIS, the next step is a more complete description covering: all possible spatial representation types (spatial profiles: from text to topology), include 2D, 3D and mixed spatial units, describe all constraints mentioned in ISO19152, all specializations of spatial units (such as LA_LegalSpaceBuildingUnit and LA_LegalsSpaceUtilityNetwork), etc.

5.4 3D Support

INTERLIS supports 3D point / line and polygons but there are no special 3D-types (i.e. solids) in the standard at the moment. As 3D cadaster becomes more and more common in urban areas the better integration of 3D data types will be an issue in future versions of the language (INTERLIS 3?). In Lemmen et al 2010 [7] an overview is given of all spatial representation types and the challenges that occur when integrating 2D and 3D spatial units in one environment.

6. CONCLUSIONS

By applying INTERLIS to the LADM ISO 19152 standard we get directly computer processable data models. This approach can significantly speed up the implementation of LADM country profiles. As access to all specifications and important tools (compiler, checker, UML-Editor) is free, the LADM/INTERLIS approach can easily implemented with minimal financial investments.

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BIOGRAPHICAL NOTES

Michael Germann is co-founder and CEO of infoGrips LTD, Zürich Switzerland and member of the Swiss Land Aministration Foundation (SLM). In 1988, he received a master's degree in computer science from ETH Zürich. His main interests are software development, data modelling, data quality control and the implementation of spatial data infrastructures. He worked on several Swiss standards including INTERLIS and was part-time member of the Swiss delegation to ISO TC211.

Jürg Kaufmann, born 1942 and graduated from the Swiss Federal Institute of Technology in Zurich. He founded in 1988 his own company KAUFMANN CONSULTING, working in the field of cadastre and geomatics on national and international level. Among many involvements for the Swiss Development Agencies, the UN, the World Bank, and for the federal and cantonal Swiss governments. He was a member of the management board for the Swiss cadastral surveying system reform and of the legislation team for the Swiss Law on Geoinformation. From 2003 until 2010 he acted as a president of Geosuisse, the professional Association for Geomatics and Land management and he became a honorary member. Jürg Kaufmann is also a honorary member of FIG and was chairing the FIG-Commission 7 working group on 'Cadastre 2014′.

Daniel Steudler holds a PhD degree from the University of Melbourne, Australia and is a scientific associate with the Swiss Federal Office of Topography swisstopo, working for the Federal Directorate for Cadastral Surveying. He is active in FIG-Commission 7 for many years and was chair of the FIG-Task Force on «Spatially Enabled Society». He published widely in the cadastral field and consulted internationally in land administration and cadastral issues. Since March 2015, he is chair of the EuroGeographics "Cadastre + Land Registry" Knowledge Exchange Network.

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Peter van Oosterom obtained an MSc in Technical Computer Science in 1985 from Delft University of Technology, the Netherlands. In 1990 he received a PhD from Leiden University. From 1985 until 1995 he worked at the TNO-FEL laboratory in The Hague. From 1995 until 2000 he was senior information manager at the Dutch Cadastre, where he was involved in the renewal of the Cadastral (Geographic) database. Since 2000, he is professor at the Delft University of Technology, and head of the 'GIS Technology' Section, Department OTB, Faculty of Architecture and the Built Environment, Delft University of Technology, the Netherlands. He is the current chair of the FIG Working Group on '3D Cadastres'.

Kees de Zeeuw is Director of Kadaster International at the Cadastre, Land Registry and Mapping Agency (Kadaster), The Netherlands. He holds an MSc degree in land and water management (1989). After long term contracts in Rwanda and Bolivia he has been working more than 10 years in environmental and geo-information sciences at Wageningen University and ResearchCentre. After being responsible at Kadaster for product and process innovation (2007 – 2010), he now is responsible for the coordination of Kadaster's international activities and international cooperation projects. Kadaster International provides world wide advisory services in the domain of land administration, e-governance, geo-information services and SDI.

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