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Effective steps toward the Spain National Geographic Information Infrastructure.

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Abstract

We describe a three-year collaborative project to create the technology underpinnings of a Spain National Geographic Information Infrastructure. Two core SDI components will be created: an OGC-compliant metadata Catalog Server, and an OGC-compatible Web Map Server. Metadata format will be based on ISO DIS 19115 with Dublin Core compatibility, and will also provide backward compatibility to CEN and other formats. Finally, we recognise that institutional collaboration is absolutely critical, because although Spain has the possibility to jump the queue in terms of innovative open technology, the SDI cannot be successful without the leadership and collaboration of regional and especially national goverment officials.

1. Introduction

This work presents a collaborative research project initiated by investigators at three Spanish universities, and with the primary goal of sparking development of a National Geographic Information Infrastructure (or Spatial Data Infrastructure, SDI) in Spain. Although results of this project (on-line demonstrations) are not expected to be available until next year, here we discuss some of the decisions taken regarding technology and standards to be employed in the initial demonstrations.

Spain is wholly absent from comparative SDI studies such as [12], [13] and [14] because it has built no such infrastructure. This may surprise the reader given the nation's size and relative importance within Europe, also given that neighbouring Portugal does have a relatively mature SDI. As is often the case, Spain's absence from the European SDI map is due more to the lack of co-ordination than lack of technological capability, as we hope to demonstrate in this paper. While we acknowledge that institutional co-ordination is the single most important ingredient in a successful SDI and, therefore, technologists (these authors) should not expect to lead the process, we thought it useful to demonstrate the possibilities of novel technology components and standards which could be readily employed in building the SDI, and therefore instigate decisions by institutional leaders. Many SDIs begin as a political vision and then technology development starts from square one. In this case we hope that some technological demonstration will spark the vision. The project investigators have considerable experience in the prerequisite technological areas, being OpenGIS members (and devel-

opers) and having worked on web mapping projects at regional scale [15] and the ESMI metadata service project [17] at European scale. This experience allows for previously developed technology to be modified and migrated to serve national SDI needs.

As was the case with commercial GIS adoption in about 1989-90, Spain is now considered a late adopter of SDI concepts and technologies, and this may actually prove beneficial. Latecomers often benefit substantially from the false starts and lessons learned by peers. As a specific case in point, while many European regions have built geodata dissemination services (normally read-only) based on specific commercial web mapping products and formats, Spain is now poised to adopt emerging OpenGIS Web Map Server technology, opening the field and permitting a much wider range of commercial vendor (and other developer) participation in building the SDI. In the area of geospatial metadata, Spain is now poised to exploit ISO DIS 19115 (to be officially released as IS in January 2002), whereas many early adopters have invested considerably in implementations based on the CEN metadata standard, or others, and will eventually find it necessary (or advisable) to migrate to ISO (see for example [18]).

In the following section, the core of this paper, we describe the two main technology components of the pilot Spain SDI, and we then conclude with some institutional implications.

2. SDI Components

According to FGDC [1] the main components of a geographic information infrastructure should include data providers (sources of spatial data), databases and metadata, data networks, technologies (dealing with data discovery, collection, management and representation), institutional arrangements, policies and standards, and end-users (see Figure 1). Of these components we assume the presence of geodata sources, and so the obvious starting point becomes metadata, as cited in [16]: “Any public sector organisation that is planning to use the Internet to increase access to their information resources must start by creating their own metadata services.”

Figure 1 was produced in 1998 or earlier, before the emergence of SDI-based web mapping applications such as Portugal’s *Geocid* [20] or UK Ordnance Survey’s *Get-a-map*. If produced today the graphic would likely break out Technology into “Metadata services” and “Web mapping” boxes. These are the two basic components upon which our project is based.

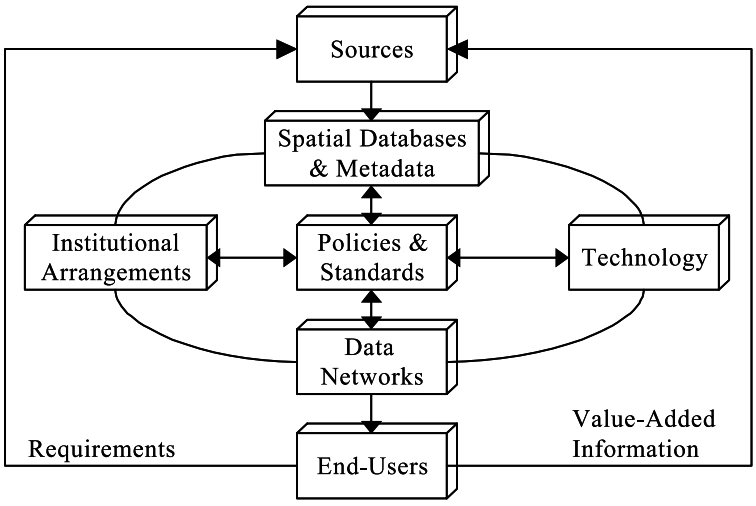

Figure 1: A system view of SDI components (taken from [1])

2.1 Metadata services

There are several standards or pre-standards in the geospatial field identifying the metadata elements that describe consistently a specific geospatial data resource. Examples include the US FGDC's Content Standard for Digital Geospatial Metadata (CSDGM) [9], ISO/TC211 DIS 19115 [3], OpenGIS AS Topic 11 [2], CEO-Recommendations on Metadata [4], and European CEN/TC287 prENV 12657 [5]. Although each metadata format (or profile) was created to meet specific technical and political criteria, fortunately most of them share a common core of description elements, facilitating the creation of crosswalks to improve interoperability.

The intent of this project is not to create and implement a unique standard: we strongly recommend that Spain does not produce a national geospatial metadata standard, as it has done with digital cartographic data transfer, resulting in the MIGRA format which has seen little use. Spain now has the opportunity to leap ahead and embrace relevant international standards, so that it might play its part in eventual European and Global SDIs. This leap ahead would be greatly facilitated, we believe, by direct ISO 19115 metadata support. This recommendation is supported by several key precedents. Both the OGC and FGDC work programmes have shifted recently to assume a wholesale migration to ISO metadata and related standards, and the UK Ordnance Survey, the SDI of Norway and that of Northrhine Westfalia also have chosen to go this route. Unless we meet with insurmountable institutional opposition among our collaborators, the metadata object model to be demonstrated within our project will follow the ISO standard, with additional features (from Dublin Core) as needed for compatibility issues.

What of support for the metadata standard developed by CEN TC287? This question has echoed numerous times around Europe during the past 3 or more years. Several implementations of the CEN metadata standard have been attempted or are now under way. The INFO2000 project ESMI, in which we were involved, was one such project, but it should be stated that the decision to adopt CEN standards was not an easy or obvious decision, even though at that time (1997) the ISO/TC211 standards were a long way off in the distance. The ESMI consortium recognised ISO as the future destination, but chose CEN as the best available standard at the time. [Also decisive was the consortium participation of CEN proponents Megrin and Eurogi.] Now 4 years have passed and a fresh decision must be made by Spanish geodata providers. While we acknowledge the hard work that has gone into the formulation of the European standard, we find no technically sound reason for implementing CEN instead of the ISO 19115 metadata standard. The oft-heard argument of lack of availability or stability in ISO 19115 is today simply not valid: OGC members and most other individuals involved in GI technology development have little problem accessing this and other ISO standards, and at the time of this writing ISO 19115 is certainly stable enough to support system and service development.

An initial stated objective of the project described here is to closely follow these standardisation processes. Most of these standards promote the use of object-oriented modelling and system development in a distributed architecture, to maximise interoperability between different nodes which support well-known interfaces as established in the distributed platform standards (RMI [6], CORBA [7], OLE/COM [8]). Once again, the metadata standard which most fully complies with our desire to follow object-oriented modelling and create geospatial services is ISO 19115, primarily because it is being adopted by OGC (alongside 19114, the ISO standard for data quality) as its next metadata Abstract Specification. From a technical standpoint ISO 19115 is clearly the best path to the future. Again, we recognise that optimal technical solu-

tions rarely drive SDI activities; institutional concerns are addressed in the final section of this paper.

The term metadata services implies more than metadata collection and maintenance. These services should also exploit the metadata to facilitate the discovery of desirable data sets. Here also there are many options to choose from, among them the public domain *Isite* system (http://www.cnidr.org/retrieval.html) used for search and retrieval by FGDC, ANZLIC, ESMI project, UK Ordnance Survey and others. Although it is considered outdated technology by today's standards, Isite was chosen by the ESMI project, again, based on availability at that time (1997) as well as budget constraints. By the end of the ESMI project, in late 1999, the search and retrieval system had been modified to allow dual support of Isite (and the Z39.50 protocol it uses) alongside more modern OpenGIS Catalog Server technology. Unfortunately funding for ESMI was not continued under EC programmes, however we plan to repackage it under a Catalog Services wrapper (as described in [17]), thus providing the Spain SDI with this dual search and retrieval capability, important for reasons of backward compatibility.

The primary search and retrieval mechanism planned for this pilot project is an implementation of the OpenGIS Catalog interface (specification available at [10]). In addition to the ESMI experience, another part of our research team contributes substantial experience developing OGC Catalog interfaces and clients. In this paper we will not go into details on catalogue services, instead we refer to the reader to a more graphic (on-line Powerpoint) overview of this work, in [19].

2.2. Web mapping

The second technology component of our pilot SDI is a service to facilitate the exploitation of available data. Informal market research of several recent metadata projects, including ESMI and Etemii, has concluded that users (citizens, government workers, researchers) of a SDI are not interested in metadata: they want to locate, visualise and analyse the geospatial data themselves. However, most SDIs are metadata-centric and do not provide direct connection: the user must first search for data sets, acquire the data, and then visualise it; alternatively the user may directly visualise certain canned datasets, details of which are beyond user control. It would seem to be highly desirable for a SDI to be able to transparently integrate the metadata system with a web mapping component, creating a truly open, on-line GIS. Multiple vendors could then provide (plug-in) compatible data storage (back ends) or client (front ends) components, breaking the vendor stranglehold now all so common in many regions.

In this direction the pilot SDI project described here will develop an integrated software component application to support some of the key OpenGIS implementation specifications, namely catalogue services (OpenGIS Catalog Interface Implementation Specification [10]) and web mapping (OpenGIS Web Map Server (WMS) Interface Specification [11]) specifications.

The OpenGIS compliant catalogue will offer components to satisfy search and retrieval services (to discover information and to present results) and management services (to register and maintain the metadata in the database). The search services access the discovery services, which have the ability to access other remote OpenGIS Discovery Services (cascading servers). These services allow consumers of GI to locate distributed collections of geographic data as well as its characteristics such as data owner, provider and distribution conditions.

Serving GI (both vector maps and images) on the Internet has evolved considerably during the past 12 months, however those outside the sphere of OpenGIS may know little of it.

Increased demand by users to publish geographical information on the net, in addition to the ability to retrieve, fuse and display information from different sources has raised the bar for GIS vendors. To meet these new challenges WMS was proposed by several OpenGIS member companies and agencies and implemented as the combination of these members' software components accessing the exposed requirements. A WMS interface specifies a set of services designed to allow the request of GI (not only maps) via Internet. OpenGIS servers need only to implement this common interface in order to enable clients, and other servers, to discover them and to exchange information. Workflows needing daily or even real-time updates to geographical information collections are prime candidates to utilise this new GIS architecture based on central repositories of data accessible through a WMS. The possibility of accessing several central repositories that offer a WMS interface makes it easier for users to fuse and work with local information combined with the most recent data from different catalogues. These capabilities are not science fiction, rather on-going specifications –Web Fusion Services, Coverage Server, Feature Server— being tested under the so-called WMT-3 under the OGC Interoperability Program. The pilot Spain SDI will exploit as many of these open interfaces as possible. Finally, the project hopes to demonstrate the value of on-the-fly conversion of vector data to GML 2.0 format, following on UK Ordnance Survey's lead.

These two component-based infrastructures hopefully will be tested sometime during 2002 in a pilot project, with a principal node in Zaragoza and two others distributed in Madrid and Castellón. Each node will contain digital content (geodata) and also support a public catalogue for testing and demonstrating these technologies to businesses and administrations interested in contributing to the SDI. An on-line portal, based on the www.mercator.org site developed by one of our research groups, will be used as the main entrance to the pilot SDI services.

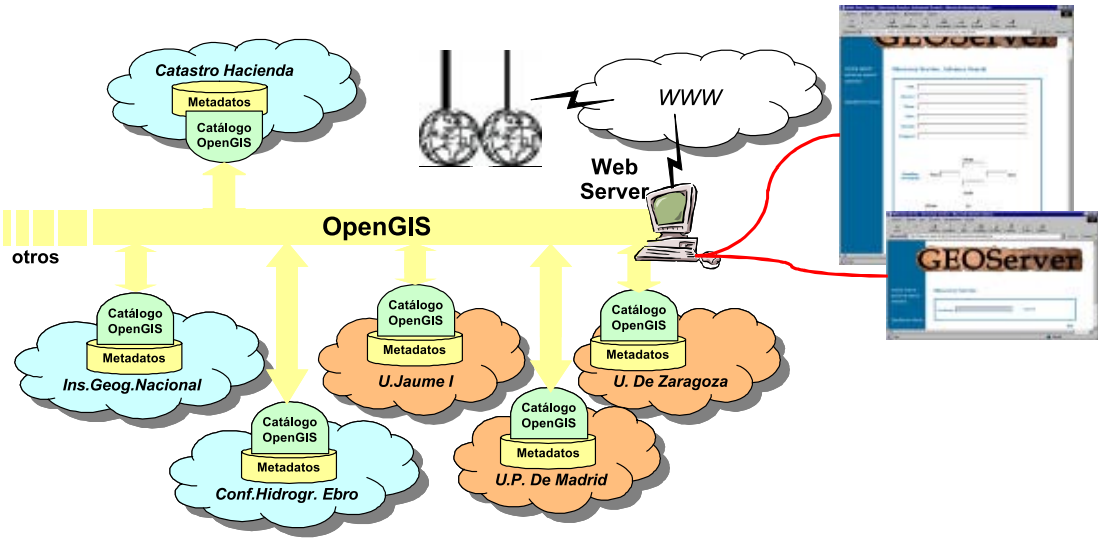

Figure 2. The proposed architecture of the pilot Spain SDI. Initially three limited metadata service nodes will be run at the participating universities, with eventual migration to large geodata providers such as the IGN, national cadastral agency and the Ebro watershed agency. This metadata service will then allow the discovery of geodata, to be displayed in vendor neutral formats on the web mapping server.

3. Institutional implications

We cannot underscore enough the fact that the National Infrastructure (SDI) must be lead by political champions, who can be supported but not coerced by innovative technology. The ultimate measure of success of our three-year research project will be the level of support and

collaboration we are able to garner from high-level officials at the major data provision agencies.

As in many European nations, most things in Spain seem to function better at the autonomous community (NUTS2) level than at the national level; this is for cultural, political and even linguistic reasons. Over the past year regions such as Andalucia (http://www.ngeografics.com/sid/ica/Portada.html), Valencia (http://www.gva.es/icv/), Navarra (http://sitna.cfnavarra.es/navegar/) and Catalonia (http://www.icc.es/homeang.html have become somewhat more proactive and have built regional web-based mapping systems thanks to local-level agreements and collaboration. While we certainly applaud these efforts, what is somewhat worrisome is that the sum of all these regional puzzle pieces certainly does not compose a single, coherent puzzle. Also, because they are regionally funded and (presumably) used, no level of interoperability was intended, so that now any users working across community boundaries are forced to utilise multiple systems, formats, browser plug-ins, and user interfaces: no single web portal directing the user to the multiple system URLs currently exists. Clearly, there exists a great deal of room for national co-ordination here.

At national level, three main data providers can be identified. The national digital Cadastre project began in 1988 and some of its data have been available for several years, although national coverage has still not reached 80%. The cadastre web site (http://www.catastro.meh.es/) lists products and prices, but cartographic representation of data coverage, or predicted availability for areas not completed, is conspicuously absent as are direct downloads; much can be improved here also.

The national statistics institute (INE) website (http://www.ine.es/welcoing.htm) describes several projects and several available products but, again, these products are not datasets to be downloaded and utilised within GIS. Additionally, combination of cadastre and INE data has historically been hampered by the lack of coincidence of spatial units i.e. urban areal units, street addressing, etc.

The main geospatial data provider is Instituto Geográfico Nacional (IGN) and its commercial arm CNIG. The website of the latter (http://www.cnig.ign.es) is similar to that of INE in that it lists “geomatics” products but does not facilitate their download or offer much in the way of coverage maps either. IGN is currently developing some sort of metadata system, which we certainly hope can be made compatible with the OGC- and ISO-based technology components which we propose to develop and exploit in our pilot project.

Some interesting precedents are available for study and technology transfer, principal among them the SDI projects in Northrhine Westfalia, Norway and the UK (Ordnance Survey). Among our key institutional objectives is the organisation of face-to-face meetings between decision makers at these SDI sites and key Spanish decision makers. We expect that the latter will soon recognise the key moment in time in which the nation finds itself: there are so many innovative SDI projects under way and –this is the key—exploiting similar, open, international standards-based methodology and technology. Spain could be as little as 2 or 3 years away from having a top-line National Geographic Information Infrastructure.

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