Geographic Information System Architecture Applied To Oceanographic Data Acquisition Systems

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Abstract:

In this work a Geographic Information System Architecture for Oceanographic Data is presented. This has been designed by the Unidad de Tecnologia Marina to be used into an Oceanographic Data Acquisition System implemented on board research vessels as a complete Service Layer integrated in the real time data services and also in to the archive data retrieval procedure. The main objective was to use opensource solutions and to follow the directives of the Open Geospatial Consortium in order to implement the different data services.

1 Introduction

The Geographic Information System developed by The Unidad de Tecnologia Marina (UTM) from the Consejo Superior de Investigaciones Cientificas (CSIC) has as a principal goal to give facilities to access and work with the data acquired at research oceanographic vessels *BO Hesperides", "BO Sarmiento de Gamboa", "BO García del Cid*" and Antarctic Station "*Juan Carlos I*" in Livingston island.

This system is easy scalable to accept more platforms and data sources like automatic sub-aquatic stations, buoys and new vessels, where the information with important spacial and temporal components are relevant.

The presented solution set its developed over Open Source projects and follows the OGC (Open Geospatial Consortium) standards in order to guarantee the interoperability of the data and the offered services***Objectives***.

2 Architecture

The system is designed for provide a geographic data access service layer to the acquired data. Is developed using the Data Service Layer Model implemented in the Data Acquisition and Operation System for Oceanographic Ships developed by the UTM.

We have identified and implemented four principal components for this service layer (Fig. 1):

Georepository

This component stores the information of the system and guarantees the persistence of the data. Manages all the spatial and thematic information or mantains a reference to the thematic information. We have been choose PostgresSQL as a relational data base with its spatial extension POSTGIS.

The data load procedure can be in real time, using a specific data service that writes information of incoming data from the different sources to a central repository, and later distributed to a central node that has data from all platforms.

Geographic information server

This component publish data as a map services procedure using WMS, WFS and WCS following the OGC standards [1]. We have choose Geoserver server for its flexibility and overall capabilities for to implement this task. This has been deployed over GlassFish application server and it is capable to integrate heterogeneous data sources like ArcInfo shape files, PostGIS and MySQL databases, KMZ files, GML files and more. Geoserver can do tiling over the visualization layers with cache preload of the cells around of the one that is displayed.

Web client

This component is the user front end for display data, using the WMS and WFS services from the GeoServer, and sends geographical queries to the server. It has been implemented as a web client and developed using the Javascript Framework: OpenLayers [2]. With this, its possible to offer an easy data access and a simple 'first tool' to work with this data: its possible to calculate areas, distances, select and edit different data layers and print maps in pdf format. Also provide access to numerical data associated to each element in a layer.

Thin client

This component is a desktop multiplatform GIS client application. It is developed using Java with custom plugging over the Kosmo [3] Open Source project. This client have the most common functionality for this environment.

2.1 Persistence

All the data its saved in a central server in two different ways depending of the data source and the final use of the data:

- **Raster and Vector files** in their different formats that the system is capable to stores in an ordered directory structure.

- In a **relational data base**. The information its stored in the relational data base PostgresSQL with the PostGIS extension that gives support to geographic objects using a Geometry data type column for the the geographic information. The system use **DBA Managment Server** as a web administration and monitor tool for the data base serve.

2.2 Data Services

Once the data that its stored in the georepository its served with OGC Web Services. OGS services are the integration of different OGC specifications, focused in geoprocessing (WMS, WFS, WCS, WTS, etc..), using *XML and HTTP technology*.

The geographic information server, Geoserver, offers the following services:

- **WMS**: A georeferenced map in form of an image using jpeg, gif, png, svg, pdf, kml, kmz, that is generated dynamically, and accessible using a web browser throw standard Uniform Resource Locators requests.

- **WFS**: Equal to WMS but allows the interaction with the server maps using a Geographic Markup Language, a derivation from XML.

- **WCS**: A geospatial data set in coverage format. As a difference with WMS this service provides the data in original semantic making possible to work directly with and its not only an static representation of it.

2.3 Data Acquisition

Two different ways for feeding data to the systems as been implemented:

<u>In real time</u>

The different sensors generate User Data Protocol (UDP) telegrams with the data that we want to integrate in the data base. These UDPs are processed and integrated as a register in a table of the database where are a Trigger that shoots in the INSERT, to update this registry with the geographic information is defined. In this case, the geometry column is calculated with the longitude and latitude data fields of the registry as follows:

```
UPDATE "public"."posicion" SET
geometria=GeomFromText( 'POINT(' ||
longitud || ' ' || latitud || ')', 4326);
```

<u>Deferred</u>

The data can be loaded to the system from heterogeneous sources to the georepository uploading the raster and vector files to the server to load them in the Geoserver.

Several applications can do this job working directly with the georepository, like **DXF_to_PosGIS**. With this last its possible to import directly from DXF files (the AutoCAD file format commonly used in severeal GIS environments) files to PostGIS. Others like **Udig** are suitable for working with multiple layers of heterogeneous data sources and with it, its possible to add and modify geometries in the layers.

2.4 Data Visualization

The use of publication map services: WMS, WFS and WCS makes possible an easy access to all the information in two ways: Directly with a web browser (Firefox) or from a GIS desktop application like Kosmo, ESRI, QGIS or gvSIG for example. In figures 2 and 3 can we see the data selector layer in the top right corner. Figure 2 shows the display of the navigation line of BIO Hesperides vessel that is used to access to other acquired data by using their acquisition time relationship.

3 Future Improvements

The UTM is working in a oceanographic survey editor. This application its focused in geologic, biologic oceanographic campaigns and others and will be possible to work with a web browser drawing sampling points and navigation lines. It works with WFS and the vector layers with the points and lines are exportable to GPX, making possible to open this with the main navigation program used by ship's crew.

There are this basic work entities:

- sampling points.
- sampling group points.
- Navigation lines.
- Group navigation lines.

The navigation lines and the separation between them will be generated manually or automatically with the depth and another parameter.

4 References

[1] Open Geospatial Consortium Standards. http://www.opengeospatial.org/standards/common. Last visit 15/06/09

[2] J. OpenLayers. http://openlayers.org/. Last visit 15/06/09

[3] J. Kosmo. http://www.opengis.es/. Last visit 15/06/09

5 Figures

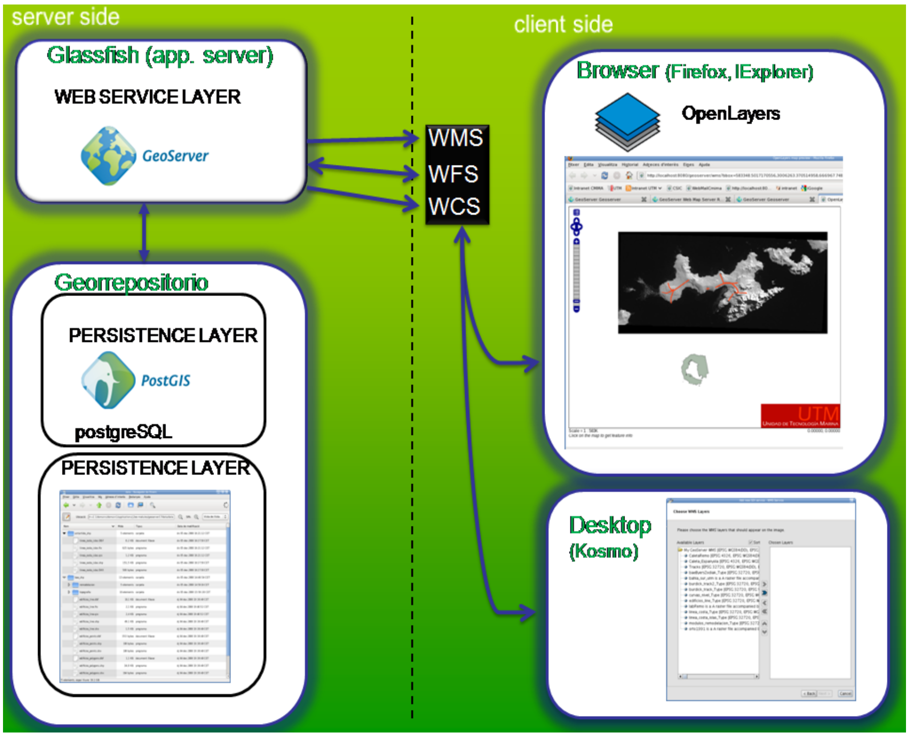

Figure 1: The four principal components of the service layer

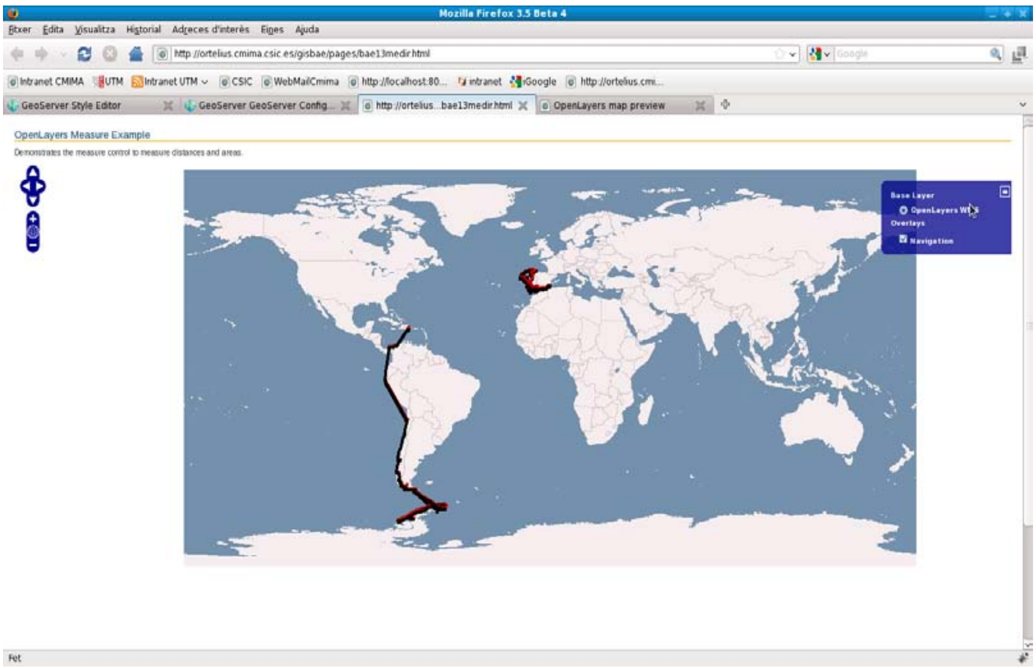

Figure 2: Data display of last 1 year data acquired by BIO Hesperides vessel (navigation track). This map frontend can be used to display data asociated at each ship navigation point.