CANADIAN GEOSPATIAL STANDARDS IN ACTION

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ABSTRACT:

The Canadian Geospatial Standards in Action is an initiative that impels the progression of geographic information technology by showcasing Canadian standards-based products as part of an integrated geospatial architecture. This initiative reflects the strategy taken by both the International Organization for Standardization, Technical Committee 211 on Geographic Information and Geomatics (ISO/TC 211), and by Open GIS Consortium (OGC). ISO/TC 211 provides a suite of abstract standards specifications that defines framework, geospatial data models, data administration, and services, while OGC delivers spatial interface specifications that are openly available for global use and that can be implemented in products. Geospatial Standards provide connectivity amongst the user interfaces, data servers and storage warehouses in the three-tiered geospatial architecture by defining a minimum set of practices, protocols, and specifications. This allows for increased and timely access to a vast quantity of geospatial data in a usable format.

The Canadian Geospatial Standards Architecture as defined in this paper is broken into three component tiers that provide maximum portability across computer operating systems. The client tier displays information and processes graphics, communication, keyboard input, and local applications. The applications service tier encompasses a set of shareable, multi-tasking components that interact with clients, peer services, and the other data source tiers. The data source tier has the data and metadata configurations and environments.

Canadian industry is building standards-based products and system components in support of the Canadian national requirements and also to address North American and international requirements. Once Canadian products encompass the standards implementations specifications from ISO/TC 211 and OGC, they can provide their expertise worldwide in addition to gaining access to other technologies. Open exchange of geographic information improves collaboration in the geospatial data industry, ultimately giving Canadians a competitive edge.

1. INTRODUCTION

Standardization work in the field of digital geographic information aims to establish a structured set of standards for information concerning objects or phenomena that are directly or indirectly associated with a location relative to the Earth. These standards may specify, for geographic information, methods, tools and services for data management (including definition and description), acquiring, processing, analyzing, accessing, presenting and transferring such data in digital/electronic form among different users, systems and locations. The work links to appropriate standards for information technology and data where possible, and provides a framework for the development of sector-specific applications using geographic data.

Through an iterative process and by building on previous standardization work, it is possible to develop new standards that guide (prescribe) new technology but support existing systems and data. The iterative process of standards development builds upon existing standards and refines them to develop new, broader standards.

International Standards in Geographic Information and Geomatics have been developed under the umbrella of the International Organization for Standardization Technical Committee 211 on Geographic Information and Geomatics (ISO/TC 211). ISO/TC 211 provides a suite of standards that defines framework, geospatial data models, data administration, and services.

The purpose of ISO/TC 211 is to develop mature concepts for GIS components. The "first generation" GIS standards being created within ISO/TC 211 are, for the most part, written at an "abstract specification" level. It is the goal of an ISO/TC 211 standard to communicate the objects, relationships, behaviors, and attributes associated with the particular component at hand. OGC's (Open GIS Consortium) mission is to deliver spatial interface specifications that are openly available for global use and that can be implemented in products. OGC manages both Abstract Specifications and a growing suite of Implementation Specifications.

2. GEOSPATIAL STANDARDS

2.1 Standards Program of Work

Scientists in Canada are conducting research in developing Geomatics Standards through the Canadian General Standard Board Committee on Geomatics (CGSB CoG), Canadian Advisory Committee to ISO/TC 211 (CAC to ISO/TC 211), and the International Organization for Standardization Technical Committee on Geographic Information and Geomatics (ISO/TC211).

Table 1 stresses the ISO/TC 211 work program as updated of March 2002. New working groups have been added to include new projects such as sensor and data models for

imagery, location based services and registry of geographic information items.

Table 1. ISO/TC 211 Work Program – March 2002

ISO Standard Number and Title	Most recent document available on the TC 211 Web Site	Availability of DIS
WG 1 – Framework and Reference Model		
19101 Reference model	DIS 19101	2000-10
19102 Overview	Deleted	Deleted
19103 Conceptual schema language	211N1082	TS 2001-12
19104 Terminology	211N1130	2001-12
19105 Conformance and testing	ISO 19105: 2000	1999-08
19121 Imagery and gridded data	ISO/TR 19121:2000	TR 2000-10
19124 Imagery and gridded data components	211N1017	Review Summary 2001-01
WG 2 – Geospatial Data Models and Operators		
19107 Spatial schema	DIS 19107	2001-06
19108 Temporal Schema	DIS 19108	2000-11
19109 Rules for application schema	DIS 19109	2002-01
19123 Schema for coverage geometry and functions	211N1227	2002-08
WG 3 – Geospatial Data Administration		
19110 Feature cataloguing methodology	DIS 19110	2001-07
19111 Spatial referencing by coordinates	DIS 19111	2000-12
19112 Spatial referencing by geographic identifiers	DIS 19112	2001-10
19113 Quality principles	DIS 19113	2001-02
19114 Quality evaluation procedures	DIS 19114	2001-08
19115 Metadata	DIS 19115	2001-09
WG 4 – Geospatial Services		
19116 Positioning services	211N1132	2002-02
19117 Portrayal	211N1114 Proposed text for DIS	2001-11
19118 Encoding	211N1136 Proposed text for DIS	2002-02
19119 Services	DIS 19119	2001-11
19125-1 Simple feature access - Part 1 Common architecture	DIS 19125-1	2000-11
19125-2 Simple feature access - Part 2 SQL option	DIS 19125-2	2000-11
19125-3 Simple feature access – Part 3 COM/OLE option	211N940/ 997	2001-
19128 Web map server interface	211N939/ 996	2002-06

ISO Standard Number and Title	Most recent document available on the TC 211 Web Site	Availability of DIS
WG 5 – Profiles and Functional Standards		
19106 Profiles	211N1134 Proposed text for DIS	2001-12
19120 Functional standards	ISO/TR 19120:2001	TR 2001-07
WG 6 – Imagery		
19129 Imagery, gridded and coverage data framework	211N1176	TS 2003-07
19130 Sensor and data model for imagery and gridded data	211N1167	2003-09
WG 7 – Information Communities		
19120/A1 Functional standards – technical amendment	211N835/ 888	TR 2002-04
19122 Qualifications and certification of personnel	211N573	TR 2003-02
19126 Profile – FACC data Dictionary	211N834/ 887	2002-12
WG 8 – Location based services		
19132 Location based services possible standards	211N1088/ 1139	RS 2002-01
19133 Location based services tracking and navigation	211N1089/ 1140	2002-05
19134 Multimodal location based services for routing and navigation	211N1117/ 1174	2003-05
WG 9 – Information Management		
19127 Geodetic codes and parameters	211N1161	TS 2002-11
19131 Data product specifications	211N1087/ 1138	2003-09
19135 Procedures for registration of geographical information items	211N1122/ 1175	2002-12

2.2 Standards in Action Demonstration

ISO/TC 211 resolved in several resolutions (e.g. Resolution 160) to arrange a workshop on standards implementation experiences. The first workshop was held on Wednesday, March 7th, 2001, prior to the plenary in Lisbon. ISO/TC 211 invited the national bodies of Australia, Belgium, Canada, Germany, Russia, Switzerland, USA, and other member bodies to prepare presentations and to assess the applicability of standards testbeds at the workshop in Lisbon.

The National Body for Canada, lead by the Canada Centre for Remote Sensing of Natural Resources Canada, has created a demonstration site to showcase the components of a standards-based distributed spatial architecture. The components are based on and related to the ISO/TC 211 19100 suite of standards.

The Standards In Action (SIA) demo comprises several implementations as follows: Distributed navigation, data access, viewing, and downloading as an implementation of Simple Feature Access (ISO 9125-1 & 19125-2), Metadata (ISO 19115), and Spatial Referencing by Coordinates (ISO 19111); Geospatial Standards-based data products, related to ISO 19107 (Spatial Schema), ISO 19110 (Feature Cataloging Methodology), and ISO 19111 (Spatial Reference by Coordinates); Multilingual support for meta-content as per ISO 19115 (Metadata); Open Geospatial Data Store Interface (OGDI), related to ISO19119 (Services); Geographic Markup Language (GML), related to the ISO 19118 (Encoding); Electronic Nautical Charts (ENC), related to the ISO 19117 (Portrayal); Self-Defining Structure (SDS) and Helical Hyperspatial Codes (HH Codes) as a type of coverage function related to the ISO 19123 (Schema for Coverage Geometry and Functions), 19124 (Imagery and Gridded Data Components), and ISO 19129 (Imagery, Gridded and Coverage Data Framework).

The demonstration provides a concrete example of integration of standards-based products that results in access to a wide array of information sources and services over the Internet. This demonstration has been given in several venues in different countries and has generated significant interest in those products demonstrated. It is an example of a success story for government, private sector and consortia such as 3i, working together to create and demonstrate Canada's ability to deliver state-of-the-art solutions.

2.3 Standards Architecture

Geospatial Standards provide connectivity between the user interfaces, data servers and storage warehouses in the three-tiered geospatial architecture by defining a minimum set of practices, protocols, and specifications. The Canadian geospatial standards architecture is broken into the following component tiers:

- Client Tier: the client component displays information and processes graphics, communications, keyboard input, and local applications. These interfaces provide maximum portability across computer operating systems;
- Applications Services Tier: a set of shareable, multi-tasking components that interact with clients, peer services, and the data source tier;
- Data Source Tier: the data and metadata configurations and environments.

This architecture stresses the components of the overall storage and query architecture with the Oracle/CubeSTOR cartridges as a distributed database environment. The application server tier components include the Feature Manipulation Engine (FME), the Open Geospatial Datastore Interface (OGDI) server, the CubeServ server, ArcIMS server, and Map Manager Server, with associated Application Programming Interfaces (APIs).

Clients link to CubeServ/ArcIMS/Map Manager Server and other OGC compliant Web Map servers through the APIs using five different protocols and mechanisms:

Geographic Library Transfer Protocol (GLTP) for the OGDI; Hypertext Transfer Protocol (HTTP) for the Open GIS Consortium (OGC) Get Protocols; Tomcat Java server to interpret calls from the Unified Service Interface (USI) and the ArcView-USI extension; Sequel Query Language (SQL)/Open Database Connectivity (ODBC) to interpret queries from Helical Hyperspatial Viewer; and Parsed html to interpret calls from Service Manager, ArcIMS, Percipio, and MetaMiner.

Clients also use metadata tools to populate and update databases and Z39.50 server protocol to connect to different FGDC clearinghouse. Clearinghouses could be created and managed using MetaMiner from Compusult. Several Canadian companies have developed tools for managing metadata. Some allow documentation of data and others provide user access to the data, using protocols such as ANSI Z39.50. As a component system, these products catalogue/organize, locate, and showcase data. At the data source tier, data warehouses receive, archive, catalogue, maintain and disseminate data holdings. Metadata search tools harvest from the data sources tier, providing data connectivity to relational database management systems using Z39.50 protocol. The search tools provide search specification fields, as well as result processing. Once data is collected and documented using metadata tools, it can be displayed, linked, distributed and published on the client tier. Currently, Canadian products support the US FGDC metadata standard and the Canadian 171/3 metadata standard, but they are being adapted to support the full ISO 19115 metadata standard and the joint Canada/US implementation specification.

The overall architecture is related and implements OGC implementation specifications and the ISO/TC 211 suite of standards, namely: ISO 19110 Geographic Information - Feature cataloguing methodology; ISO 19111 Geographic Information - Spatial referencing by coordinates; ISO 19115 Geographic Information – Metadata; ISO 19117 Geographic Information – Portrayal; ISO 19118 Geographic Information – Encoding; ISO 19119 Geographic Information – Services; ISO 19123 Geographic Information - Schema for coverage geometry and functions; ISO 19125-1 Geographic Information - Simple feature access, common architecture; ISO 19125-2 Geographic Information - Simple feature access, SQL option; and ISO 19128 Geographic Information - Web map server Interface.

Standardized products for Web-mapping and imagery, gridded and coverage data are being developed, and are embedded within the geospatial standards architecture. Web based services provide access to geographic information by way of interpretable infostructures. Canadian products support web-mapping services, including grid coverage and simple feature access within a database schema that handle multi-dimensional datasets. Map servers provide user access to spatial warehouses, while allowing OGC compliant servers to cascade and access images and additional data from other OGC compliant map servers.

2.4 Imagery

The area of Imagery and Gridded Data (I&GD) is one of the most challenging within ISO/TC 211. While most data is organized in simple grids, there are many different traversal methods for grids and structures that support the distribution of attributes over an area. In addition, the data represents the sensors from which it was collected or, in the case of synthetic data, the source from which it was generated. Sensor models and associated georeferencing are an important aspect of Imagery, Gridded and Coverage Data (IGCD) geographic information.

The standards and industrial specifications for Imagery, Gridded and Coverage Data (IGCD) vary in a different way. Almost all have different encoding mechanisms that may be needed for various exchange media or storage mechanisms. However, in general, one encoding mechanism can be converted to another. The more fundamental differences occur at the "Content Model" level. But a well-defined number of content structures, together with as much common metadata as possible, will result in a degree of alignment between the different standards.

It is not possible to endorse one standard or industrial specification, or to come up with a new and more comprehensive standard because of the very large volumes of data that exist in the various formats already in use. Nor is the solution to build a very flexible all-encompassing standard with a broad array of options; data sets can use incompatible subsets of the same overall standard.

The direction must enhance compatibility while at the same time retain compatibility with the widely used existing industrial standards. This is very complicated and can only be partially achieved. However, it is easier to build converters between a small numbers of recognized choices than between an open-ended spectrum of incompatibilities.

The Imagery architecture in Canada aims to harmonize the structure and the way Canadian companies such as PCI Geomatics, CARIS, Helical Systems, and CubeWerx have been handling imagery and gridded data. The architecture

encompasses either direct access to imagery data sets using standards of the shelf applications like Geomatica Focus or HH Viewer, or Web mapping services with OGC compliant clients and Java Viewers. The mid-architecture also includes Web servers such as CubeServ, Spatial Fusion or Spans servers. The Data itself are stored in either a RDBMS systems that include Cartridges (i.e. CubeStor Spatial, Oracle Spatial Fusion, Oracle GeoImage) or Flat files with an encapsulation schema that handles multiple attributions for the same geometry. This encapsulation schema also embraces what is known as Helical Data Fusion", which corresponds to the association of several attributions sharing the same geometry. In fact, there are several distinct types of data fusion, for example, the data corresponds to different attributes associated with the same geometry, within one architecture or file. In others, the data consists effectively of repeated measurements of different types of attributes that are assembled together using overlay techniques, which were formerly known as data" compilation or data assimilation. Such manipulations are mostly seen in Geographic Information Systems (GIS) available on the market.

The data is also stored in two manners: As a relational tables' record as a "BLOB" (e.g. GeoTIFF in an ORD Image class) or a Grid Value Cell (set of records in CubeStor or Spatial Fusion). As a set of record (Grid Value Cell "Grid", Point Value Pair "TIN") in a Flat file (Self Defining Structure Architecture).

2.5 Strategy for Standardization

There are four levels in standards and standardization that could be identified:

Level 1 deals with “Abstract” standards, meaning that a set or suite of standards, ISO/TC 211 per se includes models (e.g. UML diagrams) that describe pieces of information and how they are related to each other (see for example the Reference Model, ISO 19101). These are high level standards where an organization such as Natural Resources Canada should be involved by attending and participating in building those standards.

Level 2 deals with “National or Regional” standards, meaning that National bodies (e.g. Canada and the US) should develop their own standards based on ISO/TC 211 and other standards. National or regional standards are in fact profiles, or subsets of International Standards like ISO/TC 211 suite. National Bodies should then adopt/adapt and implement these standards. One of these standards is ISO 19105 metadata, which defines metadata elements, provides a schema, and establishes a common set of metadata terminology, definitions, and extension procedures. This standard is being implemented within infrastructure components such as CGDI and the FGDC clearinghouse. ISO/TC 211 urges countries and organizations to implement and test the standards and to report the results to ISO/TC 211 so that the ISO/TC 211 standards can be refined.

Level 3 deals with “Specific” standards, meaning that an organization such as Canada Centre for Remote Sensing of Natural Resources Canada should be involved in building a specific ISO work item as Imagery, Gridded and Coverage Data Framework (ISO 19129) and Sensor and Data Models for Imagery and Gridded Data (ISO 19130). Those upcoming standards handle remote sensing imagery, and other requirements such as metadata and quality elements for gridded data (e.g. ortho-rectified imagery, and the Digital Elevation Models). This is a specific requirement for handling (archive, document, index and diffuse) large data sets such as remote sensing imageries.

Level 4 deals with “Business and Marketing”, meaning to develop a business and marketing plan for standard-based technology, and encourage members to market all Draft International Standards as soon as they are available. When implemented by a data producer, these International Standards will:

1. Provide data producers with appropriate information to characterize their geographic data properly;
2. Facilitate the organization and management of metadata for geographic data (vector and Grid);
3. Enable users to apply geographic data in the most efficient way by knowing its basic characteristics;
4. Facilitate data discovery, retrieval, and reuse. Users will be better able to locate, access, evaluate, purchase, and utilize geographic data; and
5. Enable users to determine whether geographic data in a holding will be of use to them.

2.6 Ongoing Research And Applications

Canada is a leading nation in both geospatial science and technology development. As Canada moves further into the knowledge-based economy, many organizations will require better access to geospatial data for decision-making. Geospatial information in the framework of ISO/TC 211 leads to greater productivity because it is used for a range of purposes, including analyzing markets, deciding where to locate new plants and offices and improving transportation systems. Canadian companies continue their commitment to standards development through the Open GIS Consortium (OGC). Most of the OGC’s work is aligned with ISO/TC 211. The standards specifications will make the key issue of interoperability much easier for businesses, citizens, and governments to find, view, pan, zoom, overlay, and query geographical images and maps on the Worldwide Web. The standard specifications passed by the members of the OGC will allow maps and map queries to become a significant component of the Web.

There is a need for standardized technologies both at the content and the encoding levels, while allowing functionality between existing products. A standards-based architecture can provide end users with a direct, mandated link to geomatics and remote sensing technologies and data sets. This can provide decision-makers with a vital tool for effectively addressing issues such as local emergencies.

2.7 Conclusions

Canadian industry is building standards-based products and system components in support of the Canadian national requirements and also to address North American and international needs. Many of the products address the storage, access and display of geographic information, and Canadian companies have been active participants in the OGC test bed projects, through the Information Interoperability Institute (3i), a Canadian technology consortium. Once Canadian products encompass the standards implementations specifications from ISO/TC 211

and OGC, they can provide their expertise worldwide in addition to gaining access to other technologies. Open exchange of geographic information improves collaboration in the geospatial data industry, ultimately giving Canadians a competitive edge.

3. SELECTED BIBLIOGRAPHY

3.1 References from Websites

http://www.ccrs.nrcan.gc.ca/ccrs/data/standards/welcom_e.html

http://www.isotc211.org

4. ACKNOWLEGMENTS

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5. TRANSMITTAL AND FURTHER INFORMATION

5.1 Further Information on the Standards in Action initiative

If you have questions about the standards in action initiative, please contact us at Fadaie@nrcan.gc.ca