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Lunar Web Registry Service Under OpenGIS Specifications

Final Report

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Abstract

With the enormous amount of geographic data on the moon in existence, and more being generated daily with newer satellites such as LRO, as well as digitization projects for older film records, there is an increasing need for standardization of data. The Open Geospatial Consortium has created a set of universal standards for geospatial data, but until now the lunar geospatial community has lacked a registry of coordinate systems akin to the EPSG registry for earth. The project goal was to instantiate and populate a lunar planetary registry under OpenGIS standards. Tests of freeware OGC compatible registry packages were conducted including the Dutch government's eXcat software, Buddata's XML registry software, and geonetwork software. ISO standards relevant to the encoding and serving of geospatial metadata were studied in order to ensure the metadata is properly formatted. After analysis of existing projects and standards, it became apparent however that the EPSG Registry is itself the standard for a web registry service, and no generalized format is well agreed upon. Work on a registry based upon reverse engineering of EPSG had barely begun before the fellowship came to an end. Future projects should attempt to reverse engineer or otherwise replicate the EPSG Registry directly, rather than building from standards up. If completed, such a service would simplify data conversion and interoperability, as different data points in different projections and coordinate systems could be brought together more easily.

Text

Introduction

The Open Geospatial Consortium, or OGC is an international group that maintains a set of computer standards for Geospatial Information Services (GIS), called OpenGIS (1). Under this system, a Web Map Service (WMS) provides georeferenced mapping data as pictures or diagrams of an area plotted with geospatial coordinates (1). Catalogues of metadata concerning these maps, such as which service has what data and where, are maintained on Catalogue Services for the Web, or CSWs (2). However, it is important that everyone involved understands all the coordinate systems being used. Longitude and Latitude, well known as they may be, are far from the only system used. Each system is defined by a mathematical model, and a datum which connects the theoretical model to the actual earth. Longitude and Latitude are a model of an oblique spheroid representing "sea level," and coordinates representing angular distance north or

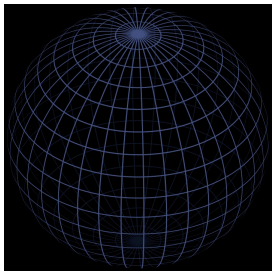

Figure 1: an illustration of the mathematical model of Longitude and Latitude

south, east or west, and a linear distance above or below sea level. The datum, or point at which longitude and latitude are defined, is traditionally in Greenwich, England. However, every land survey, most national and state organizations, global corporations, and militaries often have their own system, and each system has a myriad of ways to project the spheroid of the earth's surface onto a flat map (3). A coordinate system paired with a datum is called a Coordinate Reference System, or CRS, and they are stored and provided on a Web Registry Service, or WRS (1).

As NASA shifts its focus back to the moon, satellites are gathering new lunar geospatial data, and more is making it's way to digital form as older film is given a second look. New data means new CRSs, and servers distributing and organizing new data will require a service that can organize and provide those CRSs. It was the purpose of this project to construct a Registry, under applicable OpenGIS standards, that would cover CRSs pertaining to the moon, and be extensible to cover other bodies as well. At first, given the document "CSW - ebRIM Registry Service - Part 1: ebRIM profile of CSW," the standard involved was believed to be the CSW standard (4).

Figure 2: EPSG Registry User Interface

```
<GeodeticCRS xmlns:gmd="http://www.isotc211.org/2005/gmd"
      xmlns:gco="http://www.isotc211.org/2005/gco"
      xmlns:epsg="urn:x-ogp:spec:schema-xsd:EPSG:0.1:dataset"
      xmlns:gml="http://www.opengis.net/gml"
      xmlns:xlink="http://www.w3.org/1999/xlink"
      xmlns:rim="urn:oasis:names:tc:ebxml-regrep:xsd:rim:3.0"
      xmlns="http://www.opengis.net/gml"
      gml:id="epsg-crs-4723">
 <metaDataProperty>
  <epsg:CommonMetaData>
   <epsg:type>geographic 2D</epsg:type>
   <epsg:informationSource>Clifford J. Mugnier; In Photogrammetric
         Engineering &amp;amp; Remote Sensing November 1998.
         http://www.asprs.org/</epsg:informationSource>
   <epsg:revisionDate>2006-01-26</epsg:revisionDate>
   <epsg:show>true</epsg:show>
   <epsg:isDeprecated>false</epsg:isDeprecated>
  </epsg:CommonMetaData>
 </metaDataProperty>
 <identifier codeSpace="OGP">urn:ogc:def:crs:EPSG::4723</identifier>
 <name>Grand Cayman 1959</name>
 <domainOfValidity xlink:href="urn:ogc:def:area:EPSG::3185"/>
 <scope>Topographic mapping, engineering and cadastral survey.</scope>
 <ellipsoidalCS xlink:href="urn:ogc:def:cs:EPSG::6422"/>
 <geodeticDatum xlink:href="urn:ogc:def:datum:EPSG::6723"/>
</GeodeticCRS>
```

Figure 3: GML Example

Here on earth, there are oil companies. Oil companies have the two qualities necessary to push for strong GIS standards: They want very accurate maps, so they can accurately locate petroleum sources, and they have lots and lots of money. The Oil and Gas Producers, or OGP, through the European Petroleum Survey Group, or EPSG, created the epsg-registry, which is the current gold standard for CRSs on Earth. It has data and details on over 1500 different systems. The epsg-registry server "speaks" an XML based language called Geospatial Markup Language, or GML, which is used for describing CRSs, amongst other things. (3)

A Standards - Up Approach

The first approach taken to this project was to attempt to build a Web Registry Service on the django web framework (a generic database / server framework), in accordance with any standards that apply. Unfortunately, there is no standard per se under OpenGIS concerning WRSs. There is, however, a document entitled "CSW - ebRIM Registry

Service - Part 1: ebRIM profile of CSW" (4). This seemed the appropriate document to begin implementation. It is a profile for the construction of a CSW within the eb Registry Information Model, or ebRIM, which is published by OASIS (7). The standardized way to communicate with an ebRIM server is in ebXML, another XML based language (8). The EPSG registry can respond in ebXML, so this seemed an appropriate starting point (3).

A direct implementation, however, required a lot of work and a lot of standards. An ebRIM data model had to be built as a database, and a server on top of that had to be built to interpret ebXML. On top of that, a WRS had to be built that could produce and interpret GML (4, 5, 6). Each International Standards Organization (ISO) standard involved required several others for implementation, and each one was difficult to decipher (9, 10, 11, 12). It eventually became apparent that a direct implementation from standards up could not be completed in the project's ten week time limit.

eXcat

The Dutch government's eXcat software, recently translated into english, looked promising. It claimed to be a fully functional, albeit simple, CSW, packaged with its own graphical web interface and database. Unfortunately, while eXcat accepted with relative ease metadata describing data points such as specific maps, there was no way to put coordinate systems in it, to make it a registry. A developer was contacted, and it became apparent that eXcat was functional, but limited. It is a catalogue, but not a registry. (13)

GeoNetwork

GeoNetwork is another open source GIS project. It is a catalogue and map service, and also has its own, even more detailed, web interface. At first it had seemed to have more features than necessary for this project, but in the light of eXcat's limits, it seemed more promising. After sifting through the software, it's manual, and website, however, it appeared that GeoNetwork, like eXcat, could only accept CRS as references to a WRS, such as EPSG Registry. (14)

Figure 4: GeoNetwork Logo

Buddata

The next attempt was with Buddata ebXML Registry/Repository, an ongoing project that aims to be a full implementation of a CSW on ebRIM. It was much less refined than GeoNetwork or eXcat, but given its compliance with "CSW - ebRIM Registry Service" it seemed a promising choice for a registry service. However, it did not support storage of CRSs. It became clear with buddata that the CSW registry implementation on ebRIM documents were for building a catalogue only, and that the word registry was not being used to imply the ability to install any CRSs. An email towards the end of the project time from Yaman, a Buddata developer confirmed that Buddata is indeed meant to get its CRSs from EPSG. (15)

Figure 5: Buddata Logo

Reevaluation

The EPSG registry is not just the gold standard; it is the standard. There has been no real need, until now, to have another. With relatively little time remaining, the project switched to an attempt to reverse engineer EPSG-registry. Some relatively simple querying methods were explored, and an extremely simple django based server was produced to perform very basic functions, but as of yet, the project has gotten no farther.

Further development in this area should focus on meeting the needs of specific client software, and mimicking EPSG-registry's behavior when necessary, rather than a standards-up approach.

Methods

A Standards - Up Approach

Django was chosen because it is compatible with multithreaded apache, the webserver already being used by some of JPL's lunar WMS servers, which would ideally gain WRS functionality. It is also python based, making int rather easy to work with (16, 2). A series of django "models," or data structures to be stored in the database, were written to mirror the theoretical "objects" used in the eb Registry Information Model. Standards researched include ebRIM, ebXML, ISO 19115:2003: Geographic information -- Metadata, ISO/DIS 19111:2004: OGC Abstract Specification Topic 2, Spatial referencing by coordinates, ISO/TS 19127:2005: Geographic information -- Geodetic codes and parameters, ISO/TS 19139:2007, Geographic information -- Metadata -- XML schema implementation, as well as the catalogue of OpenGIS® Standards and Specifications (9, 10, 11, 12).

eXcat, GeoNetwork, and Buddata

All three of these are ongoing open source projects aimed at creating CSWs for varying purposes. eXcat and Buddata both ran on Tomcat under Apache, while GeoNetwork came packaged with its own server. Buddata used PostgreSQL and PostGIS. Manuals and websites for all three were consulted, as well as experiments with the software itself. (13, 14, 15)

Reevaluation

The reimplemented database responds to extremely simple getRecordsById requests in much the same manner as EPSG-Registry, but with static GML, stored in the database. The GML currently in the database is from spacial-reference.org. The reevaluated server is not online at this time.

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