AN OVERVIEW OF THE DESIGN AND ANTICIPATED USE OF THE NORTH AMERICAN PROFILE FOR SPATIAL METADATA

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ABSTRACT

Since the year 2005 a dedicated group of spatial data standards scientists from Canada and the United States have been working to develop a Profile of the ISO 19115: 2003 Spatial Metadata standard for use in North America. It is intended to be the formal specification for the structure and organization of spatial metadata on the North American Continent. This project is being conducted under the auspices of the Canadian General Standards Board Committee on Geomatics, and the USA International Committee for Information Technology Standards (INCITS) L1 - Geographic Information Systems.

The design and development of the North American Profile (NAP-Metadata) for Spatial Metadata is the next logical step forward to go beyond the respective Canadian and USA national metadata standards now in place, specifically the USA Content Standard for Digital GeoSpatial Metadata (CSDGM), and the Canadian Directory Information Describing Digital Geo-Referenced Data Sets (CAN/CGSB 171.3-95).

Throughout the world there are a number of other spatial data standards groups that are also working towards developing an analogous metadata profile for their area. Active examples are the European Community, Latin America, EIS-Africa, and perhaps others.

The examination and discussion presented here will begin with the raison d'etre for the uses of spatial metadata in the broader operational context as a component of the Spatial Data Infrastructure. The discussion will then turn to the design of the NAP-Metadata in terms of its underlying goals to make the ISO 19115 world metadata standard more specific and more widely useable in the North American context. These broad goals are:
* Linguistic Adaptability
* Locale flexibility for local languages
* Extend many code lists to be more specific
* Make more items Mandatory to achieve better interoperability.

The examination of the NAP will begin with the central UML model of the world standard, ISO (TC211) 19115:2003, and then compare it with the primary North American Profile module to see where such modifications have been made. Several other modules such as Data Content, Identification and Data Quality will also be examined in this context.

The latter part of the paper will look at a couple of example areas where the North American Profile could help spatial data analysts locate and evaluate candidate spatial data sets in a USA/Canadian setting: in common border areas between the two countries, and in the area of the Great Lakes. With this examination and discussion it becomes evident that the NAP-Metadata Profile will provide for wider use of spatial metadata in the North American context. It should also provide more and better opportunities for the effective search for spatial data sets in the Spatial Data Infrastructure in a more flexible linguistic and cultural setting in North America. The NAP-metadata also provides the possibilities for future interoperability of its metadata set assessments with the other Profiles of ISO 19115:2003 being developed in various places in the world.

Key Words: spatial metadata, North American Profile, spatial data standards, analytical cartography, geomatics, GIS, Great Lakes

INTRODUCTION

For many years many organizations and governments realized they could take advantage of a more systematic approach to spatial information that described the characteristics and qualities of their spatial datasets. This would promote more efficient management of their spatial database inventory, and also facilitate the sharing of such spatial datasets between their organizations. The solution is to develop an effective set of spatial metadata elements that describes the content and internal structure of a spatial database. Likewise, the development of a Spatial Data Infrastructure (SDI) involved the effective use of spatial metadata as "data about spatial databases". If this metadata is employed effectively, then it can foster the development and operation of an effective Spatial Data Infrastructure.
In the mid 1990s many countries and organizations began working to develop effective definitions of spatial metadata for their own spatial database holdings. In 1994 these efforts rose to the World level with the establishment of the ISO/TC211 Committee on Geographic Information/Geomatics. By 2003 their Spatial Metadata Working Group had developed what we now know as the ISO 19115 World Spatial Metadata standard.

Since that time, the various National and standards bodies have been working to harmonize their metadata standard with ISO 19115. In North America a Memorandum of Understanding was signed in 2003 between the Canadian General Standards Board (CGSB and the American National Standards Institute's InterNational Committee for Information Technology Standards (INCITS to develop national metadata profiles of world ISO 19115 Standard. These profiles in a coordinated way to be known as the North American Profile.

The work discussed here looks at the organizational and conceptual background of this effort The NAP was formally published in Canada and the USA on July 7, 2009, the exact day that this discussion is being written. These three announcements: USA, English, Canada: French & English can be found at: (ANSI, 2009), (CGSB, 2009, 2009). Since September 2005 the NAP/PNA Working Group has developed the North American Profile Included in this effort is the development of the Profile itself, national reviews of the Profile, and subsequent applications. This work reflects a determined effort to test and verify the effective application and operation of the Profile as they are intended to harmonize with ISO 19115. Also included is an effort to ascertain, define, and codify a set of "best practices" for the Profile to ensure a uniform and wide applicability of its use.

NORTH AMERICAN PROFILE FOUNDATIONS

Fundamental Metadata Functions

As the ISO 19115 Spatial Metadata standard has developed, many national organizations realized that after the world standard was approved, they would be obligated to harmonize their national or organizational spatial metadata standard with it. Many countries also realized that it would be a scientific, operational, and cooperative step forward if they could harmonize the spatial metadata standards of regions, or groups of countries, together. Hence, the European Community moved forward promptly under the leadership of Prof. Henri Aalders to develop a common European Profile for spatial metadata useful to all countries and organizations in the EC. This will greatly facilitate the wider and more practical use of spatial datasets from the various countries in Europe. Hence, Comité Européen de Normalization CEN Technical Committee 287, Geographic Information, set out to develop a European Profile of ISO 19115 that all countries in Europe can use (European Commission, 2008).

North America came to a similar realization at about the same time. In 2002 there were discussions between the USA and Canada on the possibility of developing a common profile for spatial metadata profile between the two countries. In 2003 a formal Memorandum of Understanding was signed between the Committee on Geomatics of the Canadian General Standards Board (CGSB-CoG) and the Geographic Information Committee L1 of the InterNational Committee on Information Technology Standards (INCITS-L1) of the USA to cooperate on developing common profiles of ISO spatial data standards for North America. Spatial Metadata was the first such Profile to be nominated for development. This reflects a very logical decision based on a fundamental insight because spatial metadata is the primary internal functional ingredient for the efficient operation of spatial data systems. Out of this effort the North American Profile/Profil Nord Américan (Metadata/Metadonnées) Working Group (NAP/PNA-WG) was formed in 2005, and held its first meeting in Sherbrooke, Quebec shortly before the Montreal ISO/TC211 meetings in September 2005. Since that time several WG meetings have been held in various places in North America, Profile was formally announced by Canada on July 7, 2009 as this text is being written. The following discussion presents the work to development the NAP/PNA Profile which has been formally announced today.

The Canadian Perspective

Early on Canada recognized the importance of metadata and published its first metadata standard in 1995 (CAN/CGSB 171.3-95). Since then, ISO/TC211 developed an international standard for metadata: ISO 19115: 2003 Geographic Information Metadata. Canada participated actively in this work. The Canadian contribution has been to ensure that its requirements for linguistic and cultural adaptability would be addressed in the profile, and then endorsed as a Canadian National standard. The ISO standard provides a generic description of metadata and allows for many implementation possibilities. It became obvious for Canada that a national profile had to be developed to cover Canada's specific needs. Because Canada and the United States are neighbors and share spatial data requirements as well as a long common border, the need for sharing metadata between the two countries has become very important. Accordingly, the North American Profile of metadata will be a key underpinning for interoperability of metadata between the two countries. The Profile also supports sharing metadata and the discovery of geospatial data within and between the countries at: Federal, Provincial, and local levels. For instance, the province of Ontario intends to use NAP/PNA for all geospatial data at the provincial level to encourage data use at the local government level (municipalities, school boards, non-governmental organization, conservation authorities, and so on). Also, Ontario is a formal partner of Canada's GeoConnections Program. As a consequence, the use of a common metadata profile by other Canada and Ontario with NAP/PNA will make it easier to discover and gain access to geospatial data at all levels and will effectively meet the users' needs through the GeoConnections well established Discovery Portal.

The USA Perspective

The broad national need for the effective access, use, analysis, and application of spatial data arises in many varied forms. There exists a very widely variegated spatial data producer community that consists of those involved in the collecting, encoding, processing, and distributing of spatial data. There is a much larger community of spatial data users who are very dependent on the producer community for completeness, accuracy, and fidelity of the spatial data that is employed for a host of user applications. It appears that the more immediate beneficiaries of the development of the NAP/PNA is the data producer community. Long-term benefits will flow to the user community in a timely fashion. The primary rationale for geospatial metadata lies in inventorying internal geospatial resources, the condition of the inventory, and the quality of the resource. Knowing one's resources and allowing the larger geospatial community access can result in cost savings to the data producer as well as the user community. Access to these resources can allow for effective and coordinated response to incidents such as natural and human-caused disasters, airborne illnesses, and similar instances. These events often extend beyond defined boundaries whether physical or political. The need to effectively and efficiently share and access spatial data requires documentation of the resource as well as the means or systems used to access the documentation and the resource itself. Data users and providers require a metadata standard which allows one to locate, evaluate, extract, and employ data to coordinate and effectively respond to incidents, study past resource use, plan for efficient use of resources, and other spatial applications. Access to the new North American Profile can be gained via the following FGDC data portal: http://www.fgdc.gov/nap/.

The TC211 Perspective

ISO/TC211 has developed a suite of standards for geographic information. These standards have been developed to satisfy a broad set of global requirements with a broad application.

ISO 19106 Geographic Information Profiles defines the concept of developing profiles of the ISO/TC211 suite of ISO 19100 standards. It defines a profile as a subset of a standard, or several standards, tailored for a specific information community. Basing national standards on profiles of the ISO 19100 standards series ensures that national information assets will be interoperable internationally. The NAP/PNA follows this concept. Metadata produced with the NAP/PNA, European, or other profiles will allow users around the world to locate, evaluate, extract, and employ datasets produced anywhere across the globe under the mantra "think globally, act locally". If users produce local datasets and metadata based on international standards and profiles, these data can be used to not only solve local and National problems, but can also be used to provide input toward many kinds of global research. Further insights into the work of ISO/TC211 can be gained by looking at:

ICA Perspective

For many years the International Cartographic Association has been promoting the effective use spatial data throughout the world. In 1989 the ICA Spatial Data Standards Commission was founded under the leadership of Professor Harold Moellering to participate in the development of world spatial data standards, and to write several books on spatial data standards. The Commission's most recent book is on spatial metadata standards World Spatial Metadata Standards (Moellering et. al., 2005. Many members of the ICA Standards Commission are members of ISO/TC211 and other national and international spatial data standards bodies. Five Commission members have served in leadership roles in developing spatial metadata standards: Mr. David Danko, ESRI, as the Chair of ISO/TC211 WG3 to develop the world ISO 19115: 2003 Metadata Standard, Professor Henri Aalders, Delft University, as Chair of the CEN/TC287, Geographic Data, that is developing a European Metadata Profile, and Professor Harold Moellering, Ohio State University, who is a member of the North American Metadata Profile Working Group. Dr. Tatiana Delgado is a member of the PCIDEA group that is working to develop a Latin American Metadata Profile, and Antony Cooper who is a member of the EIS-Africa group that is developing an African Metadata Profile. Other Commission members are involved in many other standards efforts elsewhere in the world. One may access the ICA Standards Commission web site at: http://ncl.sbs.ohio-state.edu/ica/.

Fundamental Metadata Principles

In its most fundamental form, spatial metadata is information about spatial data, which is usually housed with the spatial database. It is widely understood that in order to efficiently manage and use all kinds of spatial databases, sets of spatial metadata that pertain to the database in question are required. Please see Moellering, Aalders and Crane (2005) for an expanded discussion of the fundamentals for spatial metadata and concepts of use.

Now one can focus on the use of spatial metadata in its fundamental forms of Locate, Evaluate, Extract, and Employ to find and utilize specific geographic datasets as articulated by Østensen and Danko (2005).

Locate: find the location of a geographical dataset that pertains to a specific set of characteristics, e.g. topography of an area; in many cases, this locating process takes place over the Web in an SDI network environment;

Evaluate: Ascertain if the geographical data in the spatial database has the desired characteristics, e.g. accuracy, currency, etc. desired by the user;

Extract: Transfer the spatial database from its home location, usually via the Web, to a location convenient to the user of the data set;

Employ: Use the metadata to successfully process the geographical database to analyze, and perhaps solve the problem at hand.

Active use of spatial metadata is taking place on all continents of the world. To see a systematic summary of those efforts, please see Aalders, (Ed., 2005). To see metadata activities in Latin America, please see Delgado-Fernandez, Rey-Martinez, and Chaparro-Dominguez (2005).

ISO 19115 Geographic Information: The World Spatial Metadata Standard

By necessity, a world standard is very broad and general. So when the TC211 Working Group on Metadata began their work, they looked at all of the parameters in all of the 22 existing National and International metadata standards existing at that time (Østensen and Danko, 2005). The world metadata standard that emerged is something like an umbrella, consisting of almost 400 metadata items with many Conditional and Optional obligations. By necessity such a world data standards is very general. The strong point is that new all scientific and technical terms have been homologated by the TC211 Terminology group.

Usually the National and individual International, e.g. IHO, metadata standards are then harmonized to the new world standard to achieve world compatibility with the terminology and much of the operational framework.

With these activities with the spatial metadata standards, many countries and organizations have realized that there is much more to be gained by establishing Profiles on a continental basis. Hence, a European Metadata Profile has emerged, and now the North American Profile/Profil Nord Américan has been announced as a cooperative effort between the Canada and the USA.

THE NORTH AMERICAN PROFILE - METADATA

Working within spatial data communities in the respective nations, between nations, and global communities, providing an understanding of geospatial data and services is an essential part of processing spatial data within these spatial data infrastructures. One provides this understanding by collecting and providing metadata about data and services. Providing metadata using internationally standardized metadata elements allows spatial metadata to be used by a wide range of user communities.

Many metadata standards, like ISO 19115, are developed by a diverse international group to meet a wide range of requirements. ISO 19115 is designed to provide metadata elements for many purposes including: locating geospatial data and services, and then evaluating them to determine if they are fit for a user's requirements. The user may then extract the data and information from the data source, and then employ the discovered data in a wide range of applications and services.

For a specific information communities, or nation, one may not need to use all the metadata elements found in an international standard. Typically they establish a profile, or subset, that meets their specific requirements. If all nations or information communities derive their subsets of metadata standard elements from a well known internationally recognized superset, then other nations and information communities will be familiar with the metadata and readily understand it. This enhances interoperability.

All standards are a balance between functionality and interoperability, the higher the interoperability, usually the lower the functionality; higher functionality results in lower

interoperability. A profile is a standard tailored for a specific community. Where a base standard can be broad and complex, a profile usually is narrower in focus and often simpler. Standards are usually very generic to apply to a broad range of needs. Profiles, on the other hand, are specific to the user's needs. Where standards have many optional items, profiles have more mandatory items that are truly needed for specific requirements. Standards like NAP/PNA provide metadata for a wide variety of digital geographic data and applications. Figure 1 below shows that general basis for the NAP/PNA. See Federal Geographic Data Committee (2008), and GeoConnections (2008). An information community can be a nation, which builds a "National Geographic Metadata Profile". The NAP/PNA is a subset of a standard set of metadata elements that are applicable to the North American information community. Information communities can also be communities that focus on specific domains, field of study, or disciplines: examples are military, biological, transportation, agriculture, or navigation. Each of these information communities in North America should produce a standardized metadata profile selecting a sub-set of the full NAP/PNA standard, using only the metadata elements required for their purposes. These community profiles of metadata standards should be fully documented, identifying the metadata elements required by that community, with examples and the reason why each metadata element is required so that producers of metadata will fully understand what metadata to collect and why.

Fundamental Conceptual Organization of NAP/PNA Profile

The NAP/PNA Profile of the following conceptual sections:

* MD Identification contains basic information to describe the resource;
* MD Constraints allows reporting legal or security constrains;
* MD Data Quality - reports the information on data quality;
* MD Maintenance - contains information on resource maintenance;
* MD Spatial Identification contains information for grid and vector spatial representation;
* MD Reference System - reports information for the reference system of the resource;
* MD Content Information - contains information about coverage description or the feature catalog for the resource;
* MD Portrayal Catalog - contains information on the resource portrayal catalog;
* MD Distribution Information contains distribution information for the resource;
* MD Application Schema - Information on application schema used. Each section describes an aspect of the resource: such as Identification Information or basic resource information. Each section then allows for recording specifics such as Extent or the spatial extent of the resource. The following diagram, shown in Figure 2 below, provides the general conceptual organization of the NAP/PNA. This notation is a simplification of the formal Universal Modeling Language (UML) nomenclature.

MODIFICATIONS TO ISO 19115 REFLECTED IN NAP/PNA

Restraint was exercised in profiling ISO 19115 to the NAP/PNA. Obligation changes were limited to only those deemed absolutely necessary and, as stipulated in ISO 19115 Annex C, to only more stringent obligations. No elements were omitted. Several approaches were employed to allow easier interpretation of the NAP/PNA. The NAP/PNA developers chose to replace ISO 19115 UML notations with a simplified diagramming in the Profile to assist the non-UML user's interpretation of the Profile as shown in Figure 2. The NAP/PNA workbook will offer implementation guidance through best practices which direct the appropriate use of NAP/PNA elements and attributes. Two best practice examples of interest to the NAP/PNA community are:

6.2.1.9: Language (M, 1) Type: CodeList NAPMD_LanguageCountryCode

Description: Language of the metadata using standard ISO three letter codes.
BP: Three letter language code and country code: ISO639-2/T three letter language code; ISO 3166-1 three letter country code e.g. FRA; CAN. This attribute constitutes the default language for description of free text attribute of this profile. When more than one language is used in the metadata, then the attribute locale (see 6.1.12) is mandatory.

6.1.12: locale (C,Repeatable)Type: PT_Locale
Description: Other languages used in metadata free text descriptions.
BP: Mandatory when more than one language is used in free text descriptions. See CodeList NAPMD_LanguageCountryCode, included in the NAP – Metadata register for a short list of language and country codes. The character encoding shall be set to the default value "UTF8".
Obligation codes specify the required levels of elements in the profile. Mandatory means required at all times, while Conditional means is conditioned on another situation, such as if Cartesian coordinates are used, then the X and Y components of that coordinate are required, otherwise not. Optional obligation means that the information will be entered if the coder deems it necessary. The following is how the obligation codes are use in the Profile itself:

(M) Mandatory, maximum 1
(C) Conditional, maximum 1
(O) Optional, maximum 1
(M, *) Mandatory, Repeatable
(C, *) Conditional, Repeatable
(O, *) Optional, Repeatable.

Internal Modules for the NAP/PNA Profile

If one looks beyond the central module of the metadata information, one can examine a couple of additional modules of particular interest to cartographers. They are the Identification Module, and the Data Quality Information Module. Identification Module This module informs the user of the intended uses of the dataset, the kinds of data contained, and how one could access this dataset, legal and security constraints among others. The full rendering of the Identification Module is shown in Figure 3 below. Data Quality Module This module contains all of the information relating to data quality, including Completeness Commission, Completeness Omission, Topological Consistency, Positional Accuracy, Thematic Classification Correctness, Attribute Accuracy, and Temporal Accuracy. These parameters specify the critical data qualities to the operational spatial scientist, critical information. The full rendering of the Data Quality Module is shown in Figure 4 below.

EXAMPLE AREAS OF USES OF NAP/PNA IN NORTH AMERICA

The Great Lakes in North America are an excellent example where the NAP-Metadata will serve a very useful function. Figure 5 shows all of the Provinces/States the encompass the Great Lakes, and inside of that is shown the drainage basin for the Lakes that lie within the Provinces/ States depicted. On the Canadian side, most of the Lakes area falls within the Province of Ontario, with just a small part in the Province of Quebec. On the American side, there are seven States involved, Minnesota, Wisconsin, Illinois, Indiana, Ohio, Pennsylvania, and New York. The GLIN Organization together with the Great Lakes Commission bring together more than a hundred cooperator organizations into the Great Lakes Regional Data Exchange. This consortium is voluntary for an organization, but most organizations understand that it is in their interest to join, and to participate in the GLIN network.

The second Figure 6 is an image of Lake Erie, the lake at the head of Niagara Falls. Note that the Southern side of Lake Erie is bordered by the States of Michigan, Ohio, Pennsylvania, and New York. On the Northern side Lake Erie is dominated by the Province of Ontario. It is the shallowest of the five great Lakes, but because of its position it sees a fair amount of international shipping transit through it to the Upper Great Lakes. This image shows the international boundary between Canada and the USA. This 4,000 mile, ~6,000 Km, is the longest undefended political border in the world. However, the border does create big problems when it comes to data collection for entities that overlap the border into Canada or the USA. The North American Profile-Metadata is designed to be the first step along the path to making spatial data more sharable between the various organizations and agencies of the Federal governments, State/Provincial governments, and local organizations, whether they be private sector, nonprofit sector, or in the governmental sector.

The third example is a virtual map of North America, as shown in Figure 7, which includes territory of Canada, the United States, and Mexico. This visualization was created through the cooperation of agencies from all three governments. This version of the map shows three broad sources of geographic data: topographic variables, population characteristics, and geologic characteristics. It is obvious that there is a significant gain in efficiency to be made while collecting, rectifying, processing, and visualizing this data, if one has a common Profile for spatial metadata to facilitate the process. It is clear that the use of the NAP Metadata Profile will save countless hours of processing and rendering time, and reduce the overall cost of such a project. In the end, this data will be compatible and perhaps interoperable.

SUMMARY AND CONCLUSIONS

The NAP-Metadata Working Group has made remarkable progress in designing and developing the North American Profile-Metadata through to its formal announcement and publication on July 7, 2009. To accomplish this the WG began with a thorough review of the ISO 19115 Metadata Standard, and then proceeded to make it more specific to the situation of North America. This will insure the shared use of many spatial databases and facilitate interoperability between them. In doing so, the NAP/PNA increases the specificity for use by organizations and agencies in the region at a wide variety of levels and settings. More directly, NAP/PNA increases the specificity of metadata encoding, and reduces the optionality of both metadata encoding and encoding conventions. Cultural and linguistic adaptability has been enhanced by including specific items from ISO 19115 to recognize things like language, locale, and other appropriate metadata items. The formal specification of the NAP/PNA has been made user-friendly by employing a more straightforward set of conventions to specify the Profile. This is expected promote a wider use of the profile. This NAP/PNA work is being shared with the larger spatial data community as the official PNA/NAP Profile is being announced and published.

FUTURE WORK

The immediate task at hand is to design and develop software tools for the gathering, processing transfer, and dissemination of spatial metadata. Many of these tools are in a prototype stage just now, awaiting the finalization of the details of the PNA/NAP Profile. A second opportunity is to share this work with our colleagues in Latin America. Although they are working on their own spatial metadata profile of ISO 1915, there is hope of finding commonality such the two profiles, though different are yet still compatible. Some colleagues have dreamt about a "Profile for the Americas". We will know much more about this possibility as our Latin American carry on their scientific work towards fruition.

ACKNOWLEDGEMENTS
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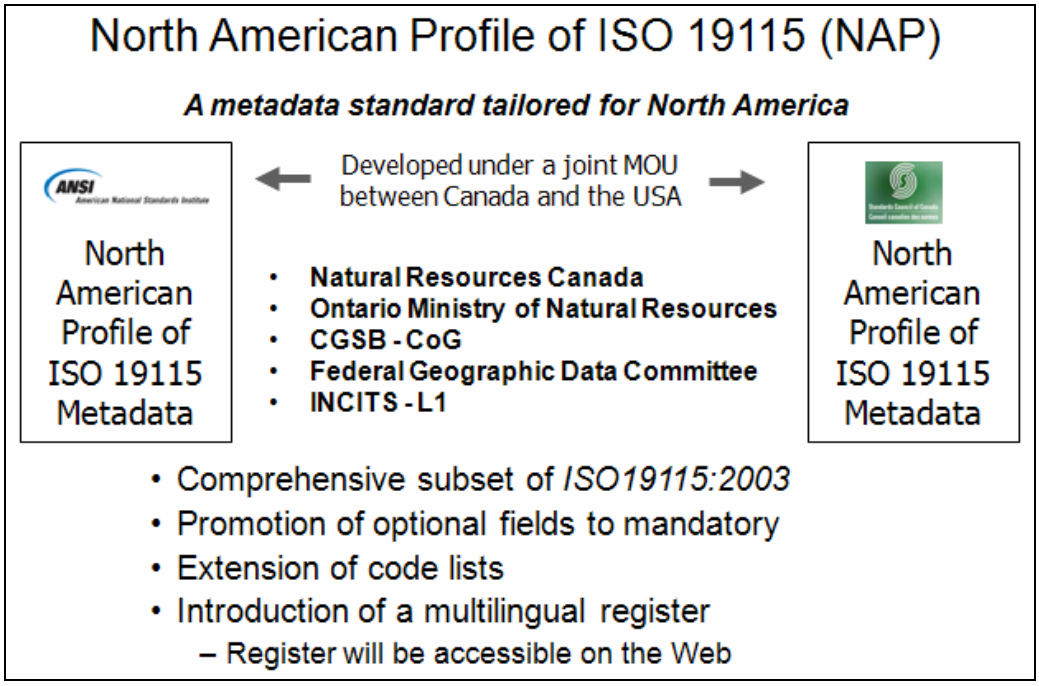

Figure 1: North American Profile of ISO 19115 (NAP/PNA)

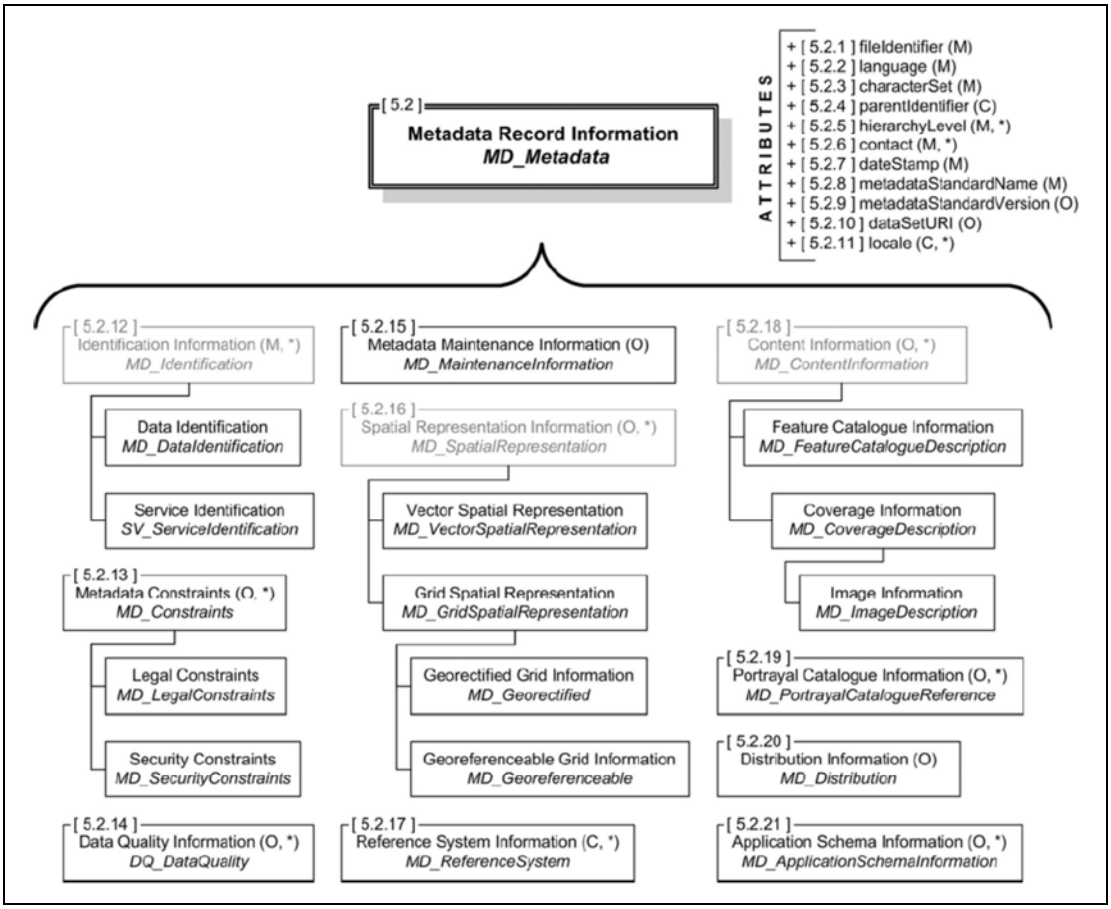

Figure 2: Conceptual NAP/PNA UML Organization Portraying the Metadata-Specific Attributes, and Resource-Specific Section and Subsections of the Profile.

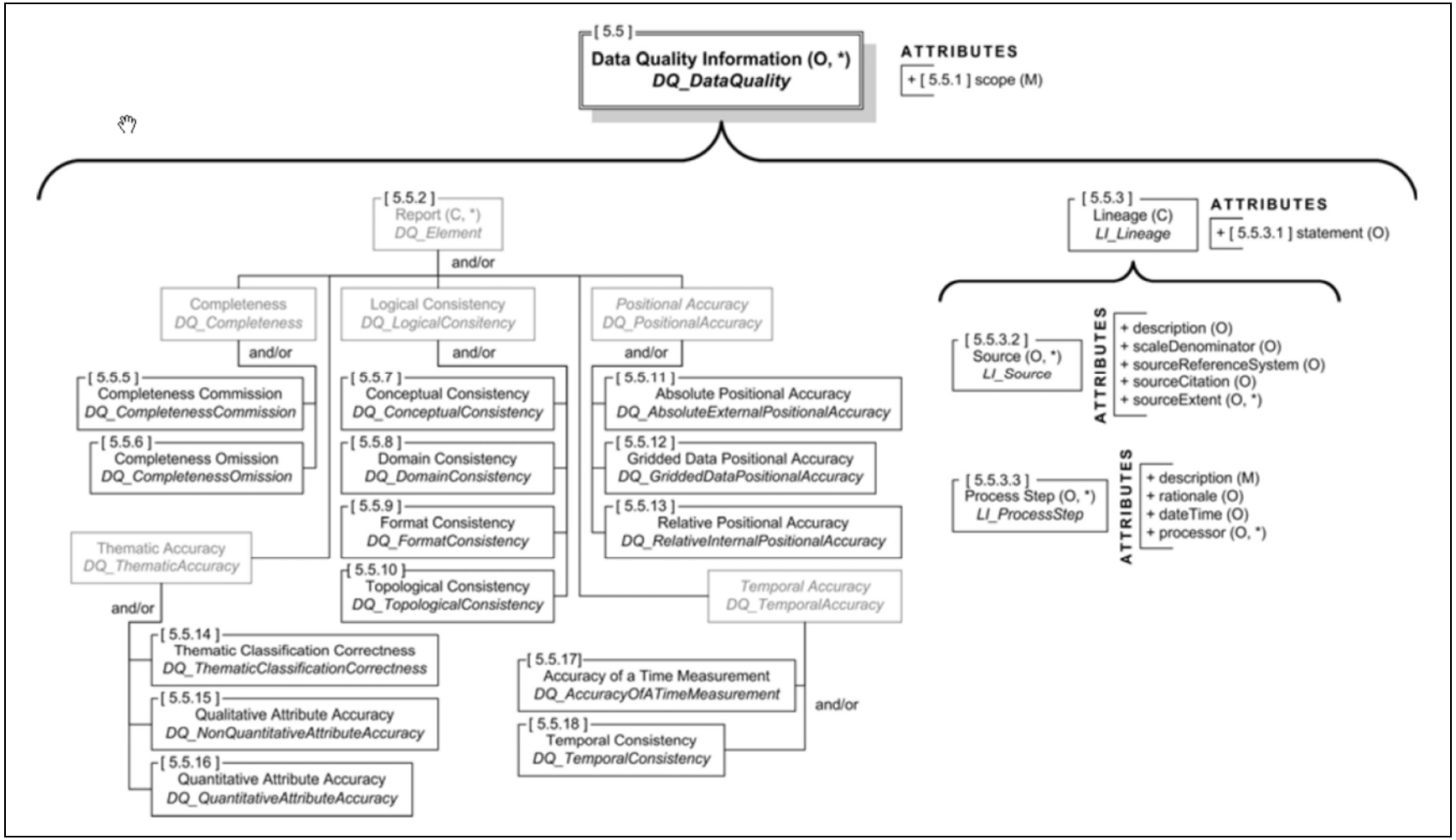

Figure 4: NAP/PNA Data Quality Module.

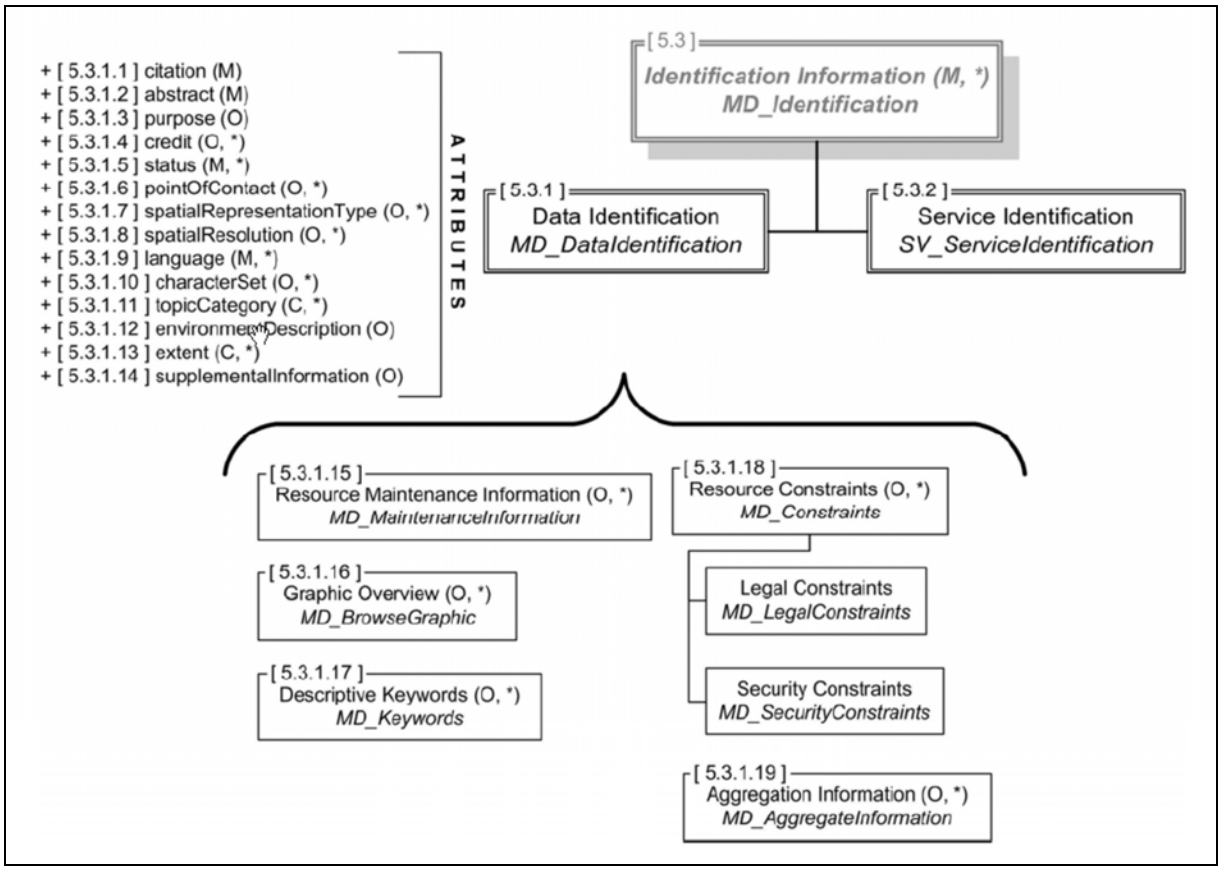

Figure 3: NAP/PNA Identification Module.

Figure 5: The Great Lakes Basin in Canada and the United States.
Source: The Great Lakes Information Network

Figure 6: Lake Erie and Environs in Canada and the United States, with international Boundary.
Source: The Great Lakes Information Network

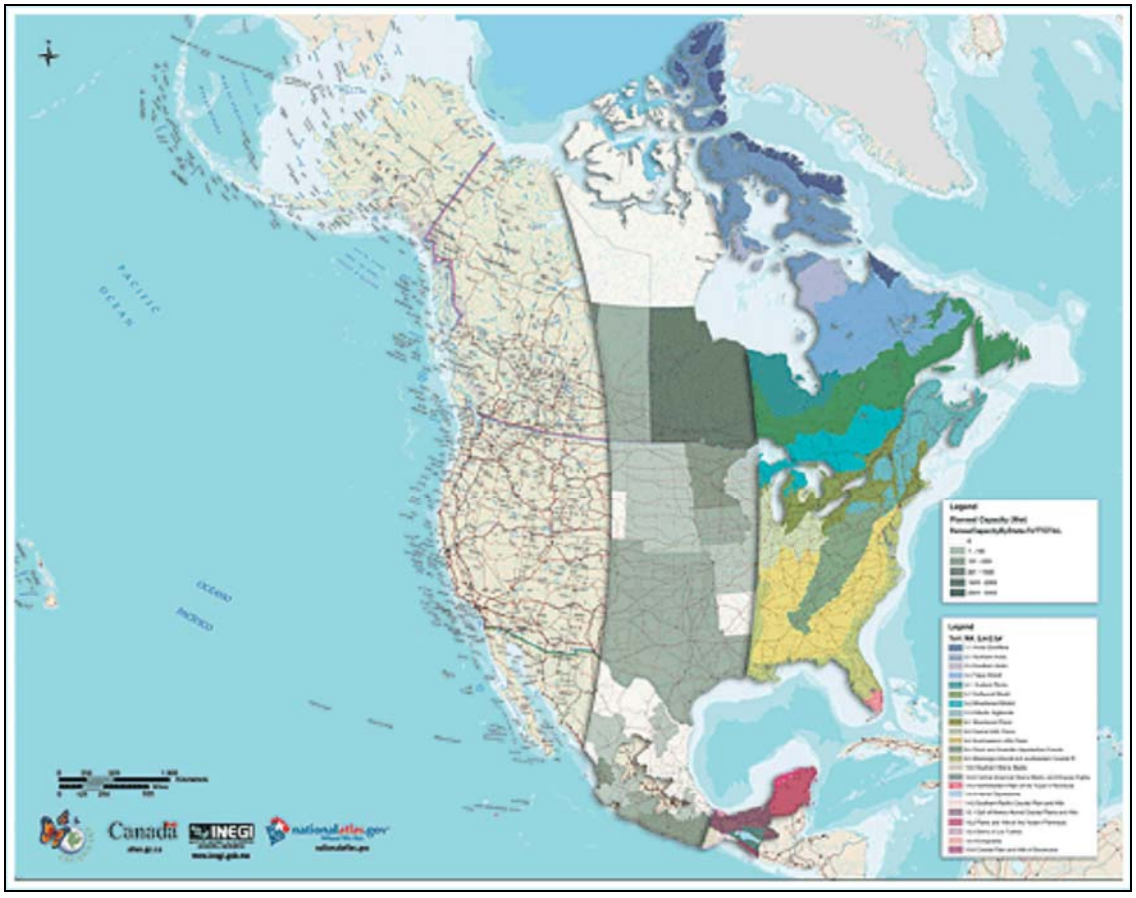

Figure 7: North America: Canada/United States/Mexico: Topography/Population Characteristics/ Geologic Characteristics. Source: U.S. National Atlas.