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WEB CATALOG SERVICES OF GEOGRAPHIC INFORMATION, AN OPENGIS BASED APPROACH IN BENEFIT OF INTEROPERABILITY

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1. INTRODUCTION

The geographic information (also known as geo-spatial data) is the information that describes phenomena associated directly or indirectly with a location with respect to the Earth surface. This information is vital for decision-making and resource management in diverse areas (natural resources, facilities, cadastres, economy...), and at different levels (local, regional, national or even global) [1]. Nowadays, large amounts of geographic data are gathered by different institutions and companies. In fact, it is recognized that around 80% of the databases used by the public administration contain some kind of geographic reference (postal codes, cartographic coordinates...). Nevertheless, in many cases geo-spatial data-consuming companies or people do not find the data they need and they usually pay data suppliers for custom-made products. Moreover, it is usual to find that, even among different divisions of the same company, there is no knowledge about what data is currently available. This lack of synchronism leads into a consecutive recreation of data with similar characteristics.

One solution to manage this problem is through the creation of spatial data infrastructures [2]. The main goal of this kind of infrastructures is to facilitate and enable an efficient exploitation of geographic information to the multiple stakeholders in geographic information market. One of its main components is a geographic catalog that enables users or application software to find information that already exists anywhere within a distributed computing environment. Geographic catalogs [3] are a solution to publish descriptions of geospatial data holdings in a standard way that enables search across multiple servers. In fact, they are discovery and access systems that use metadata as the target for query on raster, vector, and tabular geospatial information. The use of indexed and searchable metadata provides a selected and disciplined vocabulary against which intelligent geospatial queries can be performed, thus enabling the understanding among users from the same community or even belonging to different geographic information communities.

However, it does not seem reasonable to think about the development of different catalogs that work like standalone nodes and are accessed only by client applications developed by the same company or with the same technology. In this sense, the effort developed by OpenGIS Consortium (OGC) trying to promote the standardization mechanism for catalog query provides the tool to make possible this enterprise and technological independence. The objective of this paper is to show the work developed by a research team at the University of Zaragoza to develop a geographic information catalog that complies with the WWW profile of the OpenGIS Catalog Interface specification (version 1.1). The rest of this paper is structured as follows. Section 2 presents the interface specification proposed by OGC and the problems and weaknesses detected, as well as the solutions proposed during the development process. The design of the catalog is presented in section

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3. Section 4 shows how to deploy this catalog on the Web. And finally, this paper ends with some conclusions.

2. OGC INTERFACE SPECIFICATION

The OGC Catalog Services specification [4] describes a set of service interfaces that support the management, exploration and access to geospatial information. This specification also provides different profiles for these interfaces according to the distributed computing platform where they are going to be implemented. In particular, within this specification the profiles for CORBA, WWW (compatible with the search and retrieval protocol Z39.50, very popular in the world of digital libraries) and OLEDB are provided. This work shows the implementation of the WWW profile.

The WWW profile proposed by OGC is based on a message-passing client/server architecture. The profile establishes a mapping between each one of the operations belonging to the catalog interface general model and the corresponding service specified by the norm ANSI/NISO Z39.50 (also gathered at international level like ISO 23950 [5]). Besides, the WWW profile specifies the use of one of the following transport mechanisms:

- Directly over TCP where the services are encoded using the Basic Encoding Rules (BER [6]). This option is in fact the direct adoption of the Z39.50 standard, which according to BER rules encodes the protocol messages (specified in Abstract Syn-tax Notation ASN.1) as binary octets.
- Or by means of Hyper Text Transport Protocol (HTTP) where the services are encoded using XML Encoding Rules (XER [7]). XER are encoding rules analogous to BER but translating the protocol messages into XML, thus enabling the transport over HTTP.

The implementation presented in this work has chosen the second of these transport mechanisms. The client sends request messages to the server, which in turn responds to them over HTTP. Within the interface for this implementation, each operation of corresponds to a Z39.50 service, each service consisting of a client request message and the pertinent server response message. Only the mandatory operations in this specification [4] have been implemented, that is, the services concerned with search and result-presentation.

During the development process, some problems and weaknesses have been identified in the OGC specification that had involved the adoption of a set of decisions and assumptions. The more important ones are detailed next:

- Selection of the query language. The query languages (for restrictions creation) that appear in OGC specification are the OGC Common Query Language [4] (similar to the specification of WHERE clauses in SQL) or RPN languages (Z39.50 protocol languages to specify restrictions), but it does not exclude other languages (the specification in XML of the restriction within a SearchRequest message is flexible and allows the use of other languages). In fact, in the last OpenGIS specifications (Web Feature Server [8] or Web Services Stateless Catalog [9]) the generalized form to express restrictions is by means of a specification denominated Filter Encoding Specification [10], which is based on XML language. Moreover, thanks to the advances in technologies and tools available for the treatment of XML, this language is much more suitable for the catalog implementation or for the creation of user interfaces that facilitate the construction of restrictions. Therefore, given its widespread use and additional facilities, this last query language has been selected.
- Some optional services have not been implemented. There are some messages for service-requirement messages, which are specified in the optional part of the OGC interface, that is to say, they do not correspond to any mandatory message. The most reason to justify this omission is that they are not offered in later specifications of OpenGIS with analogous objectives. This is the case of services catalog specification (Web Services Stateless Catalog [9]) which differs from a

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geographic information catalog in that services catalog manages metadata describing services while the second one manages metadata describing geographic resources. Anyway, this implementation provides a default treatment of these services, but the response messages given to an OGC client indicate that the service is not supported. This allows the server to be complete and consistent at any circumstance.

- Difficulties in the understanding of the specification. The specification presented by OGC results a bit cryptic and incomplete. A detailed study of the official specification of the ANSI/NISO Z39.50 - 1995 [5] was required in order to clarify the content (definition of attributes, domains,…) and scope of the messages exchanged between client and server.

3. CATALOG DESIGN

The implementation of the OGC standard interface has been based on the use of a geographic information catalog component, denominated CatServer [11] that had been already developed by the authors of this paper. For the development of this component, the functionality offered by the different OGC interface profiles (especially the CORBA profile) had been taken into account. CatServer is a Java component accessible via Java-RMI that is able to manage user sessions. The services offered by this component correspond to those of the interface in charge of administration and discovery (search and presentation) of metadata. Besides this, this server offers additional services for the own management of this catalog such as users control, license control, statistics of use and so on. More details about this component can be found in [12].

Two main elements can be distinguished in the design of the OGC catalog: the design of the server and the design of the messages that will be exchanged between client and server. **Fig.1** shows the basic classes that integrate the server. OGCServer class provides the HTTP interface, because it inherits from the Javaclass HttpServlet, and implements the characteristic methods of a servlet. Additionally, it communicates with the SessionsCatServerRequestProcessor class that, by means of the service processRequest, takes care of all requests, identifying them and invoking the appropriate private service of type processRequest, which corresponds to the processing required. These private methods are those that call the suitable services of CatServer component and compose the response messages.

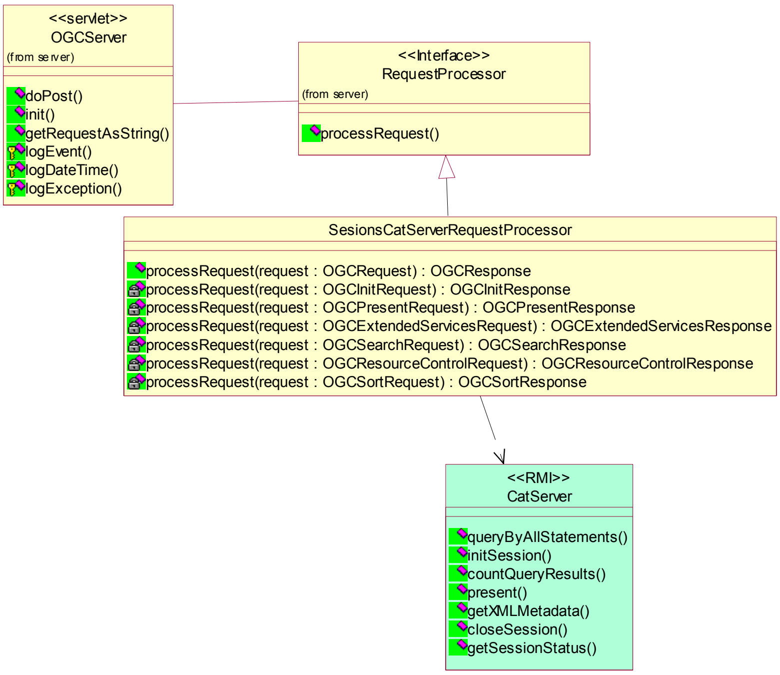

Fig. 1 Design of the OGC catalog server

Fig.2 shows the sequence of calls that are performed to attend a typical request (in this case the client asks for the presentation of results corresponding to a previous search). When a client makes the request, the method doPost of the servlet obtains the request as a String and translates it into an OGCRequest object. Next, the generic method processRequest from the SessionsCatServerRequestProcessor class is invoked. And depending on the type of request, it will invoke the corresponding private method processRequest (in this case, supposing that the client has requested a presentation of results, it would invoke the processRequest(OGCPresentRequest) method). This is the method in charge of invoking the corresponding service in CatServer component (in the example it is called present). Once the CatServer has done its job, the processRequest service will verify that everything has been successful in CatServer, will complete the response message for the client, and will return this message to OGCServer servlet, which in last instance will deliver it to the client.

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Fig. 2 Sequence of calls to attend a request

The aforementioned communication mechanism is based on exchange of messages that are encoded in XML according to the standard interface specification. The management of these messages is made through the classes that appear in **fig.3**. The *OGCMessage* class gathers all the methods and common attributes to all the messages, both requests and responses. The *OGCRequest* class manages exclusively the common elements to request messages, while the *OGCResponse* class manages only the common ones to the responses. Finally, each kind of request and response message has its own class with attributes and methods. The constructed catalog implements the messages of OGC interface corresponding to the services *Init*, *Search*, *Present*, *ResourceControl*, and *Close*, and gives the necessary support to implement in the future the services *Sort* and *ExtendedServices*. **Fig.3** shows only two request messages and their corresponding responses so as to simplify the class diagram and make it more understandable.

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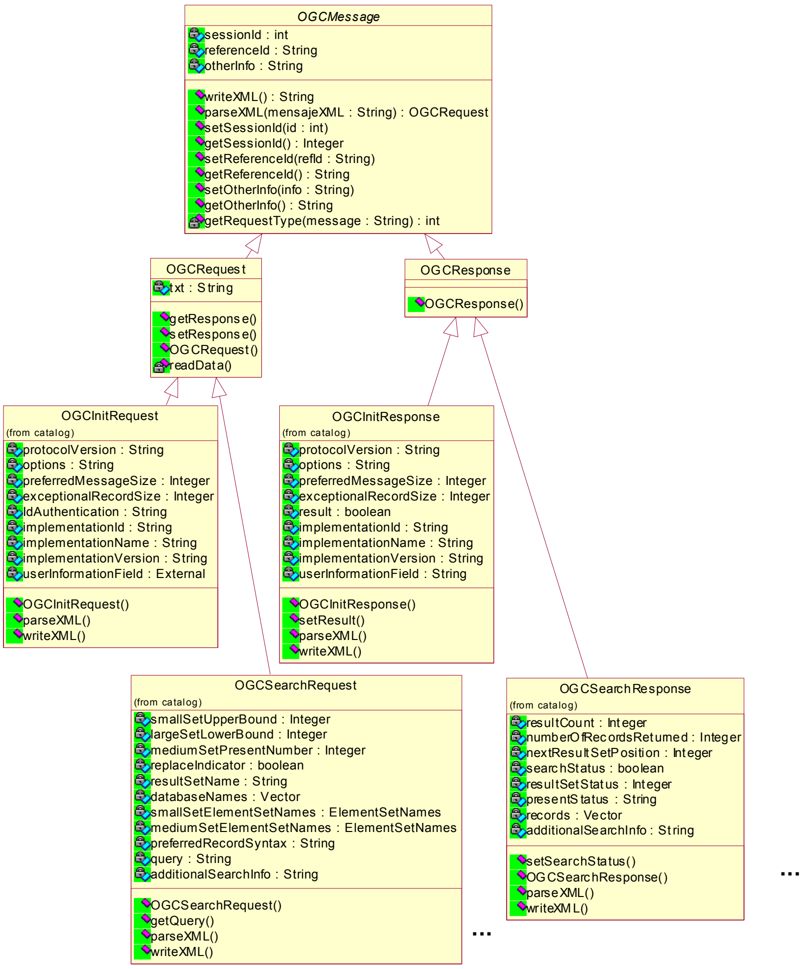

Fig. 3 Messages system of the OGC catalog

4. DEPLOYING THE CATALOG ON THE WEB

At present, there exists an operative version of this OGC-compatible catalog implementation that has been installed on a Web server hosted by the University of Zaragoza (see **Fig.4**). This version works against the same instance of the catalog server (CatServer) that is usually accessed by other researchers for development and technological demonstration purposes. Additionally, this version allows the selection of the metadata standard that will be used to specify the property names in search requests (Search service) and to receive metadata records (Present service). Currently, it is possible to choose between the American standard from the FGDC [13] and the almost definitive version of the international standard ISO/19115 [14].

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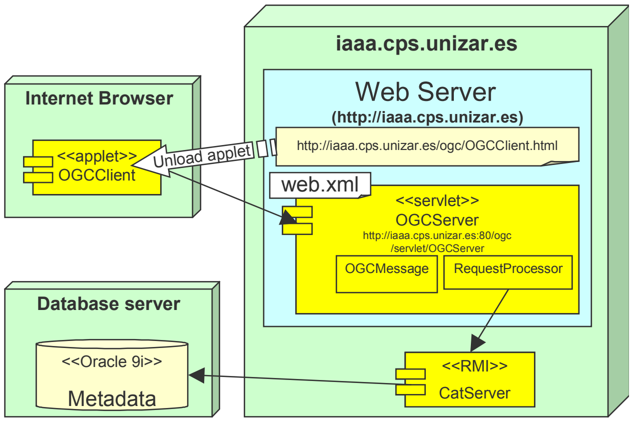

Fig. 4 Deployment of the OGC catalog

Through the URL http://iaaa.cps.unizar.es/ogc/OGCClient.html, a catalog client, implemented as a Java applet, can be downloaded to perform queries against this catalog. This client offers a simple graphical user interface whose main objective is to validate the correct implementation and operation of catalog services. It does not aim at offering an ergonomic interface; it just serves as technological demonstration (see **Fig.5**). In this URL address, it is also possible to download a user manual, which contains the instructions to use this client as well as the way to connect directly to the server from any client compliant with the OGC specification. The URL of this server is http://iaaa.cps.unizar.es:80/ogc/servlet/OGCServer.

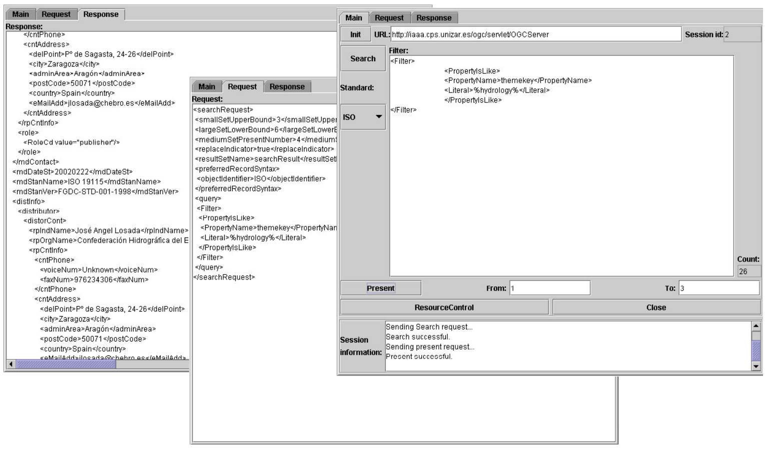

Fig. 5 Applet client giving access to the OGC server

5. CONCLUSIONS

This work has presented a geographic information catalog compatible with the WWW profile of the OpenGIS specification that has been developed by the University of Zaragoza. This development has been implemented in Java and has made use of a catalog server component, which had been already developed by the authors of this paper. This work complements this previously developed component since this OGC interface enables the instantiation of interoperable geographic information catalogs within distributed networks where each catalog node complies with the same interface, but whose implementation do not need to have been developed with the same technology. Given the frequent technological dependence derived from the election of a particular product or technology, this development based on standard interfaces results crucial to avoid problems of interoperation.

At this moment, the authors of this work have initiated contacts with OpenGIS in order to ask for certification conformity of this catalog. The main problem to obtain this conformity is the inexistence of the appropriate test suite tools to verify the compliance. Apparently, this is the first request received by OpenGIS to certify this profile implementation. Given the great interest that exists in geographic catalogs at worldwide scale, and the clear trend towards the creation of Web Services based on XML technology, it is believed that the low number of certification requests can be explained by the complexity of this work, rather than by the little interest.

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