TOWARDS INTEROPERABILITY OF GOVERNMENT GEOGRAPHIC INFORMATION SYSTEMS IN SOUTH AFRICA

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Government departments in South Africa own large Geographic Information System (GIS) datasets, required by fellow government departments and the public. There is a need for these datasets to be at their most current and available in real-time. Additionally, such datasets are required to interface with the datasets of fellow government departments in order to operate meaningful and intelligent GIS. This paper discusses possible mechanisms by which government departments in South Africa, can achieve interoperability of their GIS to facilitate the sharing and interfacing of the most current GIS datasets. The discussions below have been derived from a literature survey.
INTRODUCTION

The Constitution of South Africa (Act No. 108 of 1996) calls for co-operative governance. The Promotion of Access to Information Act (Act 2 of 2000) calls for "the constitutional right of access to any information held by the State". The Spatial Information Bill of 2000 aims "to promote the efficient, economical and effective use of State resources as enshrined in the Constitution, by the sharing of spatial data and spatial information". Interoperable GIS across the South African government, would facilitate the sharing and access of information and data, and enable coordination of sustainable spatial development and government initiatives across the country. Interoperability can be defined as the ability of organisations, systems, information, technologies and infrastructures to operate together.

PRINCIPLES AND POSSIBLE SOLUTIONS

Modularity

Modularity is a process by which a complex product or process can be built from smaller subsystems (or modules) that can be designed independently yet function together as a whole. Through the widespread adoption of modular designs, the computer industry has dramatically increased its rate of innovation, and the pace at which the industry has changed (Baldwin and Clark, 1997). For the various components to work together it is essential that each of the components follow the basic design rules and parameters. Modularity is only beneficial if the module is precise, unambiguous and complete.

In United States, the Information Management Technology Reform Act of 1996, revises national policy on information technology procurements and directs federal agencies to employ modular contracting approaches where possible. Modular acquisition should foster better, more timely procurements consistent with rapidly evolving user needs and commercial product cycles. However, this does mean that modular acquisition must be framed around a modular architecture for the organisation. Architectures based on interoperable modules with open interfaces is the way to achieve a modular acquisition process across organisations that strive towards interoperability.

Modular software principles ensure data flow between the different computing components in the architecture that serves the human/institutional components, and these principles make it possible for components to share network-resident software services and computing resources. Standards-based interfaces are the glue that holds a modular information architecture together. Modular components, supported by standard interfaces, interoperate to provide effective and flexible communication of information.

Some ISO/TC 211 principles


These standards may specify, for geographic information, the methods, tools and service for data management (including definition and description), acquiring, processing, analyzing, accessing, presenting and transferring such data in digital/electronic from between different users, systems and locations.

The ISO/TC211 technical committee develops the ISO 191xx series of standards for geographic information. The base series of standards is intended to be independent of any particular implementation environment or distributing computing platform, and is to support data and service interoperability between different environments.
The ISO Reference Model-Open Distributed Processing (IRM-ODP) provides a framework for developing distributed systems that can be integrated. This framework addresses interoperability from an enterprise, information, computational, engineering and technology point of view. The computational viewpoint focuses on service interfaces and interaction between different system components and the information viewpoint focuses on the information model for geodata that is being maintained and processed for components. (Gronmo, et al, 2001).

The ISO TC211 models are implementation-neutral, meaning that the models are at a conceptual level and independent of implementation details of a particular environment or distributed computing platform, but precise enough to serve as a basis for further mapping to implementation specific models. The Unified Modelling Language (UML) was chosen as the common language for describing implementation-neutral models. The rules and guidelines for developing implementation-neutral UML models can be found in the ISO19103 standard. The ISO 19118 encoding contains rules for how to map from the implementation-neutral UML models to a corresponding representation of data according to these models in a range of Extended Markup Language (XML) formats. The goal of the ISO 19119 standard is to define implementation specific profiles of the implementation-neutral models, ensuring that there is well-defined mapping between these to ensure interoperability between different implementation platforms.

Furthermore, the ISO/TC211 Business Information standardisation activity is working on two areas that will assist in the global specification of content models for framework and non-framework data. The ISO 19109, which provides the rules for defining an application schema, including the principles for classifying geographic objects and their relationships to application schema. Using the Unified Modelling Language (UML), software applications that provide access to geospatial data, such as framework, would be defined in a consistent way so as to improve sharing of data between applications and even allow for real-time interaction between applications. Before software can reliably access mapped features in remote data systems, there must first be a common understanding about the nature and composition of the objects being managed. The ISO 19109 includes guidance principles for classifying geographic objects. These rules will be used by geographic information users when classifying geographic objects within their applications and when interpreting geographic data from other applications.

Closely related to the ISO 19109 is the standard proposing a feature cataloguing methodology, ISO 19110. A feature catalogue acts as a dictionary for feature classes that can be used in software. Publishing an application schema with a feature catalogue for a given data set of common interest can provide the basis for framework data definitions of use to global, regional, national and local data. Done carefully, schemas and feature catalogues can be similarly constructed for existing framework-like data in order to enable discussion among participants, and transformation of content into conforming framework data sets (DD Nebert, 2000).

Open GIS Consortium (OGC)

The Open GIS Consortium (OGC) is an international industry consortium whose objective is market enablement through interoperability between commercial geoprocessing software products, by
supplementing the work of recognised standards organisations (such as the ISO, World-Wide Web consortium, Wireless Application Protocol, etc.) with implementation detail guidelines. The OGC and ISO TC211 have an agreement to sustain the technical alignment of their respective developments.

The OGC seeks to address the Babel-like profusion of data format and data transfer standards by creating open, common interfaces between software components, and letting those systems use any data format internally. The Open GIS Interfaces provide access to both information and functionality, and OGC aims to provide software that will address inconsistent data dictionaries and metadata schemas. GIS vendors can send their products to the OGC for compliance testing to the OpenGIS Specification, and those products which pass the test may carry the OGC certification mark and logo.

OpenGIS Specifications include:-

- Open GIS Coverage Specification for satellite images
- OpenGIS Catalog Services Implementation Specification for common architecture for online automated directories, or clearinghouses, or Web-based geospatial data and geoprocessing services.
- OpenGIS Presentation Specifications address basic Web computing image access, display, and manipulation capabilities.
- The OpenGIS Feature Identity & Relationships Specification and Geometry Specification will specify interfaces that unambiguously model behaviours of feature identifiers.

**Interoperating with the public**

Public access to the large volumes of existing geodata and their exploitation is of significant value for the development of an open and democratic "information society" and a true global market. The widespread use of geo-data and GIS will promote general public awareness and social cohesion. However, publically available geo-data is of little use unless people can easily access it and use it.

The term "CommonGIS" is to enable geodata to be accessible and usable for everyone, from everywhere, by providing a WWW-based Geographical Information System with specific functions for the automatic generation of specific maps. The solution enables people who would like to work with geodata from time to time, but do not have the time and effort to master GIS and cartography, and who have a variety of educational levels and personal skills to access the geodata. Data providers should be able to easily hook up their data to CommonGIS services.

Common GIS is an open, object-oriented, distributed system providing knowledge-based GIS services. The user interface is a web-browser, that provides comfortable and easy access to the geodata in the form of thematic maps. In contrast to other GIS, this generation is completely automated.

Within the OGC, expert geoprocessing technology users work with software vendors, earth imaging vendors, database vendors, integrators, computer vendors and other technology providers to reach agreement on the technical details of open interfaces that allow these systems to work together over the world-wide web. Members of the OGC agreed to create a Geographic Markup Language (GML) for the transport and storage of geographic information to the world-wide web, using the World-Wide Web Consortiums (W3C) standards as its basis.

The more data stores that are behind OpenGIS-enabled servers, the more "vertical integration" of different themes becomes possible. Vertical technical integration across many themes is virtually equivalent to horizontal policy integration across many departments and agencies. Web Mapping technology allows
government offices to leap over the barriers to horizontal integration, and achieve virtual horizontal integration using technology, not policy. As an example a water department can become integrated with a civil works department, and both of these integrated with a transport department, etc. (Kottman, 2000).

As organisations develop component-based, object-oriented information systems, and as the OpenGIS Specification is extended by the OGC Technical Committee, Open GIS conformance interfaces on geospatial software components will enable true “plug and play” of GIS, remote sensing, and automated mapping and facilities management components in enterprise information systems, consumer serving web sites, and mobile devices. Digital geographic information, despite its underlying complexity and heterogeneity, will become available and useful to everyone.

An example of CommonGIS Initiatives

Geography Network, available on the website: http://www.GeographyNetwork.com, is an initiative for the sharing of spatial data across the world. The Geography Network can be likened to a large online library of distributed GIS information across the world, available to everyone, and that is designed to OGIS standards for the dissemination and sharing of data and services. Data is shared and integrated using a wide spectrum of simple to advanced GIS and visualisation software technologies. GIS software can be used to connect one or more sites at the same time and using the techniques of digital map overlay and visualisation. Users can simultaneously combine and analyse many types of data from different sources. The Geography Network is designed for GIS Users who wish to share and disseminate their data, discover and use other people’s data by searching a metadata catalogue; provide applications, such as location and mapping capabilities, and sell data and applications.

A POSSIBLE WAY FORWARD FOR SOUTH AFRICA

Internationally a great amount of work has been done towards standardisation, and hence accessibility of digital geographic information. South Africa should seize the opportunity by joining existing international initiatives and introducing them locally, so they too can benefit from these initiatives. There is a great need, particularly at government level, to share current and real-time information to enhance co-ordinated planning and co-operative governance across departments. Key factors in the successful implementation would include:

- Organisational readiness in terms of willingness to share data,
- Conformance to accepted standards and practices, and
- Providing sufficient financial and human resources to meet the objectives.

A common vision between government departments and the ability to strive towards this common goal is desirable to achieve interoperability of government Geographic Information Systems.

REFERENCES


CommonGIS, 2001: http://commongis.jrc.it


ISO/TC 211 Scope, 2001: http://www.statkart.no/isotc211


