Observations on the Proposed Standardised Cadastre Domain Model – Where Do We Go From Here?

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Key words: OGC, FIG, domain models, consensus, cadastre, interoperability.

SUMMARY

The proposed Cadastre Domain Model is a standardisation effort of great importance that will benefit greatly from close coordination with the work of the Open Geospatial Consortium, Inc. FIG is proposing to standardize the content and some of the methodologies of cadastre management and OGC is perfecting a method to lower the costs and challenges of implementing the Model in computer software. As a not-for-profit consortium, OGC does not create computer software, but organizes the geospatial industry to produce a consensus standard for interfaces that link functional applications that will provide the cadastre automation needed. The end result is the ability of cadastre information from many countries, running on hardware and software from many different companies to work seamlessly as if they all used exactly the same data model, and computer hardware, operating system and application software.

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1. INTRODUCTION

The proposed Cadastre Domain Model presented by Oosterom and others at the Brno Conference offers the Information Communications Technology (ICT) and Cadastre communities an important opportunity to converge on a number of critical fronts. First, the Model sets out a discipline based product defining user requirements for distributed processing across the community-at-large. Second, the Model provides a rich substrate for the two communities together to move the model forward into the engineering process. The Open Geospatial Consortium's (OGC) process for developing and enhancing service specifications, encodings and application schema, our recent accomplishments and current work agenda, plus the activities now underway by OGC's European subsidiary provide the best way for the next steps to occur. We agree with the authors' conclusions that it is appropriate to establish a working relationship between OGC and FIG to foster the continuing development of distributed Cadastre information systems. To elaborate on technical and business issues about European transnational property and land tenure information processing we believe the time is right for initiating collaborative FIG/OGC work efforts, along with member states, under the umbrella of Sixth Framework Programme (FP6) and/or European Science Foundation (ESF) programmes. There is precedent for this kind of strategic development and funding approach. Subject to approval by the membership, other internal OGC specification steps could be proposed.

The Model and OGC's efforts mesh perfectly in that the UML used in the former is an input to the work flow for the latter and the output from the OGC process is then used by FIG. A UML model, by its very nature is not suitable for direct use by computer software. It defines the system and the data that moves through it but the detail provided is inadequate for automated exploitation by software. OGC, on the other hand, has focused its work on the process of enriching the user specific model to the level needed for it to support computer processing. That work has produced an automated tool that ingests a UML model and creates an XML Schema Document (.xsd) encoded using the OGC's Geography Markup Language (GML). That schema defines the data being passed in sufficient detail for a software application to 'understand' the data based solely on the information found in the .xsd file that is passed with it. The UML model is a correct expression of what FIG has defined as required and the use of a Model Driven Architecture (MDA) tool ensures that any number of organizations can process the original data into an identical .xsd description. Figure 1, UML to GML Application Schema Process graphically illustrates the steps involved in transforming a UML Model into a GML schema. The Cadastre Model is merged with an individual country's content in the UML to GML Application Schema Tool (UGAS) that then creates a country specific GML application schema based on the Cadastre and the individual country content.

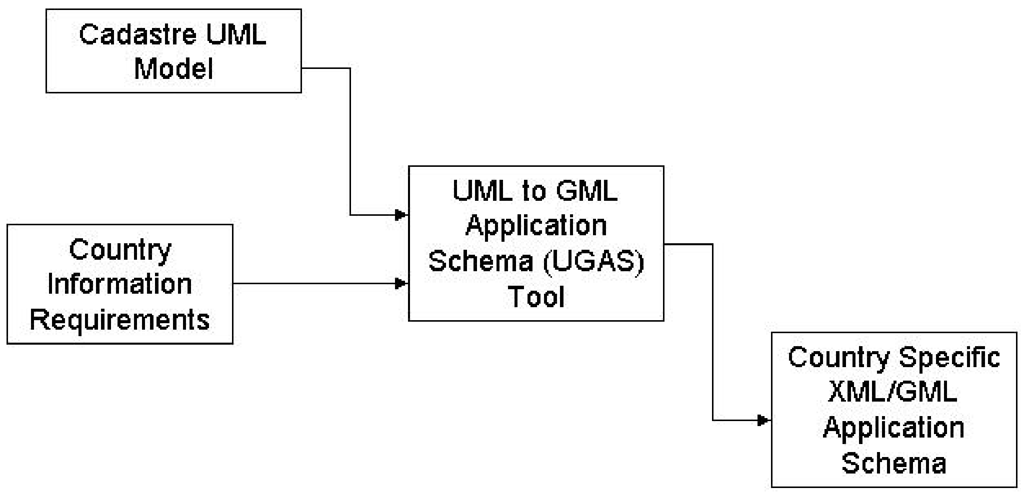

Figure 1: UML to GML Application Schema Process

At the technology level, work undertaken over the past 2 years by OGC to converge geospatial and Web standards has prepared us to engage the Cadastral community and offer unprecedented capabilities related to publishing, discovering, processing and displaying land data, and capabilities for automating the translation of data from one information model to another. To realise these capabilities, in the form of Standards-based software products and services, we propose a series of activities that enable these capabilities to be introduced into the market over the next two years. The activities defined below promote the Cadastre's community needs to the ICT community so that both communities may collaborate to address the requirements in product and services.

The steps we define below constitute our ideas for activities that can take the Model forward. These include establishing an understanding about and the formulation of an agreed to method for architecture and architecture governance, conducting broader modeling activities to establish a business rationale, and to set the stage for establishing reference implementation facilities for testing and definition of operational requirements and other issues regarding adoption in National and sub-national settings. These steps we discuss are presented in a way to facilitate future dialog within the community on these issues and to arrive at more precise strategic and funding considerations.

2. SERVICE ARCHITECTURE: USE OF WEB SERVICES, WEB SERVICE AND OpenGIS® STANDARDS FOR CADASTRE INFORMATION SYSTEMS

Previous attempts at distributed computing (CORBA, Distributed Smalltalk, Java RMI) have yielded systems where the coupling between various components in a system is too tight and requires too much agreement and shared context among business systems from different organisations to be reliable for open, low-overhead B2B e-business.

Meanwhile, the trend in the application space is moving away from tightly coupled monolithic systems and towards systems of loosely coupled, dynamically bound components. Systems built with these principles are more likely to dominate the next generation of e-business systems, with flexibility being the overriding characteristic of their success. OGC believes that applications will be based on compositions of services discovered and marshaled dynamically at runtime (just-in-time integration of services). Service (application) integration becomes the innovation of the next generation of e-business, as businesses move more of their existing Information Technology (IT) applications to the Web, taking advantage of portals and e-marketplaces and leveraging new technologies, such as eXtended Markup Language (XML).

Service oriented architecture (SOA) is an architectural design style for developing modern web services. SOA which has its foundations within the business application domain, is now being applied to middleware technologies and is spreading into other domains (e.g., geospatial).

Without SOA, software application packages are written to be self-contained, with many application functions tied together in a complete package. The code to accomplish integration of application functions is often mixed into the code for the functions themselves. We call this approach to software design "monolithic applications". It is tightly coupled, in the sense that changes to one part of the code will have a big impact on code in another application function that uses it, and this leads to complexity of systems and expense in maintaining them. It also makes it difficult to re-use application functions, because they are dependent on too detailed knowledge of what happens in another application.

One of the distinguishing characteristics of an SOA is the separation of individual application functions from each other so that they can be used independently, as individual application functions or "building blocks”[1]. These building blocks can be used to create a variety of

[1] Building Blocks have generic characteristics as follows:

1. A Building Block is a package of functionality defined to meet business needs across an organisation
2. A Building Block has published interfaces to access the functionality
3. A Building Block may interoperate with other, interdependent, Building Blocks
4. Is reusable and replaceable, and well specified
5. It considers implementation and usage, and evolves to exploit technology and standards
6. It may be assembled from other Building Blocks
7. It may be a subassembly of other Building Blocks
8. May have multiple implementations but with different interdependent Building Blocks

other applications inside the enterprise, or if desired, exposed externally for business partners to use in their applications.

The notion of a "service" is to construct these "building blocks" with standardised interfaces that are independent of the implementation details. Figure 2: Application E from A,B,C,D illustrates how this is done. Applications A and B are left entirely alone in their existing proprietary format as are Applications C and D, but by exposing them to integration via open interfaces it is possible to assemble Application E from the capabilities of A,B,C, and D. Applied to cadastre this would imply that all of the existing systems could continue and still be assembled into a cross-enterprise application.

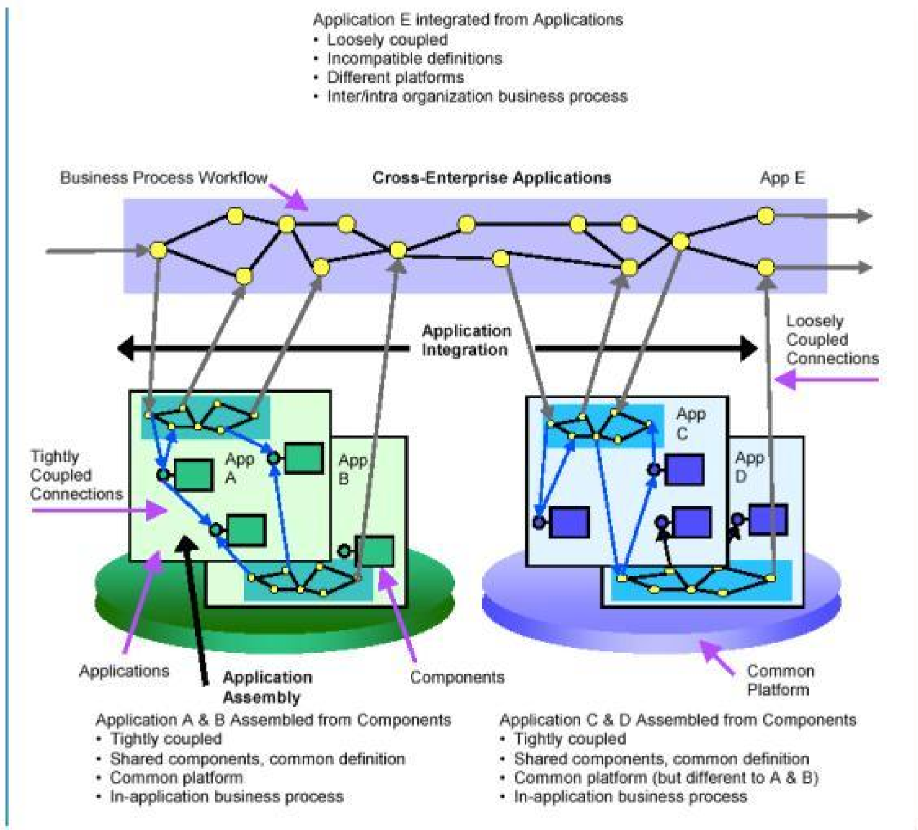

Figure 2: Application E from A,B,C,D

Web Services is a set of standards that can be used to create an SOA. While it is possible to create an SOA without the Web Services standards (for example, people have used XML over HTTP or JMS to achieve a similar result, before the Simple Object Access Protocol (SOAP) standard), for interoperability with external software the use of Web Services standards is the best approach we have today.

The basic standards are in place for Web Services, and these can be used to implement a service-oriented architecture. XML and XML Schema have been standards since 1998 and 2001, respectively. SOAP 1.2 has been a standard since June 2003. Universal Description and Discovery Interface (UDDI) was standardised in summer 2003. Web Services –Security (WS-Security) became a standard in April 2004.

Aside from these official standards supported by well-known standards bodies such as World Wide Web Consortium (W3C) and Object-Oriented Administrative Systems-development in Incremental Steps (OASIS), many "technology proposal specifications" are well-accepted and well-supported as interim "defacto" standards. For example, until Web Services Description Language (WSDL) 2.0 is finished at W3C, most vendors claiming Web Services support in their products use the WSDL 1.1 specification. SOA is the basis for advanced capabilities in Web Services, such as the WS-Trust and Federated Identity Management specifications. Indeed the support we have today for Web Services standards from major software vendors has lead to widespread implementation of SOA using Web Services.

Web Services, such as WSDL, document a set of application services. They describe the names and types of data to be passed as inputs to request a particular service (for example, a "check inventory" function may require a part number) and the details of the response from the service (e.g., may return an integer representing number of units in stock).

On the geospatial front, OGC has constructed a suite of basic interface services for mapping, features, coverages, catalogs, location services, sensors, portrayal and encodings for XML. The market has responded with 227 products that implement one or more specifications. Many of these standards are adopted or in the pipeline to be adopted as international standards by ISO. We also have begun developing suites of application schema according to user requirement so that vendors may tailor their products to the precise needs of particular value chains. Much of the work of OGC's OWS2 testbed involved testing these standards within UDDI, WSDL and SOAP based messaging environments.

What is common across all web service developments is that functions appear to be the same whether the function is implemented in Java, C++, COBOL, etc, so the requester of the service does not need to know which language was used, and the request can be written in any required language. This allows services from one platform to be integrated in an application written for another platform. The key point here is that the request and response messages understand each other (e.g., using SOAP messaging where messages are coded in XML).

The Reference Model – Open Distributed Processing (RM-ODP), ISO-IEC 10746 is a repeatable process methodology upon which one architects an information system, such as an SOA for Cadastre. It provides a way to structure ideas that need to be considered for architecting, to guide engineering and ultimately construction of an information system. Other process methodologies include the Rational Unified Process (RUP) from IBM, MDA, and The Open Group Architecture Framework (TOGAF). Architecting an SOA can be accomplished using any one or combination of these process methodologies. What distinguishes RM-ODP is that it is the only process that possesses an ISO standard and that captures the relationships between service and content to a level of detail that enables an engineer to code them in product.

The primary benefit of Web Services is interoperability, which is the ability to use the functions between any kinds of platform, regardless of programming language, operating system, computer type, etc.

In the "check inventory" example above, the function may have been written as a service that was required for one application, for example one that monitors inventory and automatically reorders when required, but we could find later that the same service can be used without modifications to support a Web-based inventory monitoring tool used by a human clerk.

Internally, the reuse of application functions is a key benefit, because it leads to reduced development costs. A long-term implication of reuse of services is the reduction of redundant functions in the enterprise, a simplification of the infrastructure, and thus a lower cost of maintaining code. By organising applications as users of services, we stand to get a much more flexible and agile model of integration, allowing us to quickly revise the business process model, compared to traditional programming techniques.

Externally, SOA's enable a well-defined "contract" for interacting with a service to exist, and this leads to a "loosely-coupled" style of interaction between business partners that provides the required stability of integration, and a solution to the problem of changes to underlying software. While the message format stays the same, the software that supports it can change as much as required, so long as it still supports the message contract. The system could even be completely replaced with an implementation in another programming language, so long as it supports the same message format, the requester application would not require changes. When message contracts evolve and must change, it is easier to support multiple versions of application requests as a transitional strategy using versioning, compared to the rather difficult task of supporting multiple versions of program APIs and file formats.

The OpenGIS Reference Model (ORM) (http://www.opengeospatial.org/specs/?page=orm) is based on RM-ODP and provides a context for understanding how our specifications and other activities fit in the broader world of standards, product development and use. The ORM provides different views into the OGC architecture so that others can use it to guide the creation of their own systems. Organisations, be they government, private surveyors vendors, suppliers or integrators will need to track the Cadastre architecture from their own interdependent perspective – for policy development, business modeling, requirements analysis, product evaluations and product development. So, our message to the Cadastre community is that without a consistent process (such as RM-ODP) applied to the very important work, that starts with the Cadastre Domain Model, there can be little probability the market can interpret, understand and integrate this work into their respective business models and product development plans that can be delivered back to end user organisations.

Since 1999, OGC test beds and pilots have used RM-ODP processes. We have maintained this regime for developing OpenGIS specifications (service interfaces, encodings and application schema) as well as the high level architecture defined in the ORM. OGCE and others will be applying the RM-ODP process in two upcoming FP6 engagements -- RISE and MOTIIVE. These projects will develop application schema associated with the Water Framework Directive under the umbrella of GMES and INSPIRE. Consideration for using RM-ODP process is being analyzed for use in the Orchestra Integrated Project whose focus is establishing European service architecture for Risk Management. The general ICT market and the geospatial market are familiar with this regimen. In architecting cadastre information systems, we recommend a similar discipline apply.

3. USE CASE MODEL AND NEXT STEPS FOR THE CADASTRE COMMUNITY

The Model is the beginning point from which the Cadastre community can engage wider areas of necessary activity – particularly the technical architecture side. Not only do technical (semantics, distribution, engineering) aspects of the problem need to be addressed, but also a wider perspective dealing with the business rationale for migration. From this context, OGC suggests the community consider several overarching objectives for itself:

- To describe the current baseline business environment within the Cadastre/Land Tenure value chain
- To model the way information processes operate today
- To develop a target Cadastre/Land Tenure business architecture, describing the product and/or service strategy, and the organisational, functional, process, information, and geographic aspects of the business environment, and based on the business principles, business goals, and strategic drivers.
- To analyze the gaps between the baseline and target business architecture
- To use RM-ODP architecture viewpoints that show how stakeholder concerns would be addressed in the technical architecture.

Complex architectures that are extremely hard to manage, demonstrate this fact not only in terms of the architecture development process itself, but also in terms of getting buy-in from large numbers of stakeholders. What is required is a disciplined approach to identifying common architectural components, and management of the commonalties between them to decide how to integrate, what to integrate, etc.

Knowledge of the business architecture is a prerequisite for information systems architecture work (data, applications, technology), and is therefore an element of architecture activity that needs to be undertaken, if not provided for already in other organisational processes (enterprise planning, strategic business planning, business process re-engineering, etc.).

In practical terms, the business architecture is also often necessary as a means of demonstrating the business value of subsequent technical architecture work to key stakeholders, and the Return on Investment (RoI) to those stakeholders from supporting and participating in the subsequent work. Use of business modeling techniques illuminates the key business requirements and indicates the implied technical requirements for the IT architecture.

In undertaking business architecture activities, a key objective is to reuse existing material as much as possible. Where existing architectural descriptions exist, these can be used as a starting point, and verified and updated if necessary to bridge between high-level business drivers, business strategy and goals on the one hand, and the specific business requirements that are relevant to a Cadastre/Land Tenure architecture development effort. (The business strategy typically defines what to achieve - the goals and drivers, and the metrics for success - but not how to get there. That is the role of the business architecture.)

The extent of the work in this phase will depend largely on the enterprise environment and in Europe's case many key elements of the Cadastre/Land Tenure business architecture have been accomplished, or at least started, in the INSPIRE Initiative and the FIG and COST activities that led to formulation of the Model. Expression of these findings and results in terms that management will appreciate is most critical.

Aside from Activity Models, Use Case and Class modeling efforts accomplished by FIG and COST, other modeling tools and techniques may be considered, if deemed appropriate. For example:

- A **Node Connectivity Diagram** describes the business locations (nodes), the "needlines" between them, and the characteristics of the information exchanged. Node connectivity can be described at three levels: conceptual, logical, and physical. Each needline indicates the need for some kind of information transfer between the two connected nodes. A node can represent a role (e.g., a property examiner); an organisational unit (a planning authority); a business location or facility, and so on. An arrow indicating the direction of information flow is annotated to describe the characteristics of the data or information – for example, its content; media; security or classification level; timeliness; and requirements for information system interoperability.
- Using an **Information Exchange Matrix** documents the Information Exchange Requirements for Enterprise Architecture. Information Exchange Requirements express the relationships across three basic entities (activities, business nodes and their elements, and information flow), and focus on characteristics of the information exchange, such as performance and security. They identify who exchanges what information with whom, why the information is necessary, and in what manner.

These models are finding increasing use in throughout of governments globally, and their use in multi-organisational settings like the Cadastre community is well justified.

4. META-ARCHITECTURE CONSIDERATIONS AND NEXT STEPS FOR THE CADASTRE COMMUNITY

RM-ODP provides a standards-based, repeatable set of procedures to undertake technical architecture design work. Use of a disciplined set of activities that support technical architecture development method and consider the broader aspects of business, enterprise and meta architecture issues is thought worthy. The major benefit of this approach is the establishment of companion business architecture elements that compliment the heavily technical focus of RM-ODP.

The Cadastre is a meta architectural object in that it defines the needs of the community, but will never actually be built itself. It will be used to guide the creation of multiple, interoperable systems at the national and sub-national level. Cadastre taken as a unitary element of information is a collective of many enterprises that will need to be disentangled (to find and expose the inter-links among and between communication, processing and information, the areas where collaboration, information sharing, information exchange and services cross). Once disentangled at the meta level systems can then be designed to enable this collaboration and information exchange and sharing.

The market response to this kind of challenge is the trend for architecture developments to explore forms of "federated architectures" - independently developed, maintained and managed architectures that are subsequently integrated within a meta architectural framework. Such a framework specifies the principles for interoperability, migration, and conformance. This allows specific business units to have architectures developed and governed as stand-alone architecture projects.

The US government has undertaken and published leading work in the field of federated architectures, emphasising the need for integrated repositories and metamodels to aid integration and ensure interoperability. This work is very much at the leading edge of the state of the art, however, and what works in practice is still very much a matter of debate. There are two basic approaches to federated architecture development:

- The overall enterprise is divided up "vertically", into enterprise "segments", each representing an independent business sector within the overall enterprise, and each having its own enterprise architecture with potentially all four architecture domains (business, data, applications, infrastructure). These separate, multi-domain architectures can be developed with a view to subsequent integration, but they can also be implemented in their own right, possibly with interim target environments defined, and therefore represent value to the enterprise in their own right.

- The overall enterprise architecture is divided up "horizontally", into architectural "super-domains", in which each architecture domain (business, data, applications, infrastructure) covering the full extent of the overall enterprise is developed as a major project independently of the others, possible by different personnel. For example, an architecture for the complete overall enterprise would form one independent architecture project, and the other domains would be developed and approved in separate projects, with a view to subsequent integration.

Current experience seems to indicate that, in order to cope with the increasingly broad focus and ubiquity of architectures, it is often necessary to have a number of different architectures existing across an enterprise, focused on particular time frames, business functions, business requirements. In such cases, the paramount need is to manage and exploit the 'federations' of architecture.

A well-regarded starting point is to adopt a publish-and-subscribe model that allows any resulting architecture to be brought under a governance framework. In such a model, architecture developers and architecture consumers in projects (the supply and demand sides of architecture work) sign up to a mutually beneficial framework of governance that ensures that:

1. Architectural material is of good quality, up to date, fit for purpose, and published (e.g., reviewed and agreed to be made public).

2. Usage of architecture material can be monitored, and compliance with standards, models, and principles can be exhibited, via a compliance assessment process that describes what the user is subscribing to, and assesses their level of compliance; and a dispensation process that may grant dispensations from adherence to architecture standards and guidelines in specific cases (usually with a strong business imperative).

Publish and subscribe techniques like these cited above are beginning to being developed as part of general IT governance and accountability.

5. THE SIGNIFICANT GEOSPATIAL OPEN STANDARDS FOR CADASTRE: GML, LandXML, LandGML AND THE OpenGIS® CATALOG SERVICES SPECIFICATION

As was mentioned above, OGC has constructed a suite of basic interface services for mapping, features, coverages, catalogs, location services, sensors, portrayal and encodings for XML. In framing a program of work for Cadastre services and application schema, the following standards and results of OGC projects might serve as a basis for work:

- The OpenGIS® **Geography Markup Language (GML)**[2] 3.1 is the dominant XML schema for geospatial data, developed by the members of the Open Geospatial Consortium (OGC). The UK Ordnance Survey, the US Census Bureau (in its TIGER data) and other agencies have committed to GML. XML-encoded geospatial metadata are a keystone element of the OGC Web Services architecture that makes possible detailed, complex, automated searches for spatial data and spatial services on the Web. The information model contained within the metadata schema is encoded in GML. Because GML separates content from presentation, the way in which data is presented (on desktop systems and PDAs, for example) is entirely under program control and can thus be tailored on the fly to suit user requirement with a given display device capabilities. Very importantly, one of the major breakthroughs with GML is that, when used with XML tools, GML makes it possible to resolve many of the difficulties associated with incompatible data formats. GML is an integral part of the OGC's system of standards. For example, an information system for cadastre operations or other spatial application that implements an interface that complies with the OpenGIS Simple Features Specification, will, when issued a "GetInformation" request for a data set, return an "application schema" for that data, that is, the

[2] The **eXtensible Markup Language (XML)**, an encoding system for structured ASCII text is the lingua Franca used in the World Wide Web environment. XML can be described as a language for creating self-describing data files, that is, data files whose headers explain how to interpret the data that comes after the header. This has turned out to be a very powerful concept. Scores of industries and professional domains have seized on the opportunity to develop "XML schemas" (schemas are essentially formats) to capture the specific kinds of information that need to be shared within those industries and domains by organizations whose legacy systems are very different from each other's. Virtually all Web browsers now include software to process text encoded in XML. In the geospatial industry, the Web provides justification for something like a universal open format and GML is the resulting encoding.

information model for that data, encoded in GML. Requests for actual data cause the server to return the data in GML.

- **LandXML** is an industry-driven, open XML data exchange standard that provides interoperability in more than 40 software applications serving the civil engineering, survey and transportation industries. The LandXML.org Industry Consortium, initiated by Autodesk and now comprised of 190 companies, government agencies and universities, developed the standard.

- **LandGML** is a GML application schema, convertible to and from LandXML, which enables LandXML-encoded data to be used with applications, services and portals that comply with OpenGIS Specifications.

5.1 LandGML <> LandXML

In the summer of 2004, the OGC ran a LandGML Interoperability Experiment to test methods and tools for converting between LandXML and LandGML. The US Army Corps of Engineers, Engineer Research and Development Center (ERDC), Autodesk and Galdos Systems initiated the Interoperability Experiment. Participating organisations were invited to submit samples of their data for conversion. The goal was to bridge the gap between Civil Engineering data and geospatial data using LandXML and GML interoperability tools. Participants developed methods to automate the flow of civil engineering and land survey data directly into geospatial applications and back again using XML-based open standards. The Interoperability Experiment successfully produced two automated transformation tools to ease application development and direct end user use. Phase 1 created a LandGML schema and provided a LandXML to LandGML transform tool. Phase 2 created a LandGML to LandXML transform tool. These tools and commercial products based on them will enable land development, transportation and geospatial professionals to exchange high precision design data throughout the entire lifecycle of a project.

5.2 Bridging Diverse Metadata Schemas and Data Models

Efforts are underway in many countries to develop standard geospatial metadata schemas and standard information models. Achieving thoroughly consistent information models is not possible, but standard models will have an important role as “Rosetta stones” that enable each user to map their data to a common model. That is, software will be able to go from one local model to the national model and thence to the user’s own local model that is different from the first. One-to-one mapping of data models is unworkable when there are thousands of models to map between. But GML enables a one-to-many solution.

One-to-many mapping of data models is made possible by XML tools (prototyped in OGC's OWS2, GOS-TP and CIPI-2 pilot projects) that map GML-encoded data from a local model to the national model and vice versa. The data thus becomes “as useful as possible” to the data sharing partner who uses a different model. Typically, certain elements of one model do not map to the other, but the XML tools make these inconsistencies plain in all their details, so that it is easy for data managers to focus on the critical schema elements that don’t map.

This makes both data sharing and data coordination much easier. It makes it easier for people at the local level to accommodate national standards in an affordable and practical way, and it makes it easier for people at the national level to work with local data that does not conform in all its details to the national standard.

Another benefit of the GML approach is that this technology makes information models easier for software vendors, integrators and data providers to support. Currently, content standards are expensive to support, and companies and governments that do not support them are at a disadvantage. The combined investment in existing data, sometimes called legacy data, is too large to be ignored and this approach enables easier use and exploitation at the same time that new data models are being implemented. The new approach thus enhances competition, increasing the choices available to users in the market.

5.3 Publishing and Discovery of Land Data

XML, GML and another OGC standard, the OpenGIS Catalog Services Specification, formally adopted by OGC members in August, 2004, enable Web-based publishing and discovery of geospatial data, geospatial Web services (on-line processing components), and schemas (such as information models in metadata that are encoded in XML). The Catalog Services specification provides the foundation for "spatial search engines" – catalogues – in which thousands of online geospatial resources will be registered. The specification documents industry consensus on an open, standard interface that enables diverse but conformant applications to perform discovery, browse and query operations against distributed and potentially heterogeneous catalog servers.

Because different Spatial Data Infrastructure (SDI) initiatives support different metadata schemas, a main advantage of the Catalog Services v2.0 specification is the support it provides for "application profiles" based on ISO 19106 (Geographic information – Profiles). Such application profiles are metadata schemas (and their included information model schemas) that conform to the ISO 19115/ISO 19119 metadata standard, but that are configured for a particular "information community" of people who share a common geospatial information model.

As organisations transition themselves to distributed services architectures, the revised Catalog Specification, in combination with application schema work, provides the Cadastre community with a window of opportunity to implement web services without having to dismantle its legacy.

6. CONCLUSION

The union of FIG and OGC to address web delivery of cadastral information is an ideal combination: OGC benefits from working with a highly precise and complex need that has been defined by a well coordinated community (FIG), and FIG benefits by leveraging the state of the art standards that OGC has already created. It is anticipated that both the Model and the OGC specifications will be improved by this coordination.

The OGC has always concentrated on its piece of the overall software world – software interfaces. We rely on dejure, (legal) bodies such as the International Standards Organization and expert community groups such as FIG to determine the user requirements for services and data content, and then use these requirements as the 'use cases' for which we engineer software interfaces. The Cadastre Model is especially important to us because it represents a very well defined, highly precise and demanding set of requirements. OGC looks forward to working with FIG and others to realise common and mutual objectives for connecting information processes and content within the Cadastre community.

BIOGRAPHICAL NOTES

Louis Hecht is chairman of the Open Geospatial Constortium (Europe) Limited. The OGC (http://www.opengeospatial.org) is an international industry consortium of more than 250 companies, government agencies and universities participating in a consensus process to develop publicly available interface specifications. OpenGIS® Specifications support interoperable solutions that "geo-enable" the Web, wireless and location-based services, and mainstream IT. The specifications empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications.

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