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Brazilian Industrial Fishing Vessels Monitoring Program

A Practical Experience with Web Services and Webgis

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Abstract

This paper presents RASTRO, a web-based information system that has been developed and implemented for the Brazilian Industrial Fishing Vessels Monitoring Program using open source technologies, such as Ka-map (MapServer), PostgreSQL (PostGIS, PL/PGSQL) and Symfony (PHP, AJAX). In its third version, the system includes features such as agents that control exclusion areas and distress requests from vessels; Web Services for tracking data reception and delivery; and a WebGIS interface for visualization of vessels that are operating on Brazilian jurisdictional waters, as well as on the Commission for the Conservation of Antarctic Marine Living Resources - CCAMLR areas. This paper presents RASTRO's architecture, functionalities and its potential impact on the industrial fishery scene.

Introduction

Fishing vessels monitoring systems (VMS) have been implemented all over the world since the mid 90's (OECD, 2005). They are considered as a primary instrument to guarantee the fulfillment of fishery management measures. Within the context of the Code of Conduct for Responsible Fishery and its main objective of warranting fisheries sustainability, the illegal, unreported and unregulated (IUU) activity is a serious, growing problem worldwide (FAO, 2002).

Figure 1: RASTRO V.1 WebGIS interface

IUU activities damage fisheries directly and prevent the implementation of sustainable measures from evolving, contributing to overfishing, therefore jeopardizing stock recovery. In the long term, this situation is leading to loss of socio-economic opportunities, as well as to negative effects on food availability and the environment. The people involved in IUU fishing try to avoid the detection of their activities, operating in areas where monitoring, control and surveillance are reduced or do not exist. This is the case in Brazil, where IUU fishing activities are mainly related to:

1. National and foreign vessels operating without the due permission;
2. Vessels operating in protected areas;
3. Unauthorized operation in restricted areas, including those originated from international commitments, such as catching quotas; and
4. Catches are not reported as required by national regulations or as established by regional management organizations (e.g.: International Commission for the Conservation of Atlantic Tunas - ICCAT and the Commission for the Conservation of Antarctic Marine Living Resources).

In order to cope with this situation, the Brazilian Federal Government has adopted many tools proposed by FAO to combat IUU fishing, such as onboard observers program, catches reports, vessel inspection in ports and on the open ocean, and preventing vessels involved in IUU fishing from accessing ports, as well as denying their privileges (FAO, 2002). The last one to be effectively implemented, at industrial scales, was the vessel monitoring program.

Brazilian Industrial Fishing Vessels Monitoring Program

The Brazilian VMS Program (Programa Nacional de Rastreamento de Embarcações Pesqueiras por Satélite - PREPS) was instituted by the Interministerial Normative Instruction n. 02, from September 4th, 2006 (SSAF, 2006a). It is important to point out that the Decree n. 4.810/2003 had already established that, in order to operate on Brazilian jurisdictional waters, owners, shipbrokers, or leaseholders were required to use equipments that allowed their vessels to be monitored, when demanded by the Special Secretariat of Aquaculture and Fisheries - SEAP/PR or the Ministry of Environment - MOE through a normative act. However, the first experience towards VMS started as early as 1999, when foreign fishing vessels leased by Brazilian companies were required to operate equipped with tracking devices. From 2001 to 2005, this fleet operates on Brazilian jurisdictional waters with an average of 37 out of 60 fishing vessels being monitored per year.

During this period, 404 trips to Brazilian jurisdictional deep-waters to fish red crab and monkfish were monitored by the Group of Fishery Studies - GEP from the Itajaí Valley University (UNIVALI), officially assigned to receive, plot and report on vessel activities. The first problem faced by this experience was that the government established poor definitions on the tracking technology and control practices. Delivering vessel position and date every four hours was enough to certify any tracking service provider and vessel to legally operate on the Brazilian shore. As a consequence, the fishery industry hired low cost services just to meet government requirements and legally run their operations. Therefore, most fishery companies chose a tracking system to provide a simple, low cost service, which delivered the GEP emails listing vessel name, date, latitude and longitude (CABRAL et al, 2003).

Figure 2: a single vessel path (CABRAL et al, 2003)

In early 2001, GEP found itself buried deep in quantities of data constantly arriving by email, and with a complex procedure involving one full-time position to receive, read, and type into a GIS desktop software incoming position data. Not to mention bi-weekly reports to be written and the possibility of human-failure due to non-automated steps. At that time, we were, at the Applied Computing Lab (G10), experimenting with WebGIS technologies. We found that the problem GEP was undergoing was a good challenge to practice our knowledge. The first version of RASTRO (Figure 1) was developed to solve this situation. The system was a collection of Web and shell scripts that perform a variety of tasks, including data fetching and processing, shapefile generation, dynamic data visualization on maps for the Web and on-demand reports (CABRAL et al, 2003).

In addition to the problem faced by GEP, the experience with RASTRO's first version has shown several operational constrains and newer problems, despite the great value it has given regarding the comprehension of the fleets' fishing strategies and legal controlling constraints. Government agencies jurisdiction overlap and the poor definitions on tracking technology, services, and operational practices, pointed out earlier, were the ground for developing PREPS. Regarding the information system itself, it was an enlightening and fruitful experience for the upcoming versions of RASTRO. Communication protocols and data format standards were among the most important system requirements that were to be officially defined by the government for a large scale VMS program such as PREPS. In the following sessions of this document, we present RASTRO Version 3 not as an evolution of the previous ones, but rather as a result of the deployment of IT state-of-the-art concepts and technologies to achieve PREPS general requirements:

1. Communication with external servers and clients should be done through Web Services standards;
2. Use of open source technologies;
3. The functionality to perform tracking data providers' accreditation; vessel permit processes; vessel(s) operation audit; cadastre and control over restricted areas (control done by agents); keeping track of the history of legal transgression and enforcement measures; and distress warning;
4. WebGIS should use Open Geospatial Consortium - OGC interoperability standards (WMS and WFS); and
5. Web-based application with access control.

RASTRO Version 3 Implementation

The development of RASTRO V. 3 took almost 20 months by a team of 14 people, including Computer Science undergrad students. The system started to operate in January, 2007, under test condition, with a monthly release of new versions. In July the system was already fully functional, monitoring 298 vessels out of an estimated number of 3500 industrial fishing vessels.

Open Source Technologies

The open source technologies that the application is built upon are shown in Figure 2, according to it architecture. Linux version OpenSUSE 10.2 is the underlying operational system in both Web and Data Base servers. PostgreSQL is the DBMS that, with PostGIS extension, handles non-geospatial and geospatial data. Requests from the Web server side are executed in two ways: non-geospatial data requests are done through PHP, while MapServer does all geospatial data, generating dynamic maps to be visualized via KaMap.

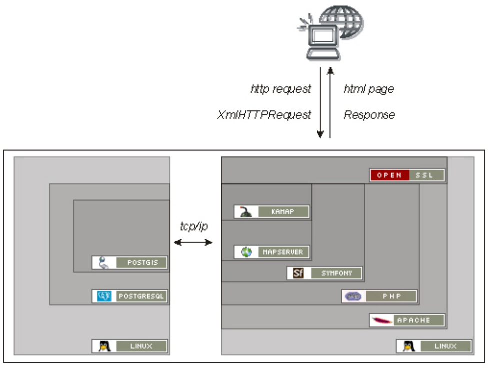

Figure 3: Open source technologies used the RASTRO application.

The entire application was developed in the Object-oriented paradigm, on three layers (e.g., model, control and view), using the Symfony framework. For users, requests are arranged in a safe way (e.g., by using OpenSSL), either in synchronized way by HTTP Request, or unsynchronized using AJAX (XmlHTTPRequest).

Web Services Standards

RASTRO uses three types of Web Services (Figure 3). The first one we developed to be officially adopted by the government through the Normative Instruction n. 20, from September 15th, 2006 (SSAF, 2006b). In order to provide data to the PREPS program, a tracking data provider company needs to be accredited after complying with the VMS Web Service Standard (VMS-WSS) tests. Since RASTRO is a WebGIS, it was natural to adopt OGC Web Services (OWS) standards. In this version, the system uses Web Mapping Specification (WMS) and Web Feature Specification (WFS) for geospatial data distribution and access (i.e. providing maps of restricted areas or displaying sea surface water temperature). Finally, the last Web Service provides data (vessel's name, characteristics and operating distances for certain periods) for the Federal Government Diesel Subsidy. Unfortunately, thus far, there has been no effort to create a standard for this WS.

System Architecture

The system operates with two servers using the technologies earlier presented (Figure 2). In the Data Base Server (DB Server), besides data management processes, it is worth mentioning the agents (Figure 3). After tracking data reception through the VMS-WSS, they are in charge of triggering and performing several analyses:

1. Vessel sensor data: searches for distress warning signal or tracking devices battery failure, communicating them to the Brazilian Navy-MB (SALVAMAR/SAR);
2. Navigation data: verifies whether the vessel is navigating/operating on protected or restricted area;
3. Timely data: verify whether the tracking data was sent in due time (every hour with a gap no longer than 4 hours); and
4. CCAMLR notice: verifies whether the vessel tracking data is within the CCAMLR area, communicating it to this organization using VMS data format NAF (CCAMLR, 2005).

On the Web Server side, one will find the VMS-WSS, OWS, and Diesel Subvention Program WS. In this server, MapServer 4.10.2 handles OWS requests as server and client.

Interface

RASTRO's interface was customized to PREPS requirements. Thus, each Government institution that holds a share on the Program operation (SEAP/PR, MOE, and MB) has a set of specific functionalities available (e.g.).: warning distress for the MB). Tracking data companies and vessel owners, shipbrokers, or leaseholders also have access to the system. It is restricted to vessels that are under their official responsibility, though.

The WebGIS behaves in the same way, granting access to functionalities according to user level. Built upon KAMAP framework, the interface provides a comprehensive set of tools, customized to support monitoring procedures for each one of the operators. These tools are presented in Figure 5. The basic WebGIS operations are available through the Navigation tool box (a), including pan, zoom in and out, reset, legend display, measurement, buffer, and save the map. The cursor is used to query vessel info on the map itself (b), as well as to define a point for buffer operation, which returns a list of vessels at a defined distance. This functionality is important for the MB (SALVAMAR/SAR) rescuing procedures, since it might be faster to dispatch a vessel that is closer to the distressing vessel, than sending any other means of rescuing.

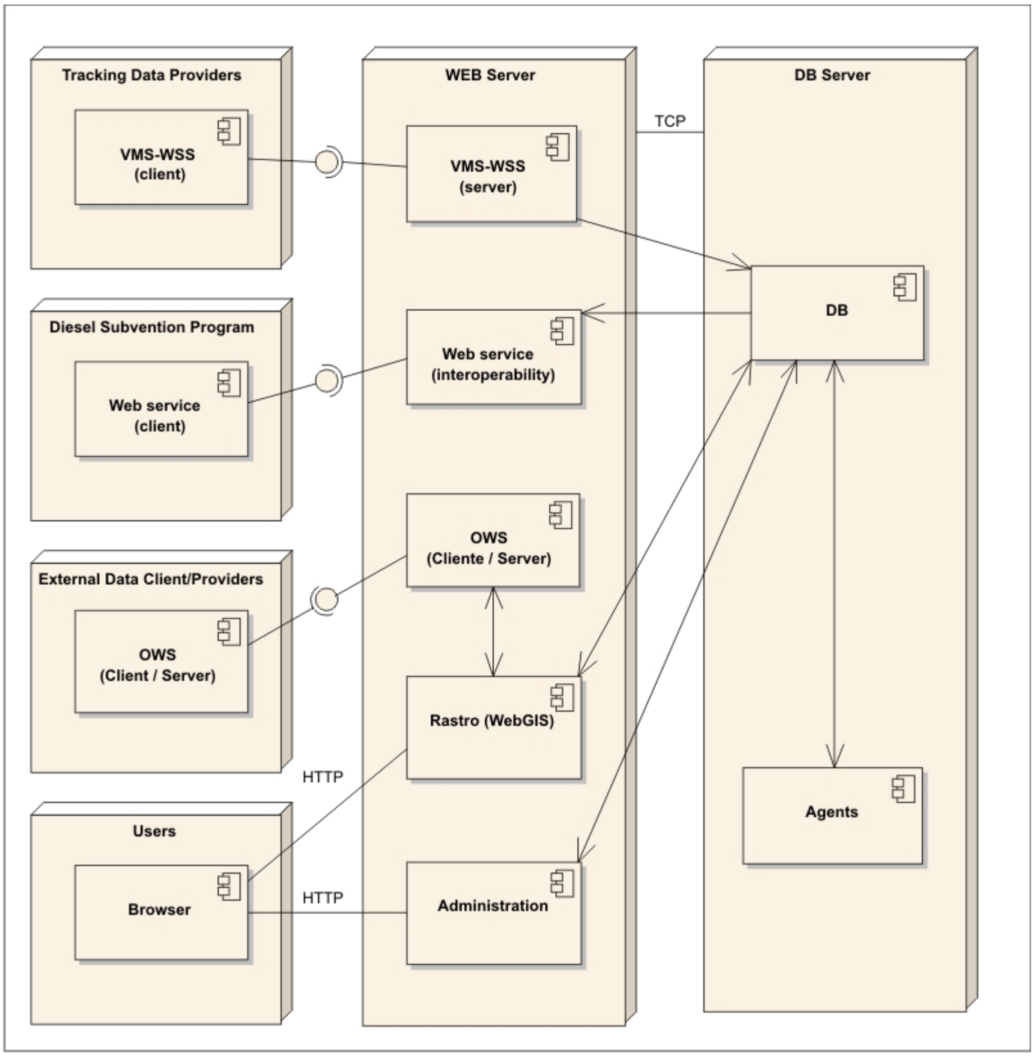

Figure 4: System's architecture.

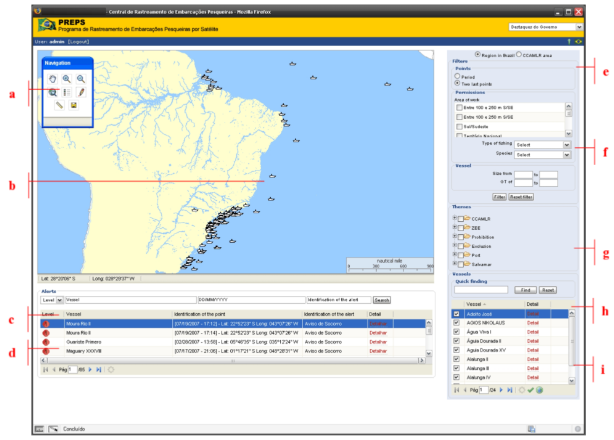

Figure 5: RASTRO administration WebGIS interface

Figure 5 (c) and (d) displays the alert area. In (c), alert filters are available based on the operator needs: level (intervention, attention, observation); vessel's name; date; and type of alert. A list of results is displayed on (d). Other filters are available in the system as well: the user might see the last two coordinates or audit the operation for a certain period of time (f); and visualize according to vessels' permit, target species, type of fishery, and vessel's characteristics (e.g. size). A quick vessel finder is available on (h), whereas in (i) the user may choose vessel(s) he wants to visualize. The interface's language might be changed from Portuguese to English (e) in order to allow foreign users (e.g.: CCAMLR officials) to easily navigate in the system. Finally, thematic maps list (g) includes themes such as exclusion and protected areas, SAR areas and bathymetry. An example of a VMS ROSTRO product is shown on Figure 6, where an operation area of two vessels (1 and 2) might be identified in the circle (a).

Conclusion

Our newly developed PREPS VMS information system is novel in several respects. First, it supports a combination of interests and jurisdictions among SEAP/PR, MOE, and MB. This combination was planned in order to avoid conflicts of interest and waste of financial and human resources. At the same time, the intention is to increase the efficiency of management and control of commercial fishery. From this perspective, this is the first innovating feature that promotes co-management initiatives. Second, not only the Federal Government is in charge of the operation. When a vessel has a gross tonnage equal or to or greater than 50 tons, or if its length is equal or greater than 15 meters, the vessel's owners, shipbrokers, or leaseholders must adhere to PREPS. Therefore, their part is defined in the vessel monitoring process itself. This can be considered as the second innovating point of PREPS.

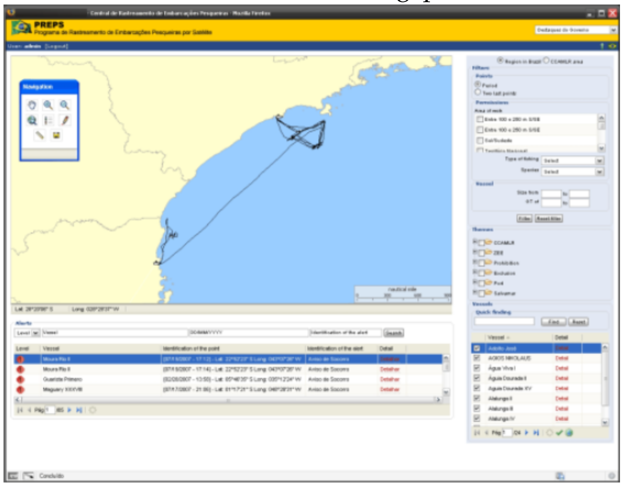

Figure 6: Example of VMS auditing with the identification of operation area

It is of their biggest interest to maintain, in the long term, the fisheries potential catches. Not by coincidence, this is also the Government's interest. Therefore, PREPS formally establishes the productive sector's responsibility related to its performance, for example, when recognizing fishing areas and providing data on catch associated to these areas. These elements are essential for dealing with fishing resources properly. When implementing PREPS, the Government makes the private enterprise co-responsible for the future of the fishery in national waters. Providing their access to RASTRO, the government grants transparency to the process, while it includes the productive sector's effort in a set of tools that eventually may lead to responsible fishery. Third, our system represents a technologic innovation. The pioneer character in which the telemetry (tracking) issue was approached deserves attention. The proposal of the Web Service Standard for RASTRO's operation made possible for any company willing to provide tracking services to apply for accreditation as tracking data provider. In other words, this standardization not only benefits the Government, which has easy conditions to integrate tracking data sent by different tracking companies. Tracking companies can establish themselves in a free-competition market, unlike the monopoly situation that other countries have experimented with in this type of service. Accordingly, the market will adjust for the competitive quality and cost, with positive impacts for PREPS and the productive sector.

Forth, the system employs state-of-the-art technologies and architecture, allowing SEAP/PR, MOE, and MB to act within their responsibilities from one system only. This allows the information system to support plans and decisions operated in a shared way. That is, the same information may be used, for example by the MOE to inspect specific areas, by SEAP/PR to control a certain fleet's operations, and by the MB to find vessels at any moment that pose a threat to the security on the sea. Finally, the fifth innovating element is the tracking system's interoperability with other governmental systems. The conception of the system developed for PREPS permits the communication of data with a system for managing the subvention for diesel, with a computerized system for managing fishing permissions, and OWS compliant systems.

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