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Joining Geographic Catalog Services and Map Servers with GIS applications

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Abstract

Several organizations, especially public administrations, usually manage large amounts of information with geographical references. Maybe, one of the most important problems of this kind of organizations is to share their data among their different departments, and to offer public access to this information, in an efficient and easy-to-use manner. This work presents a system that integrates geographic catalog services and map servers with GIS applications in order to facilitate the share, discover and access of data in such organizations.

1. Introduction

Large amounts of geospatial data have been collected for more than 35 years. Furthermore, the collection speed increases quickly with new technologies in high resolution satellites, GPS, data bases, new software technologies for processing geospatial data and the increase of people and organizations which are collecting and using this kind of data. About 80% of data bases used by public administrations have geospatial references (addresses, city distributions, cartographic coordinates, etc). From another point of view, the geographic information production market in Europe is about 10 billions of Euros per year. Information is being collected, but the market does not exploit it correctly. In many cases, geospatial data-consuming companies or people do not find the data they need and they usually pay data suppliers for custom-made products.

Most of this data is created and managed using commercial GIS tools such as ESRI products ArcView and ArcInfo. These tools are quite enough for these functions but do not offer possibilities to help users in discovering data using other reference different from file name. This problem is bigger if we try to find data across Internet. In the other side, geographic catalogs and web map servers have the functionality to locate and access geospatial data in an efficient and easy manner. This work presents a system that integrates geographic catalog services and map servers with GIS applications in order to facilitate the share, discovery and access of data.

The rest of the paper has been structured as follows. Next section presents the system architecture. Section three is focused on the component developed to interoperate ArcInfo 8 and ArcView with the rest of the system. This paper ends with a conclusions and future work section.

2. System architecture

This system is composed of four main components (see the architecture presented in Figure 1):

- a catalog built using the OpenGIS Catalog specification (see OGC 1999a as a reference),
- a set of tools to catalog and discover metadata in this catalog,
- a map server in compliance with OpenGIS Web Map Server Interface specification (see OGC 1999b) to support access to the geographic data,

and a set of sub-components which enable the connection of some ESRI GIS products (ArcView and ArcInfo 8) with the catalog.

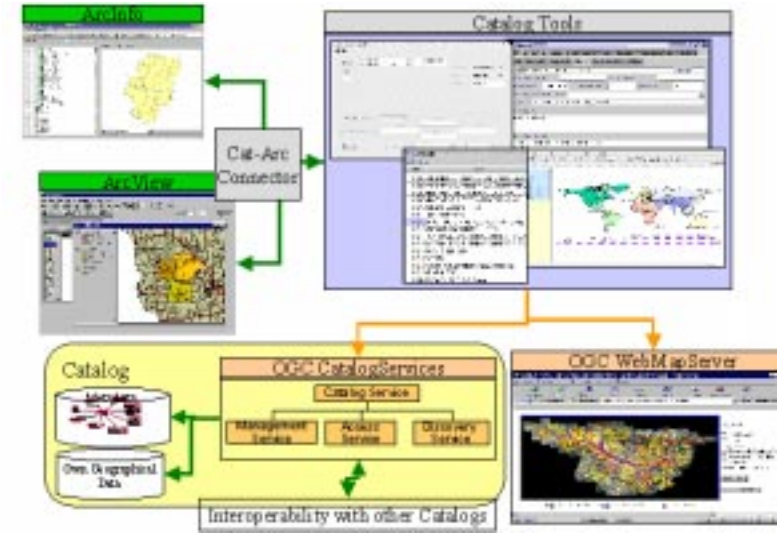

Figure 1: Information system architecture.

To develop this project, three main working areas have been defined. The first one provides the utilities to create and maintain a geographic information catalog. This catalog must be able to store metadata describing the information managed by these organizations. The OpenGIS Consortium uses the term “Catalog” to describe the set of service interfaces which support organization, discovery, and access of geospatial information. Catalog services help users or application software to find information that exists anywhere in a distributed computing environment. A Catalog can be thought of as a specialized database of information about geospatial resources available to a group or community of users.

The system this paper presents uses a Catalog built guided by the OGC Catalog Services specification (see F.J.Zarazaga et. al. 2000). One of the basic components in this catalog is the metadata object model. Metadata provided by the system must conform not only international standards, but also be capable of representing additional metadata items related with a particular organization context and not supported directly by international standards. In this way, the metadata object model under development follows basically the American CSDGM of FGDC (see FGDC 1998), with the capacity to be extended easily. On the other hand, it must be taken in mind that there is still no commitment about what metadata standard is going to succeed 100% in the future. Therefore the focus is not to implement exactly a unique standard but to be compliant with different standards. To be compliant does not mean create a new standard consisting of an increasingly number of metadata elements covering all possibilities but to make efforts on providing translation services from/to different standards

such as ISO/TC 211 (see ISO 1998), CEO-Recommendations on Metadata (see CEO 1999), or European CEN/TC 287 prENV 12657 (see CEN 2000).

The objective of the second working area is to offer tools for search and access to the data on an organization Intranet, or over the Internet. These utilities will have four degrees of complexity:

1. A set of “closed-questions” that will be solved in execution time in order to include in the answer the latest incorporation to the catalog. Organization employees using a simple language could create these questions.

2. Two different interfaces which provide users with capacity to see all the data an organi zation has available directly, or by thematic trees related with the particular organiza tion context.

3. Some interfaces to make “free-text” and “map-guided” questions. One of these inter faces will offer the possibility of using natural language to ask the catalog.

4. An OpenGIS Catalog interface in order to be able to integrate the organization catalog into a network of distributed catalogs.

These services integrate a Web Map Server to provide facilities for visualization and evaluation of data. This Map Server fulfills the OpenGIS Web Map Server Interface version 0.9 (see OGC 1999b). It has been built using Java as the programming language (see P.Fernández et. al. 2000).

Finally, the organization catalog should be able to interact with the ESRI products ArcView and ArcInfo 8. The use of these products is very common in many public administrations, and it would be desirable for these organizations to have “natural access” to these products from/ to the catalog utilities. In this way, two are the jobs to be done:

1. From the point of view of data cataloguing utilities, the system must provide access to these ESRI products in order to derive metadata from geographic data managed by these products.

2. From the point of view of ESRI products, the system must provide access to the “search & access” utilities of the catalog in order to locate and incorporate data.

The technology to communicate ESRI products with the catalog utilities will be different depending on the ESRI product possibilities. In this way, the connection with ArcView will be done using DDE (see DDE 2000), while the connection with ArcInfo will be done using COM-Java RMI technology (see Roger Sessions 1997 or R.Orfali, D.Harkey 1998). The communication between ESRI products and the catalog will be done using component named CatArcConnector.

3. The CatArcConnector component

The widespread use of the ESRI products in public administrations makes it desirable to enable the interaction of these tools with the organization catalog. In order to achieve this goal a new software component, called *CatArcConnector*, had to be deployed. Its purpose is to make a straightforward communication among the parties involved possible.

The CatArcConnector component is settled between the ESRI products and the organization catalog. Figure 2 shows this configuration.

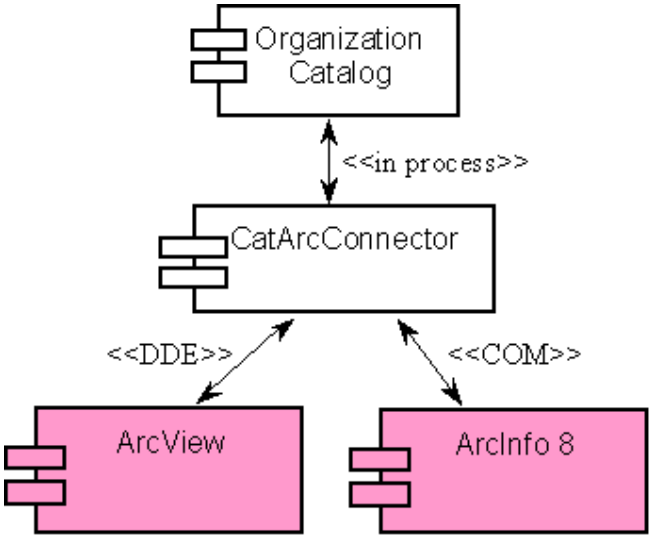

Figure 2: CatArcConnector configuration

As it is shown, CatArcConnector has to be able to use different kinds of inter-process communication mechanisms (IPC) depending on the ESRI product to interact with. According to this, CatArcConnector communicates with ArcView using DDE (Dynamic Data Exchange) whereas it uses COM to communicate with ArcInfo 8. As for the interaction with the Organization Catalog, it can be chosen the most convenient IPC mechanism.

In the following sections, we will dive into the concrete functionality and architecture of CatArcConnector regarding its interactions with ArcView and ArcInfo 8.

3.1 CatArcConnector interacting with ArcView

The CatArcConnector component enables the interaction between ArcView and the organization catalog. One of the main objectives was that it should be easy, flexible and powerful to ask for a service from one application to the other. This implies, among others, the following capabilities:

- CatArcConnector should permit the reception of requests both from ArcView and from the organization catalog.

- CatArcConnector should be able to manage the requests both synchronous and asyn chronously.

- CatArcConnector should forward the request to the corresponding component and, after receiving the answer, redirect it to the initial solicitor.

- CatArcConnector should be configurable at run-time. For this component to work prop erly several parameters have to be specified: the IPC mechanism to be used for the communication with the organization catalog, the set of operations that are allowed and the mode of operation for each service (synch-asynch). All this set-up is done at run time, just when the component is created, so there is no need to recompile the code to adapt to new scenarios.

In figure 3 the main parts of CatArcConnector for the interaction with ArcView are shown:

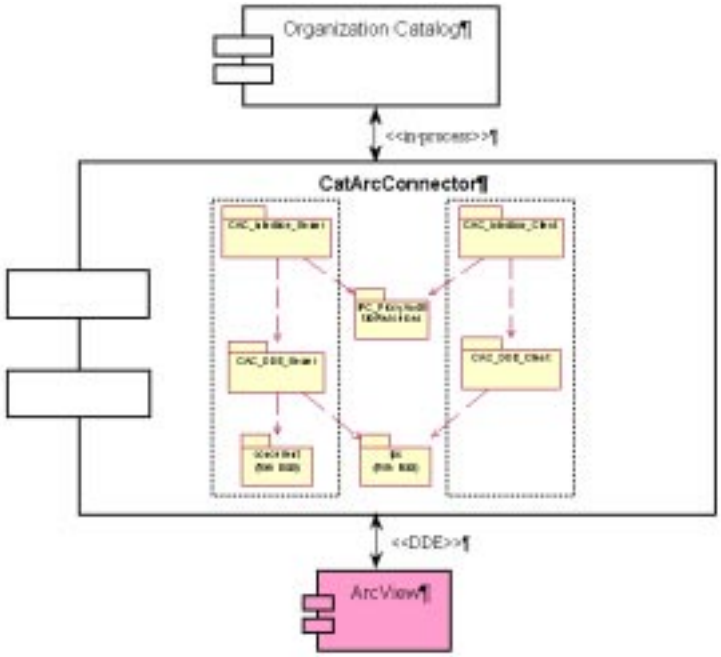

Figure 3: CatArcConnector architecture for communications with ArcView

The CatArcConnector component can be conceptually divided into two parts, which are graphically delimited by the dotted-line squares in the figure 3. This division has to do with the two roles that can be played during the interaction between ArcView and the Organization Catalog. According to the first role, ArcView will act as a client whereas the Organization Catalog will be the server. In the second role, the applications will behave in the opposite way. In either case, the requests for service can be treated synchronous or asynchronously. In synchronous mode the client will wait till the server supplies the answer. Quite the opposite will occur in the asynchronous mode: the client will continue with its work and, after some unknown time, it will receive the answer. These two modes of operation make the CatArcConnector flexible enough to adapt gracefully to the user's needs.

Finally, it is worth mentioning that the communication with ArcView is accomplished by means of DDE (Dynamic Data Exchange). This is a sort of inter-process communication mechanisms provided by Windows operating systems. The fact that the current version of ArcView is rather old makes it impossible to use a more advanced inter-process communication mechanism, such as COM.

3.2 CatArcConnector interacting with ArcInfo 8

Another important and widespread product of the ESRI family is ArcInfo 8. Therefore, it was considered to be very convenient that the CatArcConnector component should permit the interaction between this product and the organization catalog.

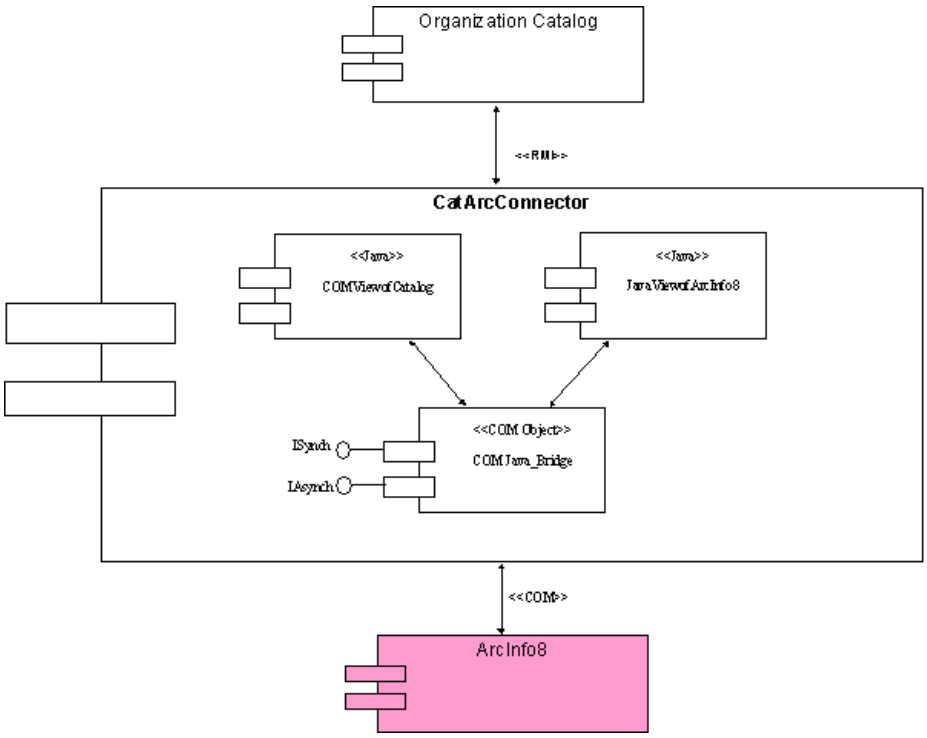

Figure 4: CatArcConnector architecture for communications with ArcInfo 8

Due to the fact that ArcInfo is built using COM objects and that the organization catalog is written entirely in Java, one of the main tasks of the CatArcConnector component is to provide a kind of adapter between these two types of technologies. This adapter is called Com-Java_Bridge, as is shown in figure 4.

The COM-Java_Bridge adapter is a COM object written in Java and interpreted by the Microsoft Virtual Machine (MVM). Of course, this is not the sole solution for overcoming this problem. In fact, the use of a COM-CORBA bridge was also studied but it was discarder in favor of the use of the MVM.

The other two components of CatArcConnector are COMViewofCatalog and JavaViewofArcInfo8. The first one's function is to provide a view of the organization catalog as if it were a COM object. That way, ArcInfo 8 can handle the organization catalog as a COM object. The purpose of JavaViewofArcInfo8 is quite the opposite: to provide the organization catalog with a Java view of ArcInfo 8. With these two components, both applications, the organization catalog and ArcInfo 8, view each other as if they were of the same class when, in fact, they are using completely different technologies.

4. Conclusions

This work has presented a system that integrates geographic catalog services and map servers with GIS applications in order to facilitate the share, discover and access of data. Currently, there are seven people working half time in this project. The development of the system has been divided into three versions. The first version of this system will be finished by June 2001, while the final system should be operative at the end of 2001. This product will be installed as a first test platform on the Ebro River Basin Organization (CHE: http://www.chebro.es), which is responsible for the management of water resources concerning the Ebro river, the biggest one in Spain, and its flowing ones (see Figure 5).

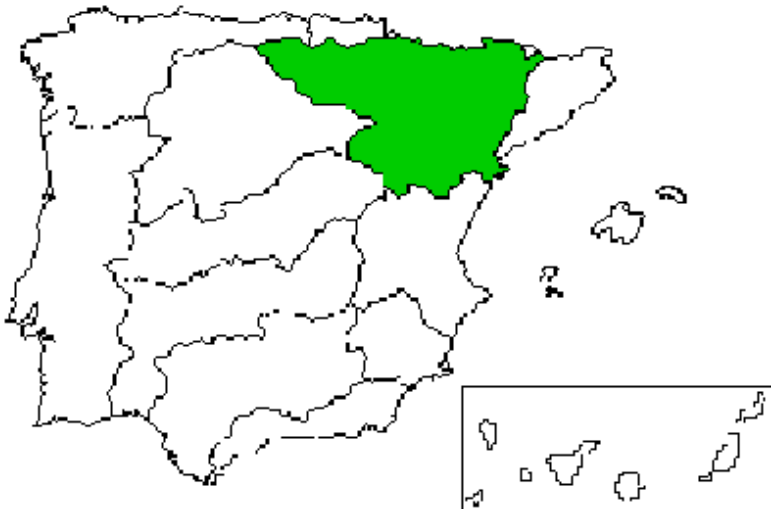

Figure 5: The Ebro River Basin Organization geographical domain

This system incorporates a catalog and a web map server developed in previous projects. Over these components, it has been necessary to build an interface to offer all the tools together.

The solution built to interoperate ESRI products and the rest of the system has needed a hard work to test different solutions and to verify its technical viability. Finally, it has been necessary to develop the component using three different compilers: Visual Basic compiler to work with ArcInfo components (COM technology), 100% pure Java compiler for the development of the main part of the component, and Visual J++ (it is not 100% pure Java) to make the COM-RMI bridge.

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