

# Collaborative Geographic Information Systems for Business Intelligence

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**Abstract** – This paper shows a number of sceneries where information (specifically, geographical-related information) is lost because there is no method for storing or sharing it. This research has been done with the aim to solve those scenery problems in a general way, by means of a geographical information system that can store geographical-related information and publish it in order to avoid loss of information and enabling geographical information sharing.

**Keywords** - *Geographical Information System, Business Intelligence, collaboration, universal access.*

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## I. INTRODUCTION

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In most organizations often occur the same problems in different places. As organizations are focused on a field or in several related fields, it is normal that their workers have to face daily with similar problems. However, they always spend a lot time with problems that never before have been happened and, once solved, is easier to deal with them again if they return. But this will only happen if the problem is found by the same person or someone that knows how to resolve it. If the person that found the problem hadn't been found before he/she will spend some resources thinking about a solution to what an amount of time was already spent. Furthermore, it is illogical to think that problems will always meet the same person.

There are many situations where:

- There are communication difficulties between employees, especially when they aren't in the same department.
- Work is done twice because nobody knows that before someone solved the same or similar problem.
- Once a work is done it is forgotten forever.
- In a company, there are people, and even departments, that are overloaded while others are idle.
- Work is sometimes somewhat inhumane because there isn't communication nor there is a chance to collaborate with people who worked on it.

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It is also common that people within that organization do not have time or space to talk about them and realize that many problems can be solved if everyone cooperates by offering its experience. Power of Knowledge [6] is a common topic, especially within a company, but as famous ad asserts, Power is nothing without control.

In any case it is well known that communication between people or within an organization can improve them in multiple ways, due that improve performance, resolve problems faster, impulses innovation and creates a better working environment [1]. Business Intelligence along with Geographical Information Systems can achieve these goals.

This document will explain a real problems and real solutions that are able to solve the loss of information in an organization. First, solution features will be presented. Then state of the art will be studied. A real prototype that solves the problem will be explained. Finally, future research will be presented.

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## II. COLLABORATIVE GIS

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As introduced, there is a problem of dialogue / collaboration in most organizations. Before making any development following should be considered:

- Does this problem exist in real world?
- Is there software to solve the problem?

To answer the first question two real cases will be explained.

### *A. Solidarios para el Desarrollo (Solidarity for Development)*

Solidarios para el Desarrollo is an spanish NGO established in 1987 that works in more than 150 social programs. Program of Care for Homeless People is one of those programs. The volunteers meet in the facilities Complutense Univesity in Madrid, where they prepared food like sandwiches, coffee, soup ... Each volunteer is assigned in a group that, once food is prepared, they follow a predetermined route through the streets. With the excuse of a sandwich or a hot coffee, volunteers come to homeless people to engage in a conversation with them and make them feel like a person and not like urban furniture [14].

In this program geographical information is very important. To perform a good following of homeless people is very difficult if there aren't suitable tools. At these routes, a lot of problems are encountered by volunteers. Many of these situations had been solved by other volunteers, but due to lack

of tools, that knowledge is lost. Sometimes the situation is never repeated, but when it has been common among the volunteers, they have found good solutions that would not have succeeded without such collaboration.

At other times the organization wondered about the social reality that is being addressed, i.e. do not have sufficient means to measure how many people are assisted, how they spread, why they are clustered in certain areas, which are the most problematic cores etc.... Most of this ignorance is given by lack of communication between members of the NGO. Actually one of the largest disappointment is that a volunteer doesn't know if her/his work is encompassed within another larger, which really can change a situation of social injustice.

#### *B. Comboni Missionaries*

The Comboni Missionaries are a religious order that assist several social problems around the world following the idea of helping the most abandoned without frontiers, started by Daniel Comboni [4]. Comboni Missionaries work around the world, especially in those places where there are more basic needs. They work in very different places, but when two missionaries are together and talk about problems they realize that their mutual experience would have been very useful if they would contact before. For example, on one occasion a comboni missionary performing their work in Ecuador, specifically in Esmeraldas, met a local person who had visual problems. His entire family depended on him. If he couldn't see he couldn't perform his work and his family wouldn't have any other resource to live.

The only place where they could heal his disease was in Quito, but transport, lodging and surgery costs were much more expensive for what they could be pay. The missionary didn't have enough resources to solve this problem, so at the moment it was unresolved. Some days later he met another missionary accidentally, who worked in another different area. They were talking about their problems and when commented that visual problems, his partner said that a team of doctors were operating for free near.

#### *C. State of the art*

With the advent of Web 2.0 and mashups, it is possible to solve many problems which have been stated in the previous examples. Here are some possible solutions to assess the problems proposed.

Openguides [12] is a technology that enables user for making custom maps about a topic. For example, there is a guide for Boston city [2] that contains a lot of geographical information about Boston. This solution enables collaboration, but has some problems:

- There is only one marker allowed on each map.
- Collaboration is limited because there is no way to put comments on a marker.
- It hasn't time management.

Community Walk [5] is a mashup where users can create maps, markers with photographs, comments, link, etcetera. This software is the closest solution to problems, since enables users to collaborate with other users about problems.

However, being a good solution for most problems, it still does not cover the following aspects:

- Google Maps is the only map source allowed.
- A user can only insert markers and routes.
- Do not enable any kind of analysis.
- It isn't free software.
- It hasn't time management.

GMap [9] is an extension for wikis that enable maps in wiki articles. Combined with a wiki, it may be a good solution for geographical collaboration. However, it is very difficult to create a full application over gmap-generated maps, so maps aren't dynamic.

There are many other solutions, among more representatives and widely uses in companies are ESRI and Intergraph.

ESRI ArcIMS [7] is a web based geographical information system. ArcIMS provides a set of powerful tools and can obtain data from any ESRI solution, which involves a wide range of formats and information sources. Although ArcIMS is a very professional solution, it has a high cost because it needs other ESRI tools in order to work properly and is hard to customize for the requirements that are described in this article.

Intergraph Geomedia WebMap [10] is the web map solution provided by Intergraph. Like ESRI ArcIMS, Intergraph Geomedia WebMap provides a set of powerful tools and can benefit from other Intergraph products. But like ESRI ArcIMS, it has a high cost and is hard to modify for GIS collaboration.

#### *D. Proposed solution*

Once there have been able to observe what problems may exist in an organization (mainly lose of knowledge), and some possible solutions, an ideal solution must provide:

- Easy collaboration between people.
- Georeference events and display them on a map.
- Analysis and studies based on data supplied by users.
- Be accessible through the Internet.
- Provide support for older/basic clients.
- Have a simple interface for those who are unfamiliar with GIS, but yet powerful to be able to perform useful analysis.
- Overlay data from different sources in the maps.
- Georeference routes.
- Manage maps, events, and users.
- Establish safety limits on the maps in terms of access and modification.
- Managing time in the data supplied to the maps.
- Being able to import / export data in formats that can use other systems.

An event is the term used for problems that an user has found at a certain place, resources whose location and details are available to other users, a point of a route, notices...

CoGIS (Collaborative GIS) is a solution designed to meet all these requirements. Its features are:

- It enables users to create custom maps.
- It enables users to put events on a map.

- There is a security management of users, maps and events.
- Events can be commented by any user that has access to the map.
- It can manage any map provider through its API. Currently google maps, yahoo maps, virtual earth, openlayers...
- Maps can contain many map layers (WMS).
- CoGIS have analysis tools like distance to points or layers opacity.
- Events have time management, so position changes in time can be analyzed.
- CoGIS can present maps even on javascript-disabled browsers.
- Places can be found by using reverse geocoding.

As stated by P. A. Burrough, "a Geographic Information System is a set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes" [3], so CoGIS is a specialized GIS that collects, stores, shows and analyze geographical data provided by its users, allowing them to collaborate in common or global tasks.

CoGIS is composed of two subsystems:

- Coordination and Management Subsystem.
- Maps and Collaboration Subsystem.

Coordination and Management Subsystem is responsible of managing users, data, maps information, news etc..., ie web application management: add, remove, modify and any issues relatives to non-geographic data (map management includes user visibility and security permissions, map descriptions..., ie, any non-geographical information of the maps). Maps and Collaboration Subsystem is the geographical implementation of the system: web mapping client configuration, map events management (add, remove, modify and queries), WMS overlay, route creation, analysis (point to point distance, point buffers, point history ...), messages management, meta-map creation, etcetera.

CoGIS uses following technologies:

- It is a java web application, running over tomcat application server, using struts architecture.
- CoGIS uses tiles to be browser independent.
- Google Maps is used by default
- Database used is PostGIS / PostgreSQL.

Why support multiple map sources? Google maps is a well known technology, it is very popular and it has a big company supporting it. However, seeing it from GIS perspective, google maps is not as good as expected.

Google Maps didn't define clearly its map projection used. T. Fernandez made a small study on the possible projection that Google Maps could have concluded that it was a Carrée Plate, so Google changed its projection over time [8]. Currently, Google Maps uses Mercator projection [13]. Besides, scale in Google Maps is unknown and it is very variable depending on the zoom and geographical place. Radiometric uniformity is another problem because there are many orthophotographs which have discontinuity int its unions (i.e., luminosity is not the same across images). That is

why Google Maps cannot be used as a precision mapping system. In fact anyone can see big differences in some areas between the satellite images and map layer. This problem is not Google's fault but companies that have created the data to Google Maps. There isn't a perfect web mapping system (well designed, cheap, browser-proof, with a good mapping source...), so the solution proposed by CoGIS is provide a method to enable using any web mapping system, making easy to support additional web mapping systems. This is achieved by using mapstraction [11]. Mapstraction is a javascript library that supports a high number of web mapping systems through a common API. That API can be modified easily, so adding support to custom web mapping systems is not a problem. CoGIS takes advantage of this feature in order to support any web mapping system.

There is one more point to keep in mind. In early example of Comboni Missionaries, a common problem to use any solution is that hardware used to access services can be very different. Almost always this is not a problem, but there is a case in which it is a serious problem: when technology used is too old to use most of current web mapping systems. This is known as digital divide. One of CoGIS objectives is "present maps even on javascript-disabled browsers". This is achieved by using java tiles technology. Tiles is a java library that allows J2EE applications to build a very versatile and personalized view of the web application. Using tiles, CoGIS can detect browser and present a mapstraction interface or a javascript-disabled interface. Imagine a situation where an Internet Explorer 6.0 browser access to the application. Internet Explorer 6 is able todo things (especially with Javascript) that an Internet Explorer 3.0 cannot. Detecting the source in the JSP client application can decide which template (tile) is more appropriate to use for each client. A simple example for this might be:

```
<% @ taglib prefix="c"
uri="http://java.sun.com/jsp/jstl/core" %>
<c:choose>
<c:when test="${header['User-Agent'] == 'Mozilla/4.0
(compatible; MSIE 6.0;
Windows NT 5.0)'}"
<tiles:insert definition="ie6_map" flush="true"/>
</c:when>
<c:otherwise>
<tiles:insert definition="basic_map " flush="true"/>
</c:otherwise>
</c:choose>
```

Thus tiles makes possible to use templates based on browser client capabilities. That is why tiles is very useful for collaborative browser independet GIS, because it makes development easy, reusable and efficient, supporting multiple browsers or views. For example, if basic\_map template uses other template, it is possible to include a script (an additional element of the mosaic) that, if the browser hasn't got some javascript features, those functions can be emulated by prototype functions. However, many other parts of the application will be compatible, so it is only necessary to specify those templates that browser needs.

### III. FUTURE RESEARCH

Throughout this article, common organizational problems have been exposed: waste of work, loss of knowledge, lack of organization control... A solution is proposed in this article to avoid them, especially in those organizations where geographical information plays an important role. There are many tools that everyone can use to solve some of these problems, but it's also true that there isn't one only valid tool that solves all problems stated in this article. CoGIS aims to solve all these problems through a set of features. Collaboration is a powerful tool to avoid knowledge loss in organizations. Community collaboration (understanding community as people inside an organization, or every person who can access the application) in any environment is one of these. It's so important the collaboration as enabling a good environment to make possible that collaboration. CoGIS enables using any browser, no matter if browser used to access application comes with last version or it's an old one. Only an internet connection is required. CoGIS has a set of analysis tools that gives more information to the organization, so not only avoid loss of knowledge, but also gives new information that could be very important. WMS layers adds many information that, combined with overlapping layers, makes CoGIS a powerfull tool. Also, it has an easy interface, so people who never has used a GIS before can benefit from all of its features. Time management is a hard issue in geographical information systems. CoGIS is event time oriented. Showing changes in an event everyone can figure out what changes has been made for an event. On the other hand, there are tools to export events in KML format, so events can be viewed in Google Earth. However, there is still much work to do. While the tool enables collaboration among people to avoid the loss of knowledge in organizations providing multimodal access to any client, there are certain characteristics that are not yet implemented. Some of these features are:

- Tools to insert other types of data, such as polylines, polygons, images, text...
- Tools to select items that meet a given condition.
- Tools for analysis of event attributes.
- Tools for time control, such as a scrollable bar to show and hide events according to the date, creation, event changes.
- Tools to provide GeoRSS.
- Ability to incorporate external data sources such as shapes, other geographic databases, KML files, GeoRSS and raster data through sources different from WMS.
- Integration with other web mapping clients like MapGuide.
- Implementation of a web client that works in handset clients like PDA, iPhone...
- Analysis tools that can generate raster images, like gradients.
- Analysis Tools for using algorithms such as routing.

In relation to the points shown on the map, CoGIS have not got any tool for grouping items or specify the scale at which they will be visible. There are many tools for both features

(particularly for the scale of viewing Google has its own API). As for the 3D visualization would be possible to use a separate tool like Google Earth, providing the same functionality as the web application but in an environment where the elevation is present and a set of tools are present in order to view events. Another aspect left for future work is more sophisticated collaborative tools. A forum is very simple and much more functionality could be implemented. An example of this is a wiki that would enable geographical article searching.

Developing collaborative tools makes possible intelligently avoid loss of knowledge in organizations, because makes an individual effort a collective result. However there is one aspect that has not been introduced: the rejection of technology. Even with best technology in the world if technology is not introduced appropriately to those who will use it, it will be a waste of time. This is, as far as I know, as essential as the technology itself. It is a great challenge to provide a good system that is both easy and pleasant to use, a system that it is not perceived as a threat and that also solves the problem for which it was designed. Failure in software projects has a high rate, and that is partly due to this risk. Future work will be not only get a good system, but also a system that cover and avoid such "human" problems.

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