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Geographic Information Standard Web Services to Improve Interoperability: an Olive Tree Recognition Application

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Abstract. Geographical Information Systems are currently in the process of adaptation to the Web. In order to make it easier the interchange of information between GIS components in the Web, several standard web services have been created. This paper shows the advantages of a standard web services based architecture in the development of a GIS application, over specific solutions that only aim to provide the requirements needed. A GIS application for automatic olive tree recognition, is presented as an example of these advantages.

1 Introduction

On one hand, the World Wide Web has become an important vehicle for information distribution, and Web based Geographic Information Systems are quickly evolving and adapting to this environment. On the other hand, public administrations are important consumers of geographical data and users of GIS applications. In these administrations, much data is usally needed in different departments for different uses. This fact suggests the design of GIS applications developed over web services based architectures, able to interoperate by means of public standard interfaces, allowing thus the remote use of data, owned, created or maintained just in one department, in different kinds of applications.

Many European countries, including Spain, have to check the number of olive trees declared by farmers against reliable data, in order to provide them with subventions from the European Union. This paper shows the use of a web services architecture in the development of a GIS application that supports a computer-assisted olive tree counting on aerial images. This application has been developed for the Agriculture Department of the Spanish region of Aragon. The breaking down of this application into different services allows that, in a future, other software can take advantage of them, and also guarantees that incorporating new data and functionality will be easier.

2 Motivation

European Union subsidies to loss-making agriculture areas allow the growth of high quality and low price competitive products. The policy taken by the European Union, regarding to olive trees farmers subsidies, is that the amount of money received by these farmers is based on the number of olive trees they own. The numbers calculated by the administration are collated with those declared by the farmers to ensure right funds allocation. This checking now usually requires in situ inspections carried out by personnel of the administration. To reduce the huge effort made by these personnel, solutions based in remote sensed data, for example from aerial images, are being adapted.

There are five countries involved in olive trees subsidies: Spain, Italy, Greece, Portugal and France. In order to assist the olive tree register creation in Portugal and Greece, the Joint Research Center (JRC) of the European Commission developed a GIS tool that enable the computer-assisted counting of olive trees on scanned aerial photography. The work done in this project mainly consists in the development of an algorithm for tree recognition in digitized aerial photography and its integration with a GIS environment (in this case, ArcView) [6,7,8]. The Spanish administration adopted the solution of creating a GIS application [1] (named "SIG Oleicola") that fulfills the specific requirements: the use of techniques that enable the automatic detection of olive trees, and the visualization and management of the geographical information needed in the tree identification process.

In both cases the solutions involve ad-hoc applications that only provide local data access, probably with a high cost, and that have several limitations, mainly related to their lack of interoperability. This makes difficult communicating with other software components, integrating new geographic information (i.e. more accurate aerial images or other cadastral raster information), or adding new ways to manage the information linked with the olive tree register.

3 Web Services Architecture

In the emerging open and distributed environments, interoperability is essential for many systems, including GIS-based applications. Interoperability involves the development of methodologies, models and tools to allow sharing, exchange and control of data [12]. The objective is to allow a collection of information systems to interoperate by means of well-known interfaces. The efforts of the OpenGIS Consortium [2] have been realized in several specifications that describe a technical infrastructure for the interoperability of GIS systems.

The OpenGIS Consortium, in its Web Services Architecture specification [3], includes three main types of georeferenced information access services: Web Map Server (WMS), Web Coverage Server (WCS) and Web Feature Server (WFS).

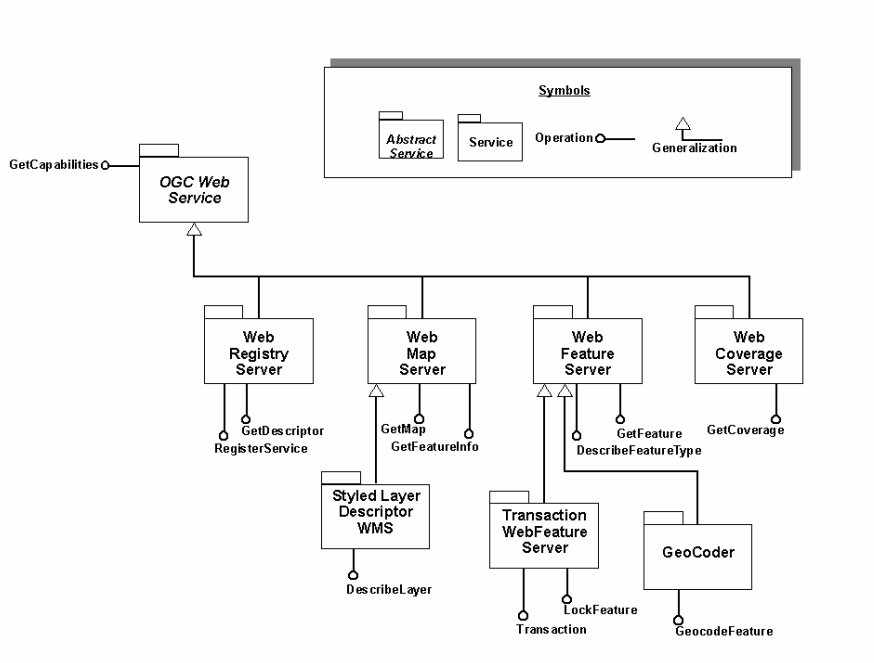

Fig. 1. OGC Web Services Architecture diagram

The Web Map Server (WMS) [4,10] provides specialized capabilities that support the visualization of geospatial information. It produces a visual representation of the geographical data requested by HTTP clients, and also allows the interoperation with other software by means of its well-known interfaces, which specify the way maps are requested by clients and the way servers describe themselves. The Web Feature Server (WFS) [11] and the Web Coverage Server (WCS) [5] provide access to collections of data, also through well-known interfaces. The WFS delivers GML representations of geospatial features in response to queries from HTTP clients. Clients access geographic features through a WFS by submitting requests for just those features they need. A WCS supports the interchange of geospatial data as raster "coverages", in contrast with a WMS that only returns images. Different services can be chained to support information production workflows.

4 Architecture of the Olive Trees Recognition Application

Besides the automatic olive trees recognition, the visualization of geographical information useful in the identification process is another requirement of the system. The geographic information used by this system can be divided into three groups:

- Vector information: groups all the digitized vector cadastral information that represents the parcel bounds and other additional information about

parcels, and the geographical elements that surround them. This information is not available for all the municipalities in the region of Aragón.

- Raster information: is made up of the ortho-photographs, with a 1 meter resolution, used as basic cartography, and the scanned maps needed for the areas where vector information has not been created yet.
- Alphanumeric data: this information includes values related with olive trees (number of trees, geographic coordinates…).

In order to overcome the limitations that similar systems show, an architecture based in web services was designed, with the OpenGIS compliant components described before. The vector cadastral information is accessed by means of a WFS that delivers the requested features (parcel lines, parcel centers, …) for a specific geographical extent, or associated to a cadastral identifier (numeric). Another WFS is used to retrieve the olive tree locations from the existent official register. A WMS is responsible for providing the graphical representation of the ortho-photographs and the raster cadastral data. An interaction with a coverage server is needed when a scanned map is requested. The WCS provides the extent of the desired scanned map, since this information is requiered to make the following requests to the WMS.

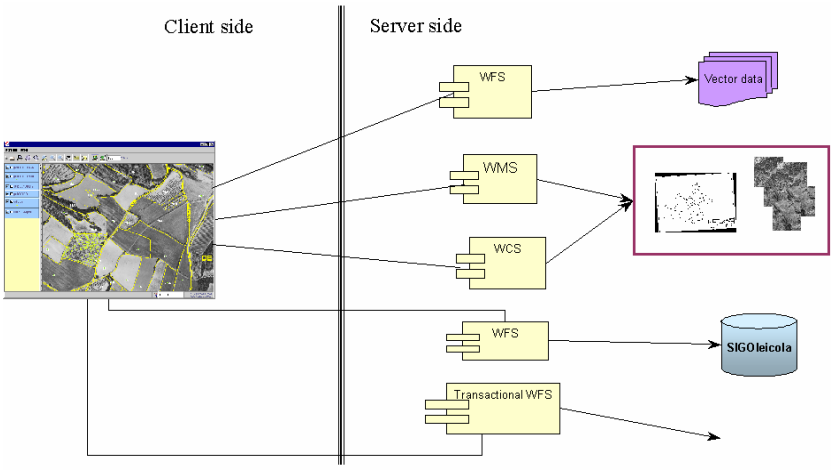

Fig. 2. Architecture of the olive tree recognition application

Using these standard components allows for future uses of the services they provide by other software components, by means of their well-known interfaces. This is important considering the fact that the services offered may be generic enough to be useful for other entities or administrations or for applications solving different

problems. The development of a component based GIS may also enable the design of customer specific interfaces [9], i.e. web clients, or remote applications, giving the same functionality with different end-user interfaces. Another important characteristic of this application is its extensibility, that allows for the easy inclusion of other geographic data.

4.1 Olive Tree Recognition Application

The main use of this information system is the visualization of the cadastral information with all the information linked to the register of olive trees. A cadastral municipality is formed by polygons. Each of these is divided into one or more parcels. The two geographical entities that lead the users workflow are these polygons and parcels. The user selects the cadastral unit that desires to visualize and the application makes the required requests to the right servers, depending on its type (vector or raster). If the unit selected is vector type, the application shows the polygon and parcel bounds, the subparcel bounds if they exist, the parcel center and some important geographic elements as rivers, roads or villages. If the vector information for the parcel or polygon requested is not available, the corresponding scanned map is used (Fig 3). Each of these maps represents a polygon, except when the polygon is large enough to be represented in several maps.

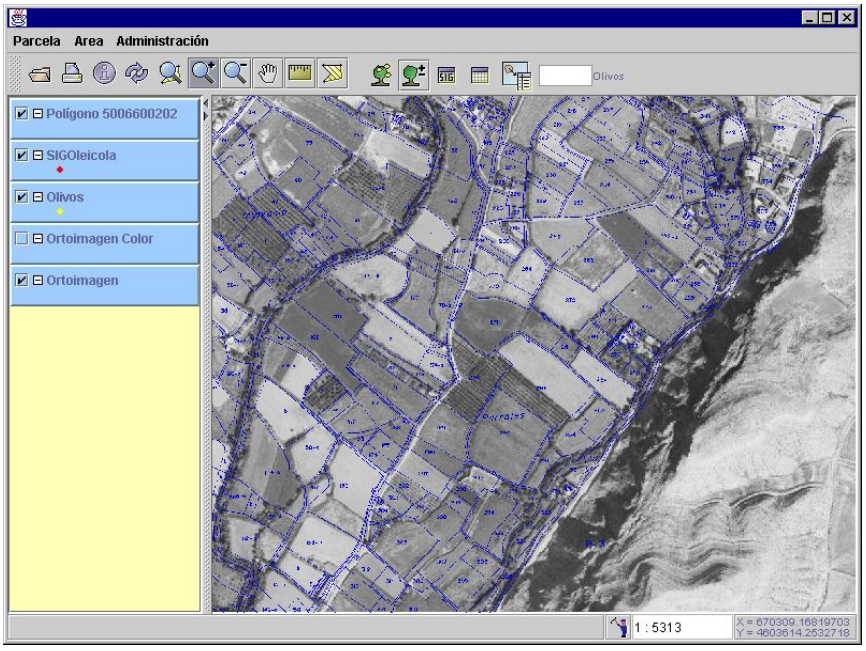

Fig. 3. Visualization of a raster cadastral data.

Previous olive trees registered locations can be visualized (Fig 4). These positions can be modified carrying out a process to detect them on the image. The resolution of the ortho-photographs (a pixel size of 1 meter) allows the applying of computer vision techniques to identify olive trees on the image. This detection process is interactive, allowing the user to improve the results manually, and requires user supervision to obtain the most suitable parameters for a certain zone, since the olive trees could vary in shape, size or colour between zones.

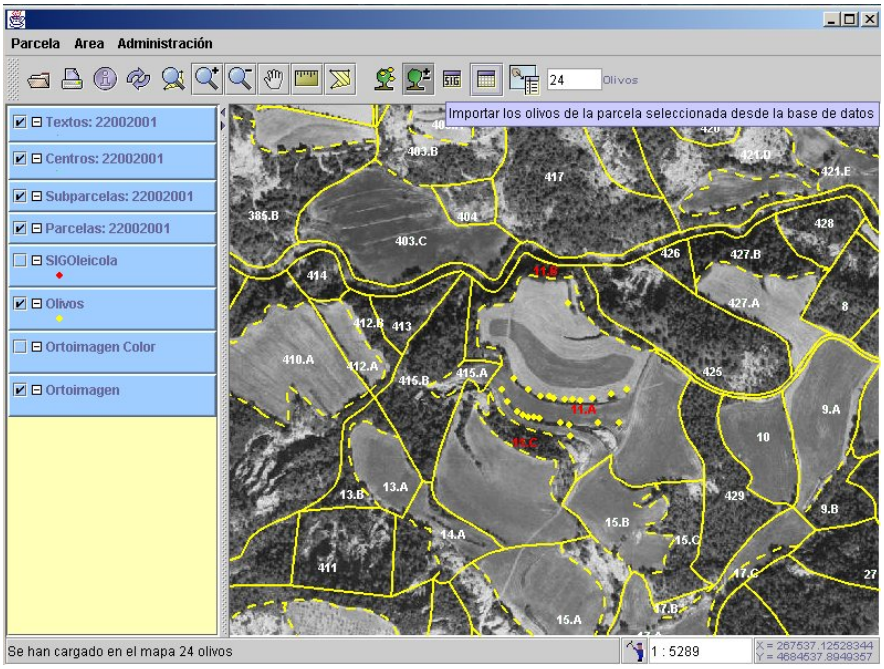

Fig. 4. Olive tree recognition

5 Conclusions and Future Work

In this paper the advantages of using a standard web services based architecture in the development of a GIS tool have been presented. This architecture leads not only to the fulfillment of the user requirements, but also to the design of an open, standard system, able to interoperate with other systems. Through the case of the olive trees identification system we have been able to show more clearly the advantages of this interoperability. Other solutions previously developed, only provide the user functional requirements, whereas this application adds the ability of providing or requesting services to / from other components without architectural changes. As an

example, the architecture presented here has been reused to create a thin web client that provides the remote visualization of the cadastral information involved in the application.

In the future, new services and new geographical information will be added to the system and this system will also need to request information from other standard servers. The chosen architecture will allow for these improvements without major changes, and will also continue to offer these new services and data to other software components from other departments by means of its standard well-known interfaces.

6 Acknowledgments

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7 References

[1] Sig Oleicola Home Page. http://w3.mapya.es/dinatierra_v3

[2] OpenGIS Consortium Home Page. http://www.opengis.org

[3] Atkinson R., Martell R. (ed.), *"OWS1 Web services Architecture"*. April 2002, available in http://www.opengis.org/techno/abstract.htm

[4] de La Beaujardière J. (ed.), *"Web Map Server Implementation Specification (WMS)"*. January2002.

[5] Evans J. D. (ed.), *"OWS1 Web Coverage Service (WCS)"*. April 2002.

[6] Gallego F.J., Kay J., Léo O., Delincé J., Fine J., Ambrosio L., Dellaportas P., Balli F. *"Estimating the number of olive trees in the European Union"*. Proceedings of the 52nd Session of the International Statistical Institute, Helsinki, Finland, 1999.

[7] Kay S., Léo O., Peedell S. *"Computer-assisted recognition of olive trees in digital imagery"*. http://mars.aris.sai.jrc.it/wine_olive/olicount2000

[8] Peedell S., Kay S., Giardino G. *"Seeing the (olive) trees from the wood – using GIS in Europe for olive tree identification"*, ESRI User Conference, San Diego, July 27th-31st , 1998.

[9] Pereira P., Neves, N. Silva J.P., Muchaxo J., Câmara A. *"Interoperability of geographic information: from the spreadsheet to virtual environments"*, chapter from Interoperating Geographic Information Systems, edited by Michael Goodchild, Max Egenhofer, Robin Fegeas, Cliff Kottman, Kluwer Academic Publishers 1999, ISBN 0-7923-8436-9.

[10] Shekhar S., Raju R., Sahay N., Burk T. E., Lime S. *"WMS and GML based Interoperable Web Mapping System"*. Proceedings of the Ninth ACM International Symposium on Advances in Geographic Information Systems, Atlanta, Georgia, USA, 2001, pp 106-111, ACM Press 2001, ISBN:1-58113-443-6.

[11] Vretanos P. A. (ed.), *"OpenGIS Web Features Server Specification"*. January 2001.

[12] Yétongnon K., Benslimane D., Laurini R., Leclercq E., Jouanot F., Cullot N. *"GIS interoperability: An Overview"*. Proceedings of Telegeo'2000, Second Internatinal Symposium on Telegeoprocessing, Sophia-Antipolis, France, May 10-12, 2000, pp. 185-204.