THE USE OF GEOTOOLS LIBRARY IN DEVELOPING WEB GIS DASHBOARDS FOR PRESSURE SENSORS

B. Văduva[1], R. Marian[2], I. Haidu[3]

ABSTRACT
The purpose of this paper is to present a real life use of GeoTools library (the library used to build the open source GeoServer). We used GeoTools to develop web GIS software needed to display pressure sensors as points on a map and the values associated with them.

Keywords: *GIS, Open source GIS, Web GIS, GeoTools, Web sensor dashboard.*

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1. INTRODUCTION

The purpose of the project was to build a web GIS dashboard to display water pressure sensors / values, in the city of Baia Mare. Pressure sensors dashboards had and still have a great need in businesses like water management, natural gas distribution and other. Our project was developed for S.C. VITAL S.A which is the company that manages and monitors the water distribution system. S.C.VITAL S.A. has a commitment to provide customers with a minimum level of pressure and they were thinking to increase the number of pressure sensors throughout the water system and they faced the following questions:

What kind of sensors should we use?

Should we use the same (old) architecture for pressure sensors?

Who are the users/employees for the new dashboard? Do we need to show the dashboard to other users/employees?

As result they decided to run the software on the internal network (Intranet) of the company and add GIS capabilities to it.

To do our data acquisition we came up with the same idea like the one used in the MIT – ORCA Project (http://web.mit.edu/orca/www/). We used a pressure transducer with a built in amplifier and the signal is A/D converted using a microcontroller, which then transmits the value to a database through a private network.

The idea for a web GIS monitoring system is not new but it suits well our needs and in the context of our community it's a new one (from our knowledge S.C. VITAL S.A. is the first company to implement something like this in our community). Probably in a few years new idea will emerge and will make this one old, but till then it's is the right approach from our perspective.

As we mentioned in our title, we used GeoTools library/toolkit to build our GIS component. The same GeoTools library is used in UDIG application (http://udig.refractions.net),

[1] *"Inspectoratul Teritorial de Munca Maramures", Baia Mare, Romania.*
[2] *"S.C. VITAL S.A.", Baia Mare, Romania.*
[3] *„Babeş-Bolyai" University, Faculty of Geography, 400006 Cluj-Napoca, Romania*

NOAA/NCDC Java NEXRAD Viewer (http://www.ncdc.noaa.gov/oa/radar/jnx/), Balloon - Transports in Catalonia and other. GIS applications on the water resources were realized, for Romanian territory, by Oneci N. (2006) or Pancescu M. (2006).

2. WHAT WE USED

Main components of the project were:

– Amber WS 128 board was used to acquire data from the pressure sensors.

– **MySQL** database server used to store the data

– **GeoTools** "*is an open source (LGPL) Java code library which provides standards compliant methods for the manipulation of geospatial data, for example to implement Geographic Information Systems (GIS). The **GeoTools** library implements Open Geospatial Consortium (OGC) specifications as they are developed, in close collaboration with the GeoAPI and GeoWidgets projects*" (www.geotools.org).We used the library to build a small and light geo server.

Note: **GeoTools** is the library used to develop **GeoServer**.

– **OpenLayer** "*is a pure JavaScript library for displaying map data in most modern web browsers, with no server-side dependencies*" (www.openlayers.org).

– Geospatial vector data (SHP files) containing the city streets and limits.

– Custom made web application to integrate all the components presented above.

At this moment we will make a note. The pressure sensors position on the map is kept in the **MySQL** database and can be modified by the users with the appropriate rights. The stored data is used to dynamically create a layer in the web map.

2.1. Capabilities of Geotools Library

Because "data is the blood of any GIS project", GeoTools tries to support the following data formats:

DataStore (vector data)

- Shapefile - an ESRI shapefile (R/W)
- GML - Geography Markup Language (R)
- WFS - Features from an OGC Web Feature Server (RW)
- PostGIS - geometric objects for PostgreSQL (R)
- Oracle Spatial - Oracle's extension for spatial data (R)
- ArcSDE - ESRI's middleware for spatial databases (R)
- MySQL - support for the new geometry types
- GeoMedia - an Intergraph format (R)
- Tiger - Topologically Integrated Geographic Encoding and Referencing developed at the US Census Bureau (R)
- VPF - Vector Product Format, a data interchange format (R) (**work in progress**)
- MapInfo - MIF (Mapinfo Interchange Format) (RW) (**work in progress**)

Grid coverage (raster)

- ArcGrid - ArcInfo ASCII Grid format and GRASS ASCII Grid format (optionally compressed) (R/W)
- Image - can load images georeferenced with a world file (R/W)
- GeoTIFF - a georeferenced tiff image (R) (**work in progress**)
- WMS - OGC Web Mapping Server client (R) (**work in progress**)

3. HOW WE GOT HERE

S.C. VITAL S.A. had an older monitoring system that was built using a non GIS approach. In these days due to increasing computer power and the existence of open source GIS tools, a GIS approach was seen as being the right path to follow.

They had 2 options:

1. Buy a "of the shelf product".
2. Build a custom made solution.

The option to buy a commercial GIS system wasn't in the price range the company was able to pay, so they decided for the second one. With these in mind we came out with a solution that uses open source GIS tools and minimize the costs. We will not insist on what is open source GIS, what are its benefits and downsizes, because we fill it's much more important to present how we developed the software system.

With this paper we don't want to minimize in any way the importance of commercial GIS systems but to present what can be done using open source GIS tools.

GIS tools are a better way to display information because is closer to what people are used to deal with. In our case the users knows the streets where the pressure sensors are located. Having a complete view of the system and how the pressure sensors function they can make better decisions regarding their work.

The web approach came as an answer to the question "How to present the same dashboard to different users with different rights in different places?" This approach answered the above question because having an intranet application with GIS capabilities the users can be virtually anywhere in the world (by using VPN connections someone who is outside VITAL's internal network can connect and be part of it).

We thought is important to keep the backward compatibility of the system, so we also added in the application a non GIS pressure sensors dashboard (fig. 1).

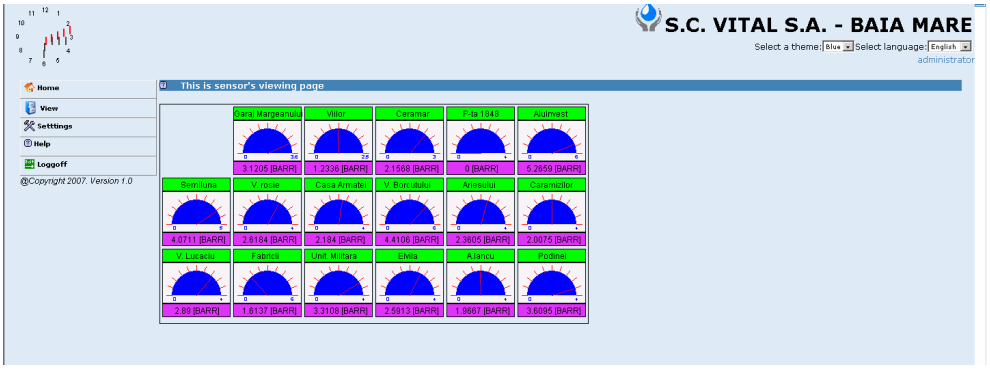

Fig. 1. ***[non GIS sensor dashboard]***

4. THE SOFTWARE

In this section we will present how the software is built and how it works.

The first step is to present the layout of the system (Fig. 2).

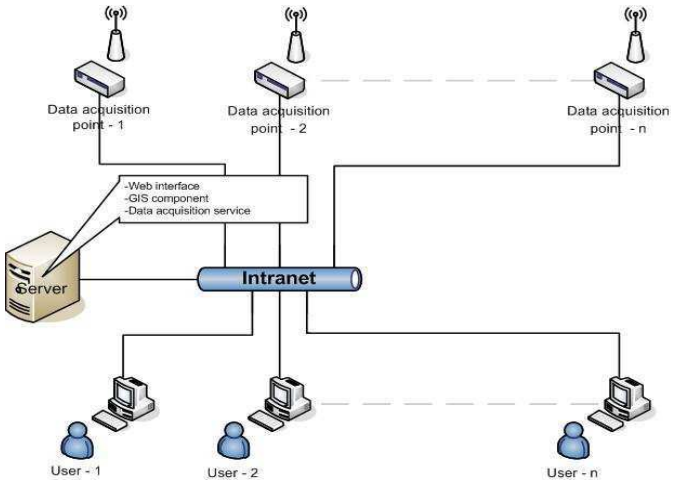

Fig. 2. ***[System layout]***

The main components are:

- **Acquisition systems –** which are designed to be able to measure pressure and return that information when asked. These acquisition systems work as independent systems and also run a small web server
- **Server service –** designed to question the acquisition systems for pressure values and store that information into a MySQL database. Fig. 3 and 4 presents how this component questions an acquisition system to get the data.

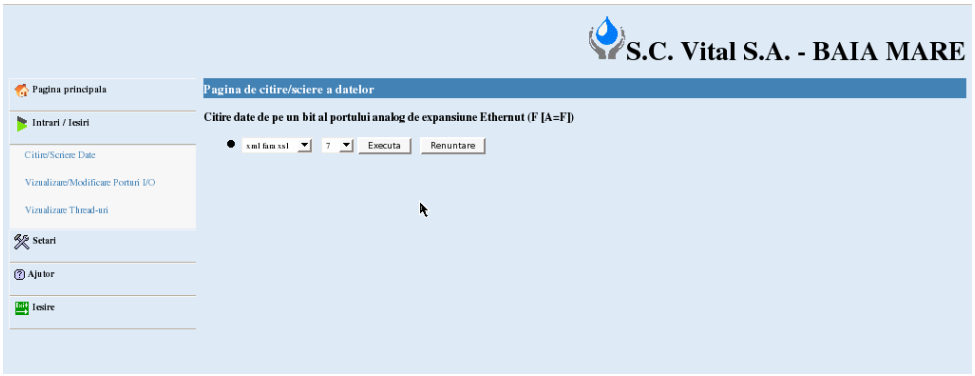

Fig. 3. ***[Data acquisition – the preliminary page for getting the pressure value]***

- **MySQL database –** which purpose is to store information.
- **GIS component –** is a library built on top of GeoTools to generate images from the vector or raster data (in our case just from vector data)
- **OpenLayer –** a JavaScript component used to display the map on the web browser.
- **VITAL application** – is the actual web software that links the GIS component, MySQL database and the users.

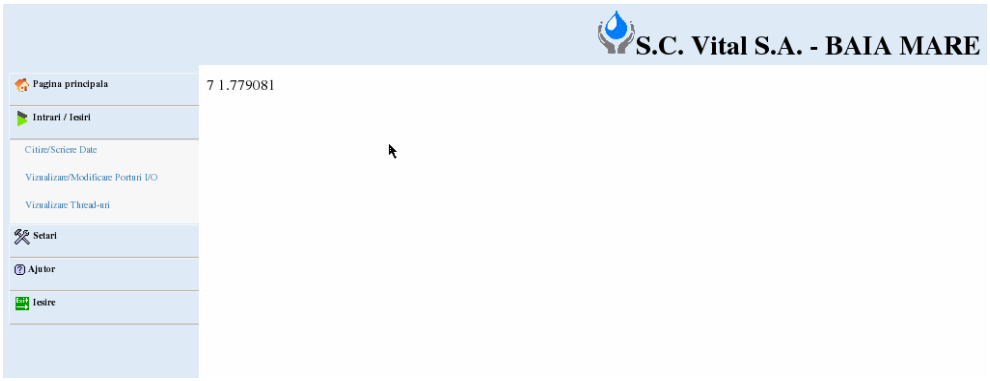

Fig. 4. ***[Data acquisition – the pressure value]***

4.1. How it works.

The users connect to the web interface through a login page (fig. 5).

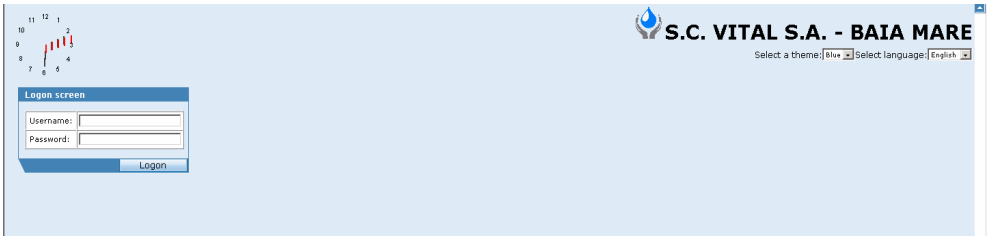

Fig. 5. ***[Login Page]***

Each user has associated rights, so some users can add information about pressure sensors and other can view information.

Once a user is connected into the application has three options (fig. 6).

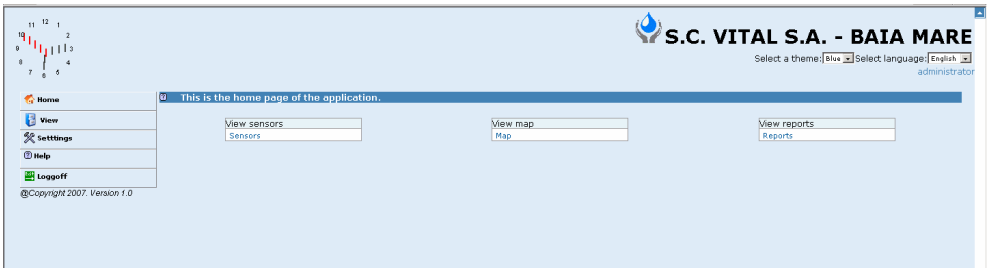

Fig. 6. ***[Home/Main page]***

The three options are:

1. View sensors – which are the old non GIS approach.
2. View map – which is the new GIS approach (fig. 7).
3. View reports – used to query the database about information.

Of course, down the road, some other options could be added here.

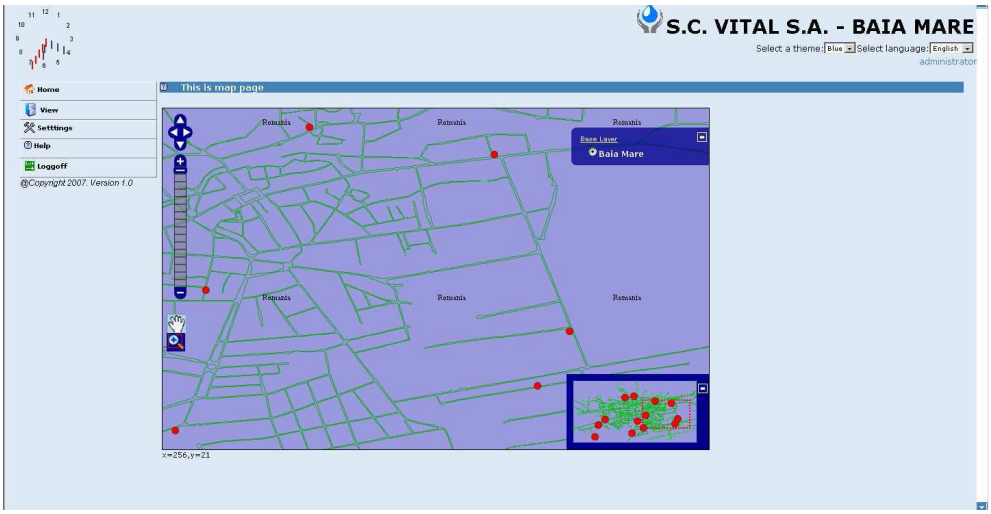

Fig. 7. ***[Map – GIS approach]***

One GIS query developed at this stage of the project is the following (fig. 8): when a user clicks a pressure point on the map a gauge will appear on the right side of the page. An improvement of the system, which is due for another stage, is to have the ability to display those gauges right on the map and the users are not gone have to click (unless they want detailed information about that pressure point).

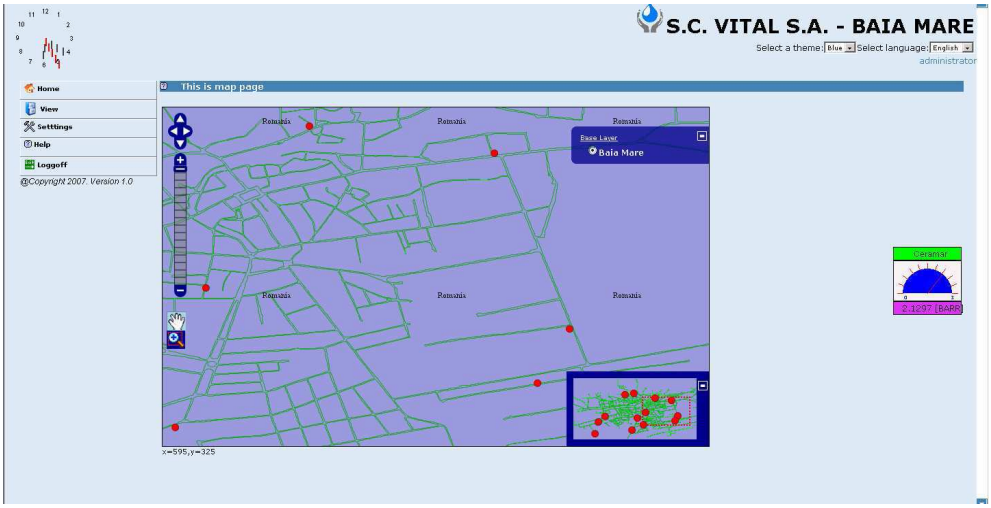

Fig. 8. ***[Map – GIS approach / gauge view]***

5. CONCLUSIONS AND FUTURE DEVELOPMENT

We think that a GIS approach for water pressure monitoring will bring ease in system exploitation because people tend to respond better to images. A downsize for a GIS approach is:

- better servers/computers to keep and deliver the GIS data
- possibly expensive GIS software
- having the data

Our solution tried to answer to some of the above questions and other. The first issue is answer by the fact that every day servers/computers became cheaper and cheaper. The second one is answer by open source GIS. The third one is a tricky one because depends on the company will (the managers to understand the need) to have that data. We answered to some other issues like:

- Can some users/employees see the pressures from outside company's premises? – we used the web approach, which allows users from outside to connect to internal network through a VPN connection.
- Can we restrict data based on user's roles?
- Can we change the position of one sensor on the map?
- Reporting – the software allows the appropriate users to see historical data for pressures sensors and compare that data in an ease to read format (graphics – fig. 9). These graphics will help in making every day decisions as well as for possible company developments.

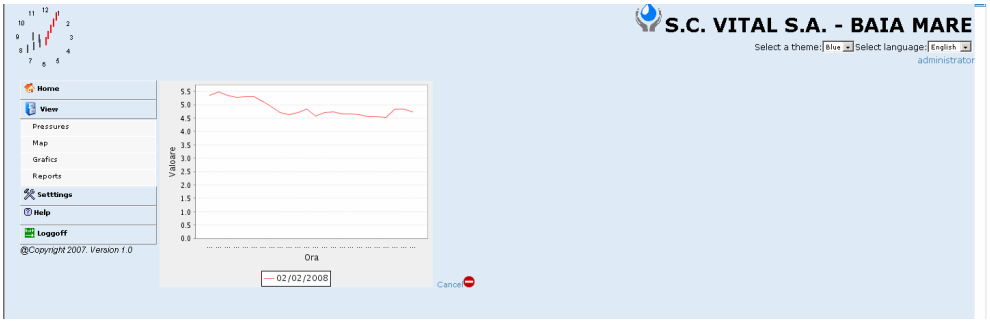

Fig. 9. ***[Graphic for a pressure sensor]***

As we know in almost any field there is room for improvement and our field is not an exception, so we are aware of the possible improvements. One of those improvements could be dictated by the fact that S.C. VITAL S.A. is in expansion and will become a regional company with multiple local branches. A future development would be to have distributed systems which cooperate to present a unified GIS, but this approach raise some other issues and benefits that will not be discussed in this paper.

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