OPEN ACCESS TO AN HYDROLOGICAL INFORMATION SYSTEM

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Abstract. A current tendency in information systems in general and geographic information systems in particular is to built them as open systems, allowing data sharing and comprising geographic data and attributes, metadata, and means to discover, visualize, evaluate, access and update the data. The INSPIRE vision of a European Infrastructure of Spatial Information defends that point of view, and this should be particularly true in the case of public administrations. This paper presents an approach to the construction of a SDI for the Ebro river Hydrographical Confederation (CHE), in charge of physically and administratively managing the hydrographical basin of the Spanish Ebro river, starting from ad hoc applications that meets the internal requirements of the CHE, and concluding with the core of an SDI that integrates the existing applications with OpenGIS standard services, like WMS and WFS, into a system that meets both the internal and external requirements of the CHE.

1. INTRODUCTION

A current tendency with information systems in general and with geographic information systems in particular is to be built as open systems, allowing data sharing, by developing spatial data infrastructures comprising geographic data and attributes, metadata, and means to discover, visualize, evaluate, access and update the data. The INSPIRE vision of a European Infrastructure of Spatial Information defends that point of view: data should be collected once and standard distributed services used to share this spatial information between many users and applications (INSPIRE).

This should be particularly true in the case of public administrations (Brox 2002) (Wilson 2000). This is the situation of the Ebro River Hydrographical Confederation (CHE), in charge of physically and administratively managing the hydrographical basin of the Ebro River. Water points are one of the areas of interest inside the CHE Hydrological Planning Department (OPH): diverse data about nature, location, exploitation and administrative status for water resources is gathered and combined to take the best profit of the basin resources and allow or deny their exploitation. The workflow process needs large amounts of georeferenciated data to allow the staff to take fully informed decisions, and tuned applications that allow the staff to perform their tasks efficiently.

In this context, it would be desirable to provide a way in which any other agents (governmental organizations, stakeholders and general public) implied in the hydrological field would take advantage of the processes and data defined by the CHE (Lichy 2001) and vice versa, in the case of governmental organizations, by sharing them without loss of autonomy and while keeping the concept of property of the data. This would also provide the information supply mechanisms needed as a base to allow public participation in the management of the river basin, as stood by the Water Framework Directive (European Commission 2002 a) in the aspects related to public participation. To support this, the information systems used cannot be closed and monolithic, but should be opened to be accessed. This way, the OPH information system can be seen as a set of data access-and-update services provided to the OPH itself, the whole CHE, other public administrations, stakeholders and public in general.

This paper is structured as follows: a description of the Ebro River Hydrographical Confederation is presented, followed by the description of the internal information system in use at the organization. Next section is devoted to explain how the system can be opened to external access by integrating into it several standard and open components, proposing different architectures for the different use-cases and trying to take advantage of the already implemented functionality and the existence of open and standard interfaces to access geographic information. The paper finishes by presenting the final SDI architecture, some conclusions and future work lines.

2. THE EBRO HYDROGRAPHICAL CONFEDERATION

The Ebro river Hydrographical Confederation (CHE) is the state organization in charge of physically and administratively managing the hydrographical basin of the Ebro river (Fig. 1), through planning (by elaborating and revising a global catchment hydrological plan), managing (by administering and controlling the different water resources in the catchment area) and investing (by projecting and carrying out the public works that may be entrusted to them).

Fig. 1. Ebro river basin

Water points, that is, water resources like wells, springs, drains or reservoir collectings, are one of the areas of interest inside the CHE Hydrological Planning Department (OPH), whose administrative work is mainly devoted to analyse and approve water point exploitation by particulars. Workflow process includes the gathering of data relative to the water point, including nature, location, exploitation and administrative status; analysing the collected data, by comparing it with data about other points, the exploitation data given by the stakeholder and the river basin management plan objectives, to finally deliver several reports about the physic characteristics and location of the point and a resolution about its compatibility with the river basin management plan, allowing or denying the exploitation of the point.

This workflow process needs large amounts of data, most of them georeferenciated, that must be collected and organized in a structured way. These data includes not only that which is directly involved in the organization workflow and that is CHE's responsibility and property, which must be collected and maintained; but also those data that are going to be used as a support to daily work. The most relevant set of data (due to its key role in the workflow process and to its volume) belonging to the first group is the water point inventory (IPA), stored in an Oracle 8i spatial database and is used to collect and maintain the 50,000 water points they have inventoried so far (Arqued 1995 a) (Comella 1999) (Béjar 2001) (Latre 2001). The rest of the information, including data maintained by the CHE, such as water points data, administrative dossier information, superficial and groundwater quality status and hydrogeology and the data obtained from other entities or organizations, like reference geographic data and orthoimages are stored in a central repository called GIS-Ebro (Arqued 1995 b), in ArcInfo, shapefiles or raster image formats, although a migration to the Oracle 8i database is planned among the changes needed to adjust the infrastructure to the Water Framework Directive. Metadata of all of this datasets has been created and stored into the database (FGDC 1998) (ISO/TC211 2001), since it will be the base for data discovery and download both within the organization and to external entities.

3. CHE INFRASTRUCTURE

3.1. OPH Component Architecture

The objective of the CHE internal infrastructure is to provide tuned functionality and applications for a perfectly established and experienced workflow process. Since some licences of commercial software were available (Albert 2002) (Tu 2002) and part of the functionality needed was already identified and, in some cases, implemented in a previous version of the set of applications used to access the inventory (Arqued 1995 a) (Comella 1999) (Béjar 2001), the design of the information system made use of all this, providing a set of applications adjusted to this workflow and maximizing the use of tools the tools are used to work with. Though most of them are not compliant with any standard (since at the moment they were designed, many of the specifications proposed by organizations like ISO and OpenGIS (OGC) that are currently available did not exist), they were built following an open philosophy, being provided with interfaces that allow the components and applications interact among them and with others.

As a result, the functionality required to perform the regular workflow activities has been separated into independent components (Fig. 2):

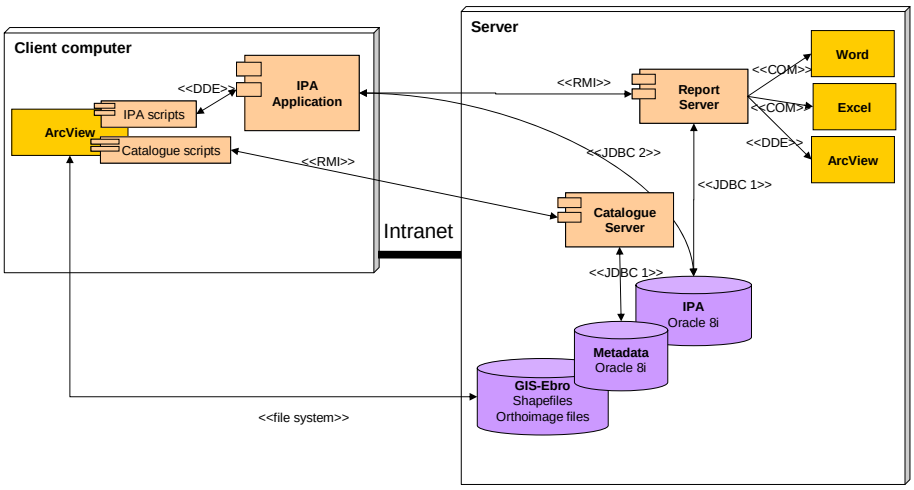

Fig. 2. OPH Component Architecture

- The inventory and administrative management application (IPA application). This Java application is the core of the set of applications used internally in the CHE, allowing managing the information of the repository by consulting, adding, deleting and updating data about water points and

stakeholders' dossiers. It enforces the established workflow process and it is the main responsible for co-ordinating the other components services invocation, along with the provision of services that allow the other components to interact with it. Its graphic user interface can be seen in Fig. 3, left.

- ArcView is used as the visualization and editing tool for the geographical information stored in the inventory. It is customized (Albert 2002) (Tu 2002) with some *Avenue* scripts that provide a communication mechanism between ArcView and the IPA application. As a visualization tool, the IPA application acts as a limited, non-standard feature server, providing a subset of points and attributes of the water points in the area that is been visualized. As an editing tool, the scripts notify changes made in the set of points (new-point insertion or point location modification) to the IPA application, by invoking the services it provides. The rest of geographical information that it is used in ArcView is taken directly from the central repository of GIS-Ebro, although, in the case of the orthoimages some scripts are used for convenience to access just the files needed in the visualized area.

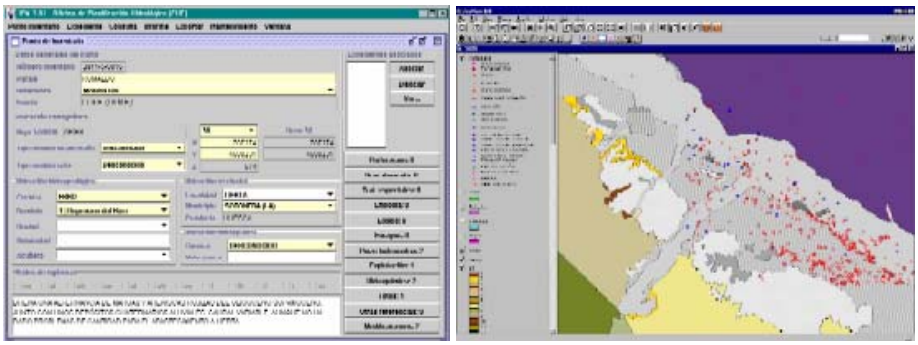

Fig. 3. IPA application (left) and ArcView (right) graphic user interface

- A catalog service with is also available at this level through ArcView (Zarazaga 2002) (Muro-Medrano 2003). When working with ArcView, users are able to launch a search client of geographic data available inside the organization, and load the selected dataset result of a search in ArcView.

- An independent server created to construct in background the administrative and informative reports requested by the users through the IPA application using the RMI protocol, avoiding increasing the load of the users' computers. The report server, upon request, generates a report file, which will be placed in an accessible directory inside the organization. The client receives the document URL and can open it with its default application viewer.

  Reports are divided into different categories depending on the generated file type and the nature of their structure. Word, Excel, ArcView or Acrobat PDF static reports have a predefined structure, and the fields are filled using a query with default parameters. This kind of reports include

comprehensive data stored about a single point or a set of them in PDF format, basic data and piezohydrometry series of a set, both in Excel and hydrochemical Piper and Stiff graphics in ArcView. Dynamic reports are based on templates not completely fixed, where the final structure depends on the specific content and it is determined at building time. Word is used in this situation, when an administrative resolution report is needed. These administrative reports combine data coming from one or more water points organized in a certain structure of sections and paragraphs depending on the nature of the point. The structure and content of these sections and paragraphs are stored in the database, so it can be maintained and updated along time.

3.2. CHE Component Architecture

IPA data is also used by the rest of the departments of the CHE, which access the inventory and, sometimes, insert new information or update the existing one, as in the case of the Quality Area, whose monitoring stations have been incorporated inside the inventory, making both departments profit of sharing this information.

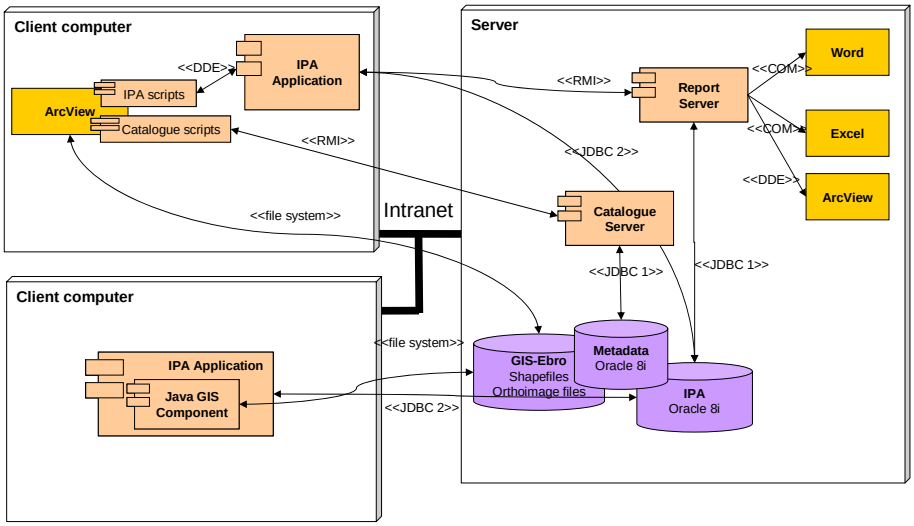

Fig. 4. Different component configurations inside the CHE

Due to the fact that all the departments in the CHE share the same intranet, the same architecture can be used and, therefore, the same functionality can be obtained in other departments, but since the use of the inventory is limited in most cases to query access, and there is no interest in administrative information, a more compact version of the application is provided: a visualization tool is integrated into a Java component inside the client. This way, an external and licensed application is not

required to just visualize in a geographical way the information managed by the application. The rest of the information of GIS-Ebro is still available through the intranet, as well the functionality provided by the report and catalogue server (Fig. 4).

4. PROVIDING ACCESS TO OTHER AGENTS

As has been explained previously, a way in which any other agent (governmental organizations, stakeholders and general public) implied in the hydrological field would take advantage of the processes and data defined by the CHE should be provided; in the case of other public administrations, by making profit by sharing them without loss of autonomy and while keeping the concept of property of the data; in the case of companies subcontracted to perform fieldwork, by allowing them to insert the data directly; in the case of general public and stakeholders, by providing the information supply mechanisms needed as a base to allow public participation in the management of the river basin, as stood by the Water Framework Directive.

To support this, the infrastructure should be opened to be accessed, if possible, in a standard way (Harrison 2002) (JRC 2002) (Nebert 2003). The optimization and customization degree may be reduced, but, on the contrary, it will increase interoperability, which will allow more and better information spreading possibilities, like, for instance, by developing client applications by chaining not only services provided by the CHE, but also standard services provided by other entities. In the case of the CHE, this is to be done by integrating some standard services compliant with the OpenGIS specification with the existing ones.

4.1. Data supplier organizations

There exist some organizations that have to work intensively adding or updating points, providing read and write access can be really beneficial for both the CHE and the other organizations. On the one hand, this is the situation of companies that have been subcontracted to perform some fieldwork in a certain area or are in charge of collecting the last measurements of a group of monitoring stations. By allowing them to access directly the system and update the inventory, work at the CHE is clearly reduced without increasing significantly the amount of work assigned to the company staff. On the other, the Spanish political system allows that other governmental organizations (local and regional administrations and the Ministry of the Environment) have also authority on other aspects related to water management. To perform they activities, they need the same sort of data (and, when the geographical scope of the administrations overlaps, the exactly the same data) the CHE is collecting and maintaining. These

organization can use the CHE inventory as if it were theirs, taking profit not only of the available data but also of the whole infrastructure.

To access and update the information stored in the inventory (Fig. 5), the IPA application has been adapted to provide optimised access to the database through internet, reducing the data transferred to the minimum. Selected external organizations which have been authorized to update the inventory, have been provided with the application and are able to access and update the information with the same tool at use inside the CHE. Visualization of geographical information can be achieved in this case by three different ways: ArcView, the internal Java GIS component and a Web Map Server client. The first two ways are the same that are provided inside the CHE. They are the most appropriate in the case of inserting new points, but they present the drawback that the geographical datasets must available within the organization is using it, so the geographical data belonging to the CHE must be downloaded first.

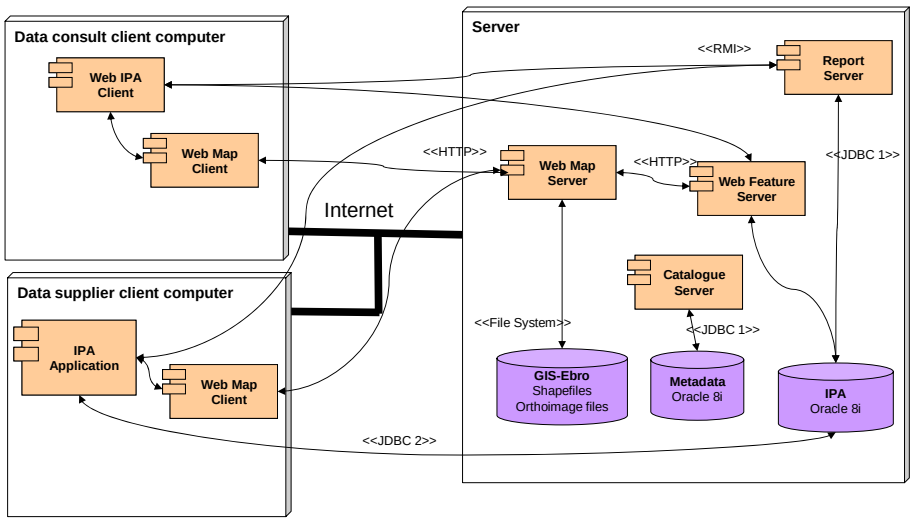

Fig. 5. Other organizations access architectures.

The third alternative can be used regardless of local availability of data and it consists in the use of an html client that accesses an OpenGIS standard Web Map Server (Fig. 6). Given a certain water point, the IPA application can launch the client, which will initially show a map with reference data (administrative divisions, centres of population, orthoimage, road and rail links, orography), hydrological data (rivers, lakes, reservoirs, hydrogeological domains, aquiferous, …), and the water points in the area, with the water point of interest centred in a 1 km^2 area. The usual tools are provided for the user to interact with the map (zoom in, zoom out, full extent, pan, …) and if the user ask for more information on other water point, it will be opened in the application. The client also allows for insertion of new points,

giving the coordinates of the point to the application, in order to complete all the information required to insert the point into the system.

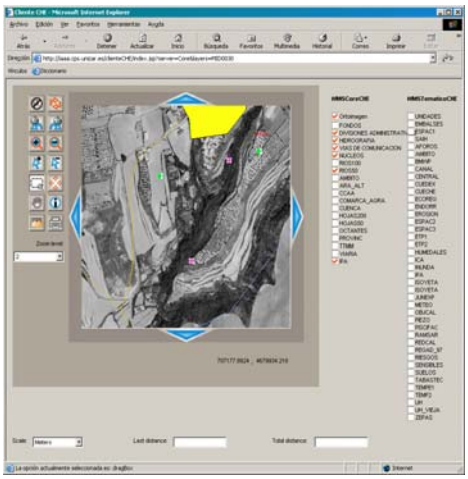

Fig. 6. Web Map Client interface

The informative reports provided by the report server are still available, that is, the whole data point PDF report and the basic data and piezohydrometry series Excel reports, not happening the same the administrative report. The report server need not to be located locally inside the organization, since reports requested are opened by the requester via HTTP from the location the server has stored it.

4.2. Data consult organizations

In the case of organizations (most of them public administrations) that are going to be mainly consumers of information, but not providers of it, the application is replaced by a client accessing an OpenGIS standard Web Feature Server. An HTML interface allows the user to specify a query of a set of points. A result showing basic data of the points is then shown. If the user wants more information any of the points, he or she has the possibility of requesting all the information available about that particular point that is shown to him as the PDF report produced by the report server. Users can also visualize maps using the same client that has been presented previously, showing the result points via the same Web Map Server through a Style Layer Descriptor. The architecture has been previously shown in Fig. 5.

4.3. General Public

As it is stood by the Water Framework Directive in the aspects related to public participation, information supply is the base for allowing consultation and active involvement from general public, stakeholders and other authorities. Regardless the Water Framework Directive, giving access to the data to the general public is also one of the duties of the CHE. This is achieved by giving access to the general public to the datasets created by and property of the CHE and by giving access to up-to-date information stored in the inventory, such as last quality net point status to the public in general or about the process status of a particular dossier to its stakeholder.

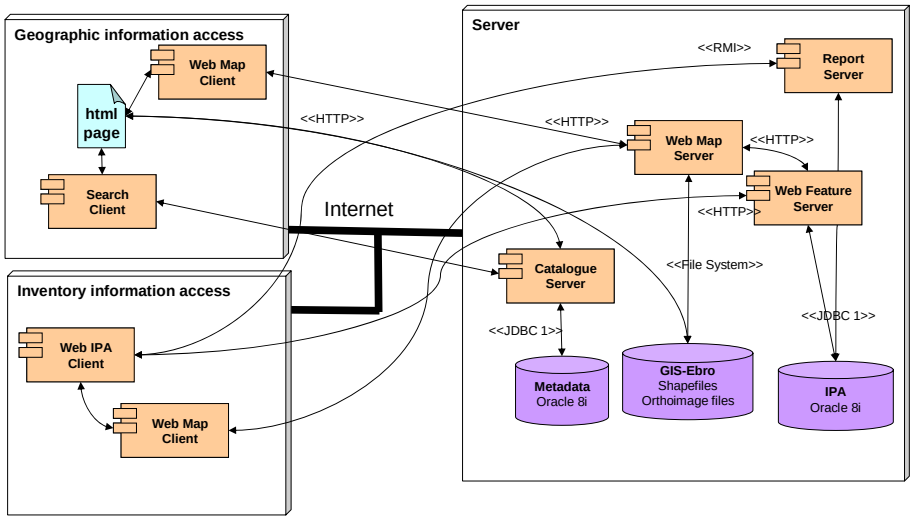

Fig. 7. General public access

Access to the data (Fig. 7) is achieved by a set of static html thematically structured pages held in the CHE's website, that allow the users to browse the dataset metadata, to access the web map server client to visualize it, and, eventually, to download the datasets (Fig. 8). A search tool is also available, so the user can query the same catalogue service that is accessible through ArcView inside the OPH to get dynamically created html page with all the datasets fulfilling the query restrictions imposed. As with the static pages, the user can visualize the data result of a query with the map server client and download it.