LADM Refined Survey Model

Anna SHNAIDMAN, Peter VAN OOSTEROM and
Christiaan LEMMEN, The Netherlands

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SUMMARY

First Edition of the Land Administration Domain Model (LADM) has three packages related to: *Parties* (people and organisations); *Basic Administrative Units*, *Rights, Responsibilities*, and *Restrictions* (of ownership rights); spatial units (parcels, and the legal space of buildings and utility networks) with a sub package for *Surveying and Representation* (geometry and topology). The latter sub-package provides the functionality to manage observations and cadastral surveys measurements.

Contents of LADM implementations are based on authentic source documents, including the names of the persons having a role (responsibility) in the process of the initial data acquisition and/or in the maintenance process. This concerns legal/administrative data and spatial data based on field surveys and observations – where responsible professionals can be conveyors, registrars, surveyors, grassroot surveyors, citizens themselves (participatory surveying) and paralegals.

Some of the existing parts of Edition I of the LADM are proposed to be refined in the context of development of Edition II of the standard. This will allow for the inclusion of better structured meta data – also in support of participatory approaches in cadastral surveying. Richer semantics may require more rigid representations of the various Code Lists and the values they contain (adding more structure and using sematic technologies to define meaning of values).

An extended survey and legal models are proposed and presented in this paper. This implies adjustments from field observations to the spatial database and the generation of quality labels.

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1. INTRODUCTION

This paper presents a proposal for a LADM Refined Survey Model, including an extended core LADM class LA_SpatialSource, several association classes and corresponding Code Lists.

The paper on '*Land administration standardization with focus on surveying and spatial representations'* by Van Oosterom et al. (2011) discusses in detail the LADM with a focus on Surveying and Spatial Representations. In the paper it is expressed that data acquisition can be based on variety of approaches (low cost/high tech); conventional terrestrial surveying may be a requirement, but not in all cases; observations may require transformations and adjustments, or other types of corrections. Those transformations and adjustments can/need to be documented in itself. All different types of geodata acquisition can be represented in LADM. Note: procedures for data acquisition itself are not included in the first Edition.

An important development since 2012 is in the use of mobile devices for cadastral purposes – combined with participatory approaches and crowdsourcing, see FIG (2019). Also Automated Feature Extraction for cadastral purposes gets more and more attention (Kohli, et al. 2017a and Kohli et al., 2017b; Marshall et al., 2019).

Contents of LADM implementations are based on authentic source documents including the names of persons having a role (responsibility) in the process of the initial data acquisition and/or in the maintenance process. This concerns legal/administrative data and spatial data based on field surveys and observations – where responsible professionals can be conveyors, registrars, surveyors; or grassroot surveyors, citizens themselves and paralegals.

Some of the existing parts of Edition I of LADM are proposed to be refined in the context of development of Edition II of the standard. This will allow for the inclusion of better structured meta data – also in support of participatory approaches in cadastral surveying. Richer semantics may require more rigid representations of the various Code Lists and the values they contain (adding more structure and using sematic technologies to define meaning of values).

It should be noted that Code Lists need to be adapted to a local situation, as the LADM Code Lists are merely informative and aim at providing examples for better understanding of the value types they represent.

An extended survey and legal models are proposed and presented in this paper. This implies adjustments from field observations to the spatial database and the generation of quality labels.

This paper presents a brief overview of the Surveying and Representation package in Section 2. Section 3 gives an overview of the proposed Refined Survey Model – with a comprehensive overview of Code Lists and its rich semantics in section 4. The paper concludes in Section 5.

2. SURVEYING REPRESENTATION IN LADM

During the design of Editions I of LADM the need for functionality to represent a broad range of spatial units, with a clear quality indication was recognised and supported and finally included in LADM. Spatial units are the areas of land (or water – e.g. water rights and the marine environment) where the rights and social tenure relationships apply. Spatial units can be represented as a text ("from this tree to that river"), as a sketch, as a single point, as a set of unstructured lines, as a surface, or as a 3D volume, see Lemmen (2012), Lemmen et al. (2015), Van Oosterom and Lemmen (2015). In those publications it is further signified that there is a need for a broad range in surveying and data acquisition approaches to be supported – in order to facilitate fast, low-cost and sufficient quality survey approaches. Surveys may, for example, also concern the identification of boundaries of spatial units on a photograph, an image, or a topographic map. Apart from that, cadastral surveys may be conventional land surveys, based on hand-held GPS. In all cases the representation of 'legal' reality should be distinct from the 'physical' reality. Spatial units in urban business districts can be conventional parcels with high accurate boundaries, whereas spatial units in residential areas can be derived from aerial photographs, total stations measurements, radar detection, automatic feature extraction, recording, CycloMedia, digital video or voice recording are also possible (Barry, 2005). Quality of spatial data may be improved in a later stage of data processing and analysis.

In LADM a survey is documented via spatial sources. A set of measurements with observations (distances, bearings, etc.) of points, is an attribute of LA_SpatialSource. The individual points are instances of class LA_Point, which is associated with LA_SpatialSource. 2D and 3D representations of spatial units use boundaryFaceString (2D boundaries implying vertical faces forming a part of the outside of a spatial unit) and boundaryFaces (faces used in 3D representation of a boundary of a spatial unit). Co-ordinates themselves either obtained from points or are captured as a linear geometry.

3. PROPOSED REFINED SURVEY MODEL

LADM refers to Observations and Measurements - ISO 19156 (ISO, 2011). This reference is in a very generic form therefore, a refined model for different survey techniques, which addresses survey related aspects is proposed. See also the overview of proposals for LADM Edition II as presented in Lemmen et al. (2019).

In order to form a Refined Survey Model, an extended LA_SpatialSource class is suggested (Figure 1) including several new attributes and corresponding Code Lists. In order to explicitly address the miscellaneous features of the survey process, the following attributes were added: *platform* – depicts possible platform types such as terrestrial, aerial or satellite; *surveyMethod* –indicates whether the survey is a formal or a participatory one, which more characteristic for the developing countries; *media* – portrays the source document media type, e.g. sketch, video, point cloud etc.; *automationLevel* – illustrates the assorted process automation level types, namely automatic, manual or semi-automatic ones; and *surveyPurpose* – which includes all the individual survey purpose types, for instance: land consolidation, control measurements or division of a parcel, applicable in a specific land administration. In addition, a new optional association class is proposed to be created in order to link LA_Party and LA_SpatialSource/LA_AdministrativeSource. The purpose of these association classes is to denote the different roles of a survey executor and administrative party/ies that are not directly portrayed by the "role" attribute in the LA_Party class.

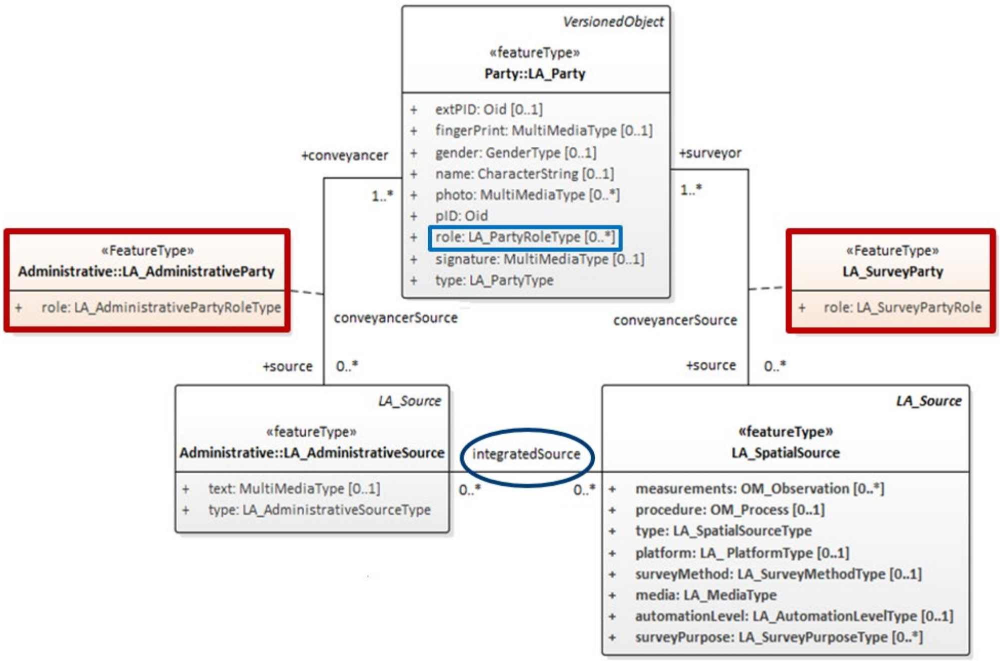

Figure 1- Extended LA_SpatialSource

Furthermore, a new concept of an "Integrated Source" is suggested which is modeled as an association between the Administrative and the Spatial source classes; see the highlight in bleu in Figure 1. Different source types are represented via assignment of multiplicity, where "0" represents a case of a pure Administrative or Spatial source, whereas "1" illustrates a situation where a document contains both attributes from LA_AdministrativeSource as well as from the LA_SpatialSource.

Additionally, in order to explicitly express the purpose of the survey, an association class LA_SurveyRelation is proposed between the LA_SpatialSource and LA_SpatialUnit As depicted in Figure 2.

Figure 2 represents the complete Refined Survey Model, which includes both 2D (LA_BoundayFaceString in Figure 2) and 3D (LA_BoundaryFace in Figure 2) cases.

The corresponding Code Lists are introduced in Section 4 of this paper.

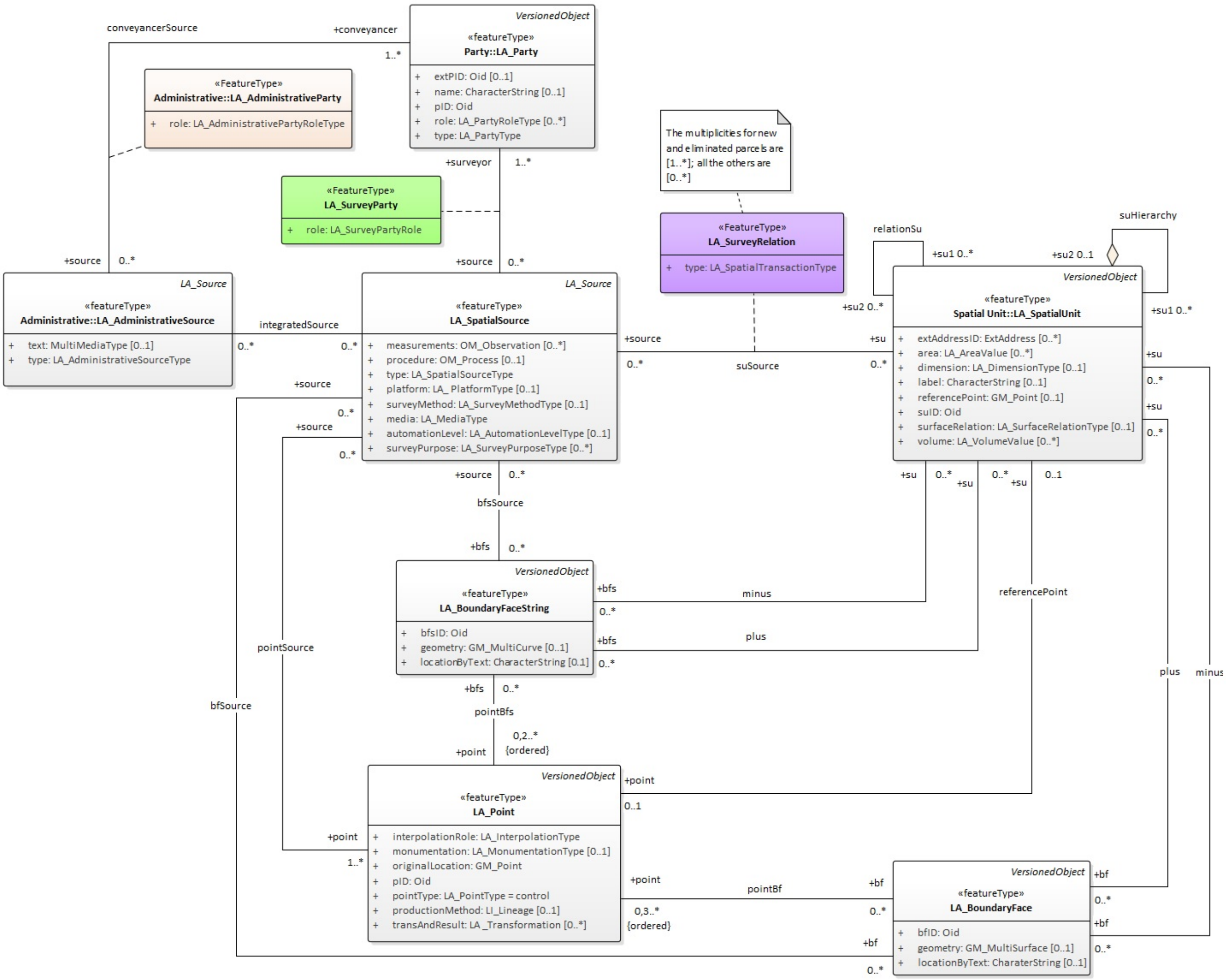

Figure 2 - Refined Survey Model

4. CODE LISTS FOR SURVEYING AND REPRESENTATION SUBPACKAGE

The Surveying and Representation Subpackage in LADM Edition 1 has four Code Lists, see Figure 3 from ISO (2012). The Refined Survey Model requires extensions as shown in a proposal for inclusion in Figure 4.

Attribute types LA_MonumentationType, LA_SpatialSourceType, LA_InterpolationType and LA_PointType are already included in the Surveying and Representation Subpackage of LADM Edition I. The Refined Survey Model adds: LA_PlatformType, LA_SurveyMethodType, LA_MediaType, LA_AutomationLevelType, LA_SurveyPurposeType, LA_SurveyPartyRoleType and LA_SpatialTransactionType:

In a country profile all those Code Lists should provide a complete list of all codes with a name and description.

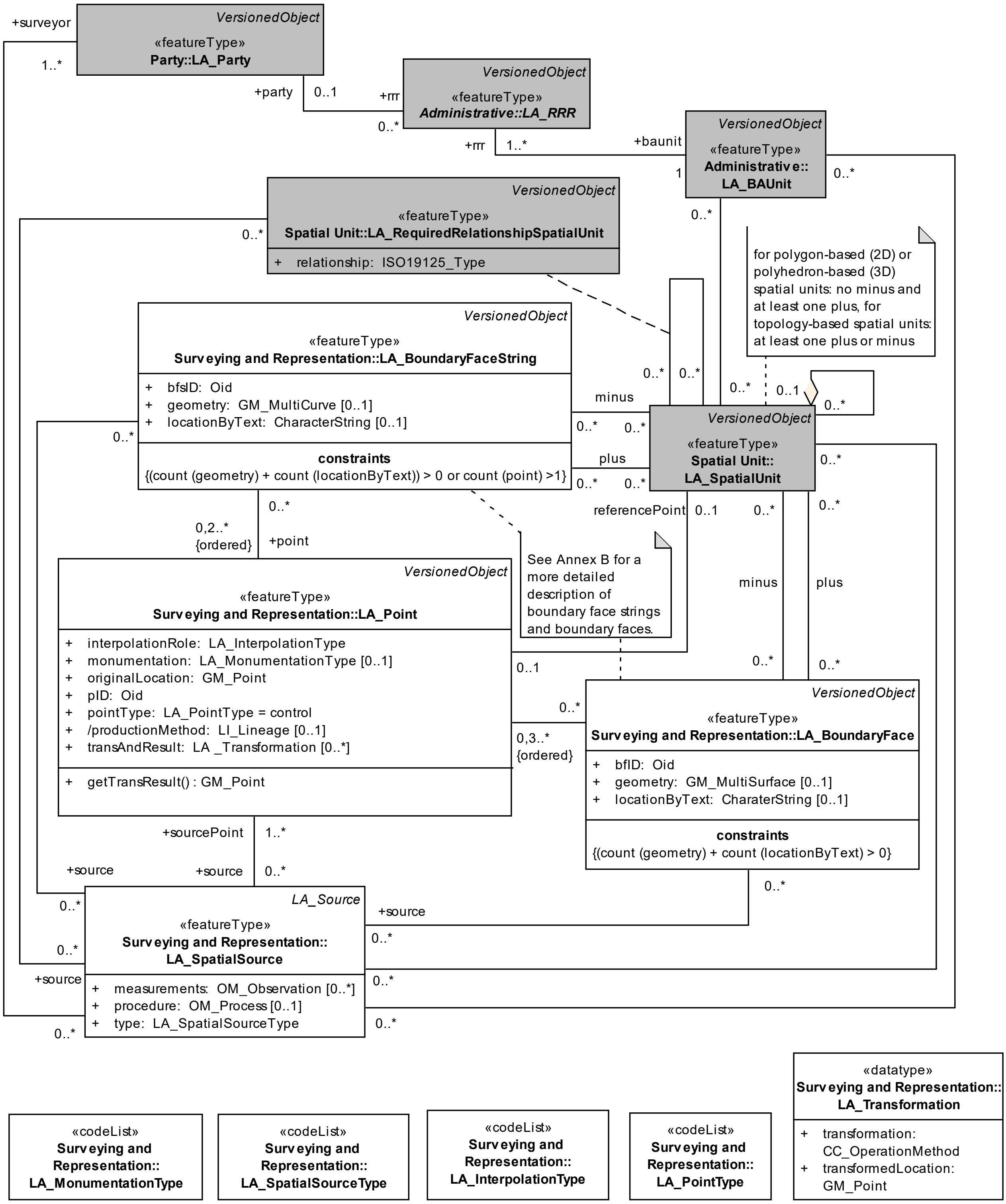

Figure 3 - Content of Surveying and Representation Subpackage with associations to other (basic) classes (ISO, 2012)

Figure 4 - Code Lists for Surveying and Representation Subpackage

LA_MonumentationType: the LA_MonumentationType code list includes all the various monumentation types, such as beacon or marker, used in a specific land administration profile implementation. The LA_MonumentationType code list is required only if the attribute monumentation in LA_Point class is implemented.

LA_SpatialSourceType: the LA_SpatialSourceType code list includes all the various survey techniques, such as GNSS, Radar, Remote Sensing, LiDAR, leveling, mobile mapping or design (BIM), used in a specific land administration profile implementation. The LA_SpatialSourceType code list is required to implement the LA_SpatialSource class.

LA_InterpolationType: the LA_InterpolationType code list includes all the various point interpolation types, such as start, end or mid arc, applicable in a specific land administration profile implementation. The LA_InterpolationType code list is required to implement the LA_Point class.

LA_PointType: the LA_PointType code list includes all the various point types, such as control or cadastral, applicable in a specific land administration profile implementation. The LA_PointType code list is required to implement the LA_Point class.

LA_PlatformType: the LA_PlatformType code list includes all the various platform types, such as: terrestrial, aerial or satellite, applicable in a specific land administration profile implementation. The LA_PlatformType code list is required only if the attribute LA_PlatformType in LA_SpatialSource class is implemented.

LA_SurveyMethodType: the LA_SurveyMethodType code list includes all the various survey types, such as: formal or participatory, applicable in a specific land administration profile implementation. LA_SurveyMethodType code list is required only if the attribute surveyMethod in LA_SpatialSource class is implemented.

LA_MediaType: the LA_MediaType code list includes all the various media types, such as: video, sketch, pointCloud or digitizedMap applicable in a specific land administration profile implementation. The LA_MediaType code list is required to implement the LA_SpatialSource class. See Annex J for media type examples.

LA_AutomationLevelType: the LA_AutomationLevelType code list includes all the various process automation level types, such as: automatic, manual or semi-automatic, applicable in a specific land administration profile implementation. The LA_AutomationLevel code list is required only if the attribute automationLevel in LA_SpatialSource class is implemented.

LA_SurveyPurposeType: the LA_ SurveyPurposeType code list includes all the various survey purpose types, such as: land consolidation, control measurements or division of a parcel, applicable in a specific land administration profile implementation. The LA_ SurveyPurposeType code list is required only if the attribute surveyPurpose in LA_SpatialSource class is implemented.

LA_SurveyPartyRoleType: the LA_ SurveyPartyRoleType code list includes all the various types of survey parties, such as licensed surveyor or volunteer (grassroot surveyor, paralegal, citizen), recognized/allowed in a specific land administration profile implementation. The LA_ SurveyPartyRoleType code list is required to implement the LA_Party class.

LA_SpatialTransactionType: the LA_ SpatialTransactionType code list includes all the various types of spatial transactions, such as creation or updating of a parcel, recognized/allowed in a specific land administration profile implementation. The LA_ SpatialTransactionType code list is required to implement the LA_SurveyRelation association class.

5. CONCLUSION

As an ISO standard, LADM is subject to cyclic revision and recurrent review from experts world-wide. Within the extended scope of version two of LADM, a Refined Survey Model is suggested. The purpose of this model is to improve work flows of land management organizations where they exist and to propose a systematic, structured approach to linking spatial sources with their counterpart spatial units which in turn contributes to a transparent and accessible survey data (Soffers, 2017).

This paper presents the development and current results of the Refined Survey Model, including an extended core LADM class LA_SpatialSource.This model provides:

- a semantic enrichment of the LADM.
- extended functionality for cadastral surveying, including crowdsourcing, and:
- linkages to the development of processes and transactions in LADM.

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BIOGRAPHICAL NOTES

Anna Shnaidman is a former Geophysical Surveys and Research Administrator in the Research Division at the Survey of Israel and a Part-time Lecturer in the Department of Civil Engineering at the Technion - Israeli Institute of Technology. She received her BSc (2008, Cum Laude) and MSc (2010) and PhD (2016) degrees in Mapping and Geo-Information engineering from Israeli Institute of Technology. Dr. Shnaidman is a Licensed Surveyor as well.

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. 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'.

Christiaan Lemmen is full Professor Land Information Modeling at the Faculty of GeoInformation Science and Earth Observation of the University of Twente in the Netherlands. His other main job is as Senior Geodetic Advisor at Kadaster International, the international branch of the Netherlands Cadastre, Land Registry and Mapping Agency. He is director of the OICRF, the International Office of Cadastre and Land Records, one of the permanent institutions of the International Federation of Surveyors (FIG).

CONTACTS

Anna Shnaidman
Delft University of Technology Section GIS-technology
Faculty of Architecture and the Built Environment
P.O. Box 5030 2600 GA Delft
THE NETHERLANDS
Phone: +31 (0)15 278 3005
E-mail: A.Shnaidman@tudelft.nl

Peter van Oosterom
Delft University of Technology
Faculty of Architecture and the Built Environment
P.O. Box 5030 , 2600 GA Delft
THE NETHERLANDS
Phone: +31 15 2786950
E-mail: P.J.M.vanOosterom@tudelft.nl

Christiaan Lemmen
University of Twente
Faculty of Geo-Information Science and Earth Observation/ITC
P.O. Box 217
7500 AE Enschede
THE NETHERLANDS
Phone: + 31 6 52481717
E-mail: c.h.j.lemmen@utwente.nl