SPATIAL DATA INFRASTRUCTURE

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Introduction

Background

The Government of La Rioja (Spain), got to work in 1989 on a Geographical Information System that has grown and adapted to the technological development becoming a corporate system.

Since then, the access to geographical information has been fulfilled through our own intranet, by means of using a file server to this aim, that stored raster and vectorial information in different geopositioned formats.

This system has allowed the technical experts in zoning management, to have at their disposal the geographical information, being essential to operate with it the use of computer programmes of geographic edition.

The recent possibility of integrating spatial details within the Management Systems of Relational Databases (RDBMS), has allowed us to tackle more ambitious objectives increasing the optimization of the spatial information within the corporate field.

Once the capabilities of the new spatial modules have been analyzed, the Government of La Rioja, through the County Council Department of Tourism, Environment and Territorial Policy, led in 2003/2004, the IDERioja project, with the purpose of making the geographical information available to all its users and all its management procedures, by means of the use of spatial models integrated in Oracle.

The development at a national and European level of the Spatial Information Infrastructures (IDE/SDI), the recent Proposal of the European Guideline INSPIRE, and the advancement of the normalization mechanisms, have been integrated into the project to meet the internal and external needs of information in a normalized method.
Since the design and initiation of IDERioja Project, we have attempted to reach the following objectives:

**Centralizing and Sharing**

The System of Geographical Information used up to now has met the needs of a small community of users who had at their disposal specialized geomatic tools, being the management of the administrative affairs out of order and not being able to handle the used data format.

The new data model, defined in the environment of a Relational Database, universalizes the access to the geographic information allowing the applications of administrative management to access with no restrictions to the spatial data.

The geographic information is totally centralized, being possible to decentralize the efforts of maintenance and actualization at the same time. These responsibilities are then shared out among the organization correspondingly to the competences of each unit.

Apart from these benefits, the use of a data base also increases the coherence of information, allowing a greater control of the referential integrity and improving the security aspects.

The System Administrator takes the responsibility to backup, prevent non-allowed accesses and the audits management.

In order to be able to interoperate between the data base and the operating tools, it has been defined a data model as neutral as possible, trying this not to be conditioned to the requirements of a given geographical software.
The Technical Committee 211 of the International Standards Organization (ISO), is at the moment in the process of drafting a set of rules 19100, aimed at standardizing the digital geographic information.

The existence of an ISO regulation, once that this is assumed by the Normalization European Committee (CEN) and by the Spanish Association of Standardization and Certification (AENOR), contributes with security in the development and with the starting of the geographical data models. This will finally be of advantage to the quality and the proper use of the data.

In the design of the model, it has been taken into account conceptual aspects already defined in the ISO regulation.

Nevertheless, it is not yet possible to totally standardize the system, due to the fact that many of the development regulations are still in their infancy.

The processing of metadata (data about data) has been implemented in Oracle, developing for this purpose an Internet application, in relation to the specifications in the ISO 19115 regulation and what it is established for the Spanish Core of Metadata (N.E.M) by the Geomatic Committee of the Geographic National Council.

Another aspect taken into account about the standardization, has been what comes specified in the European Project INSPIRE (Infrastructure for the Spatial Information in Europe), materialized nowadays in a Proposal for the European Guideline.

INSPIRE sets out the standards for the development and harmonization of the spatial information in Europe. In this sense, the first stages of the IDERioja project are being developed taking into account what has been established up to now and following the priorities defined in the attachments I, II, and III of the mentioned Guideline Proposal.
Distributing

Any good System of Information has to mediate mechanisms of distribution of the information that would meet the necessities of any user.

IDERioja Project has taken into account the Standard WMS of the Open Geospatial Consortium, in which the development of the Spatial Data Infrastructures leans, to offer in real time access to the available geographical information.

The users information search of the Data Base is carried out through a WMS/OGC Server (http://wms.larioja.org/request.asp) to which it is possible to access from any compatible OGC map viewer.

In order to offer the user who may access our pages, the highest service level, the Government of La Rioja has developed its own viewer which, by using SVG (Scalable Vector Graphics) technology, makes it possible to look up not only the geographic information but also the alphanumeric Database (RDBMS)

Trying to optimize this objective of distributing the information, in this viewer, it will be possible to present the geographical information coming from the Local Administration. The information of each city council will be available in a WMS/OGC Server.

The user will be able to have a full view of all the sources of the spatial data of the Regional and Local Administration of La Rioja Autonomous Region.
Tools

The development of the software for the management of the Spatial Data Infrastructure of the Government of La Rioja has been designed in order to fully use it from Internet, establishing two courses of action accessible from **IDERioja Portal**

- **WMS/OGC Viewer**: General map viewer
- **Management Application**: Access to the Database and ISO 19115 Metadata.

Both actions, being autonomous in its development, are connected to relate the alphanumeric management information to the graphic information of the cartography information in a clear way within the system.

In addition, it will be possible to look up the municipal urban cartography through the **municipal Viewers** or from the same portal.
IDERioja Portal

Accessing the system can be done either from the institutional page of the Government of La Rioja http://www.larioja.org or directly from the following link: http://www.iderioja.org.

From this page it is possible to access all and each of the modules that make the system.

Some of these areas are restricted for internal use by the Government of La Rioja, so the user has to identify themselves in order to access them.
WMS/OGC Viewer

It allows the interactive search through the Internet of all the geographic information, not only the one in Oracle, but also the information available in other OGC compatible servers (Open Geospatial Consortium), to represent it in an integrated way in an only map.

Access is always free, with no need to register in the system.

These are the main characteristics of the viewer:

- SVG Vectorial graphic format (Scalable Vector Graphics).
- Key of the layers (vectorial, raster and OGC) with the possibility of management, visual hiding and access to metadata.
- Guiding map to facilitate locations and movements.
- Lower notice boards: coordinates and scale bar.
- Navigation tools: zoom, centred, distances and areas measurement...
- Notes inclusion in the map (texts y and symbols).
- Possibility of the user to select the system of coordinates.
- Addition of layers coming from other WMS/OGC servers.
- Selection of the layers to be shown in the search.
Management Application

Management Application is the tool of administration, maintenance and search of the whole infrastructure of data. It allows us to keep all the alphanumeric information of the system, and to be able to visualize the associated geographic information.

All the alphanumeric and cartographic information has to be integrated in an only ORACLE data base (with the Spatial extension). This mentioned information has been designed according to the normal process used in the modeling of the relational databases.

The capture and edition of the geometries is entrusted to the geomatic tools enabled to this aim, GeoMedia and ArcSde (ArcGIS, ArcView and ArcEXPLORER), the later only in a consulting form. The access to these tools is made through the Intranet, with customer/server technology.

The application is made of the following modules:

- Geospatial information (INSPIRE).
- Utilities.
- Map viewer configuration.
- Users and menu functions.
- Oracle database Monitor.

The authorized access for the registered users in the system could be done through the password or by means of a digital certification.
- Geospatial information (INSPIRE)

Through a catalogue it is possible to store the definition of all the layers of spatial information. These are internally organized following a structure of family, subfamilies and themes according to the criteria established by the Government of La Rioja. In the Application of Management they are classified according to the INSPIRE guideline.

Foreseeing the starting of GALILEO European project of navigation, positioning and geodesy via satellite, which uses the ETRS89 coordinates system, all the layers are to include double geometry, corresponding to the coordinates systems ED50 and ETRS89.

This module also includes all the auxiliary information associated to any stage, usually defined as code charts.
- ISO 19115 metadata, C.A.R. profile

Through the Web Application it is possible to maintain in Oracle the Metadata catalogue of the existing geographic information and of the used code charts.

The design is based in the core of the international rule ISO/TC 211 DIS 19115 of the Open GIS Consortium, in what is defined for the Spanish Core of Metadata (N.E.M. 1.0 version) and in the particular additions of the Territorial Management Service of the La Rioja Autonomous Region.

Because of the complexity of the model of metadata, the maintenance of the different sections has been facilitated by means of a screen in the shape of a tree diagram, the structure and the state of the information using color icons. For the same reason, it is also given a summarized entrance of information, inspired in the requirements of the Dublin Core.

Finally, we have to add that it is also possible to export all of the information of each metadata to the structured format XMI.
- **Utilities**

This module includes functions of the administration of the system.

It allows the geomantic tools users, the authorization on the objects of ORACLE data base for the edition of the cartographic layers.

It includes tools of analysis of geometries and spatial indexes, related to ORACLE Spatial.

It provides a set of parameters whose values are of general use of the system. For instance, the coordinates $w$ and $y$ maximum and minimum, of the Autonomous Region.

It registers the audit of the objects which contain the personal information.

It makes possible the maintenance of the texts and messages of the system.

Change of the user password.
- Configuration of the map viewer

To show, using the WMS/OGC viewer, the cartography in the charts of the Data Base, it is needed the configuration of its representation by means of a group of parameters that settle the graphic answer.

The execution program of the viewer is made using the concept of “Search”. A search contains information like the system of coordinates in which it is going to be represented and the layer of the maximum rank that is going to delimit its initial representation.

It is also necessary to define for each search the layers that it has to contain, indicating the styles of their representation (basically color and transparency).

Besides for each layer it will be indicated the fields of the layer that we want to provide, taking into account that non-existing data can be defined and that they are not the result of calculations like, for instance the area or the perimeter of a given polygon.

Because the viewer can represent cartography of OGC Servers, these will be incorporated to the system in an interactive way through that module.
- Users and menu functions

The aims of this module are the administration of all the users of the system and the configuration of all the personalized menus.

The areas which compose the Management Application contain functions organized in groups (of maintenance or of search), assigned to the users.

The users will be registered in the ORACLE database, with the aim of maintaining the confidentiality of the password. Each user will be granted a given group by application; this will shape the personalized menu.

Those users who only want to access the cartographic tools will also be incorporated in this module. Nevertheless, to be able to access to the Database layers it will be necessary to confer them authorizations to ORACLE objects in the utility module.
- **Oracle Database Monitor**

In order to facilitate the designers and the project administrators the comprehension of the complex system of loading of the spatial objects, a set of functions have been developed to monitorize the definition of all the aspects of the Database.

We aspire to make the ORACLE data base more transparent to the non-experts in the field without making use of third parties tools.

It also includes the visualization of the middleware used with the geomatic tools, that is, the intermediate modules that act as conductors between ORACLE and GeoMedia or ArcSDE.
Municipal viewers.

With the aim of getting a complete infrastructure of the spatial data of La Rioja, the municipal cartography of all the municipalities of this Autonomous Region (with the exception of Logroño) which currently are in Autocad format is being incorporated to the system.

This geographical information, because of the economy of resources, is not placed in the corporative data base but in files of a shape type.

Applying technologies of free software and making use of the connectivity given by the WMS/OGC servers, a viewer has been constructed (by means of the Minnesota Map Server) that presents the information of each municipality like a WMS/OGC server, not only for its use in this viewer, but also in any compatible tool.

The access is always free, with no need of registering in the system and it is expected to be available through the official page of each municipality.
At present, IDERioja Project has gone from the design phase to the exploitation phase, basically containing thematic information according to what it is specified in the INSPIRE Guideline Proposal.

At the moment, it is still in a definition phase the data model of the 1:5000 basic topographic cartography. Once this phase has been completed and the restitution works have been undergone, the produced information will be integrated into the system.

As it has been already said, the standardized documents are not totally developed up to the moment so, as they are being completed, an effort will be made to adapt the system to what it is specified in them.

At the same time, progress is being made for the integration to the municipal IDEs in the conceptual model defined until now.

Because of the shortcomings of the personal media for the development of the project, it has not been possible yet to tackle other functionalities which are planned to implement in a near future. For instance and among others, the distribution of the information in GML format and the information search services through the catalogue.

The old expectations of the Government of La Rioja of being able to access to the geographic information from all its administrative procedures is now within reach.
Architecture

The adopted architecture is built in order to accomplish the objectives of the system; it is also being adapted to the standards adopted by the Government of La Rioja.

- Sole accommodation of all the cartographic information.
- Access through the Internet of the already mentioned information.
- Integration of the cartography within any management system.
- Universal access to the cartography contained in IDERioja.

- ORACLE Database

The following databases are accommodated in the IBM corporative server under the AIX 5.0 operative system:

- Management Database. They are implemented with the 9i version; they contain not only the information of the corporative application, but also the one relative to each one of the administrative areas of the Autonomous Region.

- Cartographic Database. It will be the only, having already being installed the 9i version with the Spatial option. It will contain all the entities with cartographic information and the entities, helpers of the previous ones, as code charts.

The relationship between each data base will be made through the Database link. This link will be used in both senses; from the management systems, to obtain cartography and in reverse order, to complement the cartographic information with the alphanumeric data placed in the mentioned systems.

- Web Applications Server

The Management Application that it is going to administrate the whole system, is developed with Java, J2EE standard; the elements used for the programming have been JSPs 9Java Server Pages), HTML, Java Script encrusted, Classes Java and Servlets Java.

For the exploitation of this project component, the applications server Sun ONE Application Server 7 are used under SOLARIS operative system. The connexion with ORACLE will be done through JDBC.

- Web Maps Servers

The WMS/OGC Viewer, it is made with GeoMedia WebMap (Intergraph), by means of the use of ASPs of Microsoft, being installed under Windows 2000 server. The access to ORACLE is by means of ODBC.

To some of these maps presentations of the IDERioja Portal, the Minnesota Map Server, access free tool, will be used.

- OGC Server

To provide with the IDERioja and Municipals OGC servers, the same software than for the WMS/OGC Viewer, will be used.

- ArcSDE Server
This server is used to connect ORACLE Spatial with all the geomatic tools of ESRI, ArcGIS, ArcVIEW and ArcEXPLORER.

- Geomatic tools.

The system is prepared for the edition and maintenance through GeoMedia PRO. In the search mode, it can take ArcGIS, ArcVIEW, ArcMAP and ArcEXPLORER tools, through ArcSDE server.

- User browsers

The access to the system through IDERioja Portal will be made through the Internet browser Explorer, which will have to have plug-in ADOBE SVG (Scalable Vector Graphics) installed for the visualization and handling of the maps.

- Diagram
Database Organization

The first step in the analysis of the project has been to define a model and a structure of the ORACLE data base compatible with the needs of a system totally accessible from Internet and with the characteristics of GeoMedia and ArcSDE in its integration of ORACLE Spatial.

These are the most outstanding aspects of the design of the Project in its implication with ORACLE:

- Users
- Nomenclature of the objects
- Security
- Integrity of the information
- Users

All database users can be divided into two groups, administrator users and system users, either of the Management Application or the cartography keepers:

- ORACLE and ORACLE Spatial administrators: Sys, system and mdsys users.
- Administrators of the geomatic tools GeoMedia y ArcSDE: gosys and sde users.
- Administrator and owner of the Special Data Infrastructure: IDERioja user.
- System users, either to access to the Management Application or to the geomatic tools.
- Nomenclature of the objects.

As a consequence of the existence of an only user owner of all the objects of the IDERioja system, we have been pursuing a strict set of rules used in the nomination of all its objects.

- Prefixes: all of the entities has been catalogued in different groups, assigning different groups of characters to each one: ICO-*, IDE_*, MET_*, etc..

- Names: Acronyms will be used, with the exception of the charts correspondent to cartography (IDE_*). They will be nominated in a more explicit form in order to facilitate their comprehension from the geomatic tools.

- Names of the columns (fields). Each chart of the system will have assigned an only prefix of one or two characters, to identify all its columns. For the rest of the name off the column, acronyms will be used with the exception of cartographic charts (IDE_*), to make their comprehension easier from the geomatic tools.

- Suffixes. They will be used to identify the rest of the objects of the ORACLE Data Base which are not charts, like '_V' for views, '_I' for indexes, '_X' for spatial indexes and in a similar way for the rest of the objects.
- Security

The control of the security system is based on the concessions and authorizations of ORACLE, given to the users and objects of the system.

The administrator users of ORACLE, ORACLE Spatial and GeoMedia have permission on ORACLE, like the DBA role or equivalent privileges.

The administrator user of ArcSDE, only has the authorization to create its own objects (connect and resource roles).

The user owner of the Special Data Infrastructure, being also the administrator of the system of spatial data has also attributed the following privileges:

- System privileges: Apart from the common ones of creation of objects, they have been given the ones relative to the audit, comments, ORACLE dictionary, sessions and users.

- Privileges on GeoMedia objects: Of reading and actualization of all the objects of the administrator user of GeoMedia.

- Privileges on ArcSDE objects: Of reading and actualization of some of the objects of the administrator user of ArcSDE.

- Authorization of the ORACLE audit.

The system users will have the following permissions:

- System privileges: They will only be able to open sessions with no access to any object of the database.

- They will not load information in their own charts, but they will access the database in maintenance mode or in search mode, through the application, depending on the permitted functions of their personalized menu.

- If the users have to update, it will be necessary to give them additional privileges on the layers to maintain by means of the use of ORACLE roles.
- Integrity of the Information

The use of the different tools for the access and maintenance of the cartographic Data Base, either from the Management Application, or from the geomatic tools, has favored the need to use the ORACLE properties to ensure the integrity of the data.

Therefore, in order to preserve the coherence of the data, the validity and the structure of the information, ORACLE has been delegated the guarantee of those controls and not those of third parties tools. This has been made by the intensive use of constraints and triggers.

Through these procedures, the compulsory data will be verified, single non repeated data, correct encoded, etc, as well as all kinds of format validations.

Additionally, the ability of the ORACLE dictionary to load the comments on the charts and columns has been used. These comments have been used as texts and fixed headings of the screens of Management Application, in a way that the system administrator users will be able to modify them with no need to alter the programmation of the mentioned application.
- Integration with other systems.

To keep to the objectives of the system, the integration of the cartography found in IDERioja with the management systems found in DDBB ORACLE, is carried out by means of links between the databases (*database links or gateways*).

These links are made through the users expressly defined to restrict the access only to the authorized objects.

The following diagram outlines the integration between systems: