Development and Integration of an Offline and Open Source Alternative Mapping Solution

Antoine Abélard
Spécinov, Angers, France

Keywords: DotSpatial, Open Source GIS, C#, .NET, OpenStreetMap.

Abstract: Nowadays, more and more business applications integrate Geographical Information System (GIS) to use and display data at the right place and the right time. However, this integration could face two problems. The first one is the integration cost of a commercial GIS and the second is cartographic data access. Indeed, the web map services used to provide cartographic background are charged depending on queries, so the cost of these services can increase quickly and the bill is not mastered. The second problem has occurred with the end of Microsoft MapPoint, so, this brings up the problem to find an offline mapping solution that can be integrated with business applications. There is a need to fill this gap and answer to these two main problems. This paper presents an offline and open source alternative which allow integration with business applications, a real business case of a truck tour management application has initiated this work.

1 INTRODUCTION

GIS and mapping technologies have grown in popularity in recent years, especially since the success of Google Maps, Bing Maps and Here Maps, all available on the web. However, these GIS platforms do not meet the requirements of some business applications such as the cost and the offline mapping.

The main issue of this study is about a business application of truck tour management called Biotour, it is a desktop application used by SARIA Industries (SARIA Group, 2015) and developed by Spécinov (Spécinov, 2015). SARIA Industries is specialized in collecting organic waste and biomass conversion. The group operates over 127 sites, in 12 European countries. SARIA Industries has four areas of expertise: Rendering, Food industry, Oleochemicals and Energy.

Spécinov is an IT services company localized next to Angers in France. Working in partnership with a university research laboratory, Spécinov developed 11 years ago this tour management application named Biotour, used by SARIA Industries for his rendering activity in 20 sites in France. This activity involves the collection, transport and treatment of animal waste. The software is designed to calculate the best collection routes to optimize the human and material resources.

This application was developed in VB and C# on .NET platform and used Microsoft MapPoint (Microsoft, 1999) for his cartographic rendering. But since MapPoint announce the end of his support, the sustainability of Biotour is threatened. Moreover, MapPoint was not built to manage multiple data layers and as important volumes of business data. So there were stability issues which stop the application or slowing it. In fact, MapPoint was the right choice 11 years ago due to the offline solution which is a key point for this application.

So, today, the goal is to build a replacement solution which is offline and with a limited cost. The chosen solution will have to implement the same functionality as MapPoint, to display data with the same rendering and to be more stable.

To build the alternative solution we have to find the two main features of a mapping solution: a GIS platform and a data provider. In the MapPoint solution, both are integrated.

The present work is divided into 8 sections. We present the data provider OpenStreetMap in section 2. Section 3 introduces the GIS platform DotSpatial. The application architecture is given in section 4. Section 5 details the management of data layers in the solution both concerning the cartographic layers and the business layers. In section 6 we describe the management of interactions. Afterwards, section 7

Abélard, A.
Development and Integration of an Offline and Open Source Alternative Mapping Solution.
In *Proceedings of the 2nd International Conference on Geographical Information Systems Theory, Applications and Management (GISTAM 2016)*, pages 139-144
ISBN: 978-989-758-188-5

shows the work done on integration and optimization. We conclude with the results and the feedback of this new solution in section 8.

2 OpenStreetMap: THE DATA PROVIDER

OpenStreetMap (OpenStreetMap, 2004) is a crowdsourcing project to create a free map of the world. This project was launched 11 years ago and provide now a high-quality world map coverage (Girres, 2010) (Haklay, 2010). OpenStreetMap data are under Open Database License (ODbL). This license agreement intended to allow users to freely share, modify, and use this dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.

The main advantage of OpenStreetMap data is that they are free and can be downloaded for an offline use. Indeed, there are no many data providers that allow to download data for an offline use. In our study case we need France cartographic data, there are only two data providers for an offline use, OpenStreetMap and IGN (French National Geographical Institute). However, the reference pricing of IGN for the France data is €160,000, so the cost constraint is important. Therefore, OpenStreetMap was chosen as the data provider of the application.

For our use with the GIS platform which has been chosen, OpenStreetMap data will not be used in their default format but in the shapefile format. It is possible to convert OpenStreetMap data default format, osm, in a format compatible with GIS platform with some tools. But, for simplicity reasons, we get OpenStreetMap data directly in shapefile format from Geofabrik (Geofabrik, 2007) server. Indeed, Geofabrik does a daily extraction and split data by region, which allow us to manage basemap by region. Moreover, shapefiles provided by Geofabrik are also split by data type (roads, railways, places, …). So it allows to manage independently each data layer depending on data type.

3 DotSpatial: THE GIS PLATFORM

DotSpatial is an open source GIS library written for .NET 4 which has been developed by members from the Geospatial Software Lab at Idaho State University, Idaho Falls, Idaho, USA (Idaho State University, 2015), as well as an international open source community (Ames, 2007). It allows developers to add spatial data, analysis and mapping functionality into their applications, it provides a map control for .NET and several GIS capabilities.

The DotSpatial architecture follows two paradigms. The first is a separation of the user interface and business logic. The second is to use a larger number of modules to increase code reusability, and allow access to certain parts of the library without requiring a whole. So, DotSpatial is divided into 17 DLL and just some of them are used to build a GIS platform needed by the business application (Cao, 2012). The reasons for choosing this library has been its ability to manage large volumes of data, its flexibility and mainly the size of the community mobilized around this project. This open source alternative for GIS allows the development of specific software (Sameen, 2014); (Wang, 2014).

4 APPLICATION ARCHITECTURE

Figure 1 illustrates the Biotour application architecture.

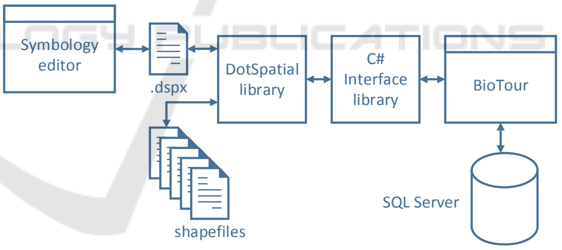

Figure 1: Application architecture.

The Biotour application being developed in Visual Basic .NET, the choice is made to develop a C# interface library that will access the DotSpatial library. It creates an abstraction layer between the business application and the library that allows to manage all function calls in the interface library and to work at a higher level. For example, when loading the cartographic background, DotSpatial called a function from the interface library which then uses the DotSpatial library to perform this action.

As can be seen from the architecture presented above, the DotSpatial library uses several elements. First, to display the cartographic background, a .dspx file (XML) is used. This file contains the description of layers to import and the symbology to apply to them. This file is editable through a symbology editor included with the library.

The cartographic data from OpenStreetMap are stored in shapefiles, they each contain a data layer (roads, natural features, places...) for a defined area. Once the data from shapefiles were loaded, the symbology defined in the dspx file is applied and the basemap is displayed in the map control. Then, business data like the Biotour network and the customer location points are displayed on additional data layers created from the data stored in the SQL Server database.

5 MANAGEMENT OF DATA LAYERS

DotSpatial allows, like any GIS solution, to manage the data in a system of map layers. Among the layers used in the map controls, some are part of the basemap and are static layers. Other layers are business layers on which the user will be able to act (selection, drawing, additional data display, etc.). The map data layers are loaded from shapefiles while business data layers are loaded from the existing SQL Server database of Biotour.

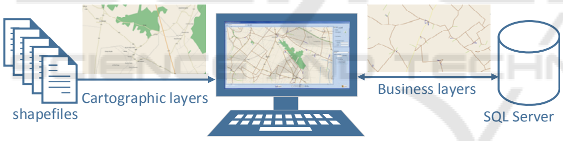

Figure 2: Layer types and their origin.

Next, when we look at the representation of data on a map, the notion of map projection comes in. In all online mapping services, such as Google Maps or Bing Maps, the projection used is the Web Mercator projection, this projection is also used by MapPoint. Because of the constraint to remain as close as possible of MapPoint rendering, this projection is used in the new solution. However, coordinates of basemap data are not projected in Web Mercator but are in WGS84 format (a standard for use in cartography, geodesy, and navigation including by GPS), so a projection of this data is required. These projections are made when the dspx file containing the legend is loaded. About coordinates of business data present in the database, they are also in WGS84 format. So, conversion functions for switching from one projection to another have been implemented to project coordinates from WGS84 to Web Mercator and vice versa.

5.1 Cartographic Layers

Data of these layers are collected under the shapefile format. In this format, each entity has metadata that includes information on it. For example, for a segment of roads data file, there is the type, the direction of movement, etc. To display raw data in an understandable representation, a symbology must be applied to each data layer based on metadata. Symbology operates on the association of a representation and a filter expression. The filtering works with simple logical expressions that are applied to the metadata. When a symbology is applied to a data layer, if the metadata associated with an entity corresponds to the case of a filter expression then the corresponding style will be applied to that entity. Here are some examples of filter expressions:

```
• [TYPE] <> 'primary' AND [TYPE] <>
'secondary'

• [NAME] = 'Rue Victor Hugo' AND
[ONEWAY] = '0'
```

Data displayed on the map depends on the zoom level. However, in the DotSpatial library, the function to manage the appearance of a data layer depending on zoom level is implemented but does not manage the appearance depending on metadata. Thus, the appearance of data is set for the entire layer and it is therefore not possible to display only a part. So, this behavior had to be implemented by modifying the symbology when the user changes the zoom level.

A basemap which look likes all others basemap provided by web map services has been implemented. The symbology is applied both from the .dspx configuration file for the majority of layers and from the interface library which allows to implement a symbology depending on zoom level.

5.2 Business Layers

Data of these layers are loaded from the existing database of the application. No changes of the data structure are required to build a map layer from an existing table. A map object is built from a business object by assigning his coordinates to the map object and all others properties to the metadata of the map object. Then all built map objects are assigned to a layer that can be displayed with the appropriate symbology. Inversely, to get a business object from a selected map object, coordinates and all metadata of the selected object are used to build a business object that can be used in a business process.

In the same way as for data of cartographic layers, metadata attached is used to manage the symbology assigned to each entity. For example, the items loaded in the pick-up points data layer will contain in metadata the period from which the pick-up point is waiting for, to have a differentiated display of points according to this criterion. Unlike basemap, data of business layers are modifiable and will take into account the interactions, so it is possible to draw or select elements in these layers.

Data from the basemap layer are loaded and are not altered. By cons, data of business layers can be loaded, modified or deleted. So, add, modify and delete functions have to be implemented for each business layer.

6 MANAGEMENT OF INTERACTIONS

The next step to build a mapping solution is the management of interactions. Indeed, beyond display data, a mapping solution has to manage user interactions with these data.

The first one is the selection. When an item is selected on the map control, an event is raised and it must be processed to get the selected item on the selected data layer.

Then, MapPoint can display a tooltip that contains information about the clicked point, but the selected framework does not implement it. So, this feature has been implemented in the interface library using the default tooltip of .NET platform.

Another interaction is the position and distance calculations. The position calculation provides a geographical position from the cursor position on the map. For example, it is used in the network design for positioning a point of a new segment. The distance calculation provides the distance between two coordinates, it is particularly used in the network design to assign a length to a drawn segment.

The print feature is used in the roadmap printing feature. This roadmap is printed for each driver, it is a representation of the tour and pick-up points on the basemap. This feature has been implemented with the new solution, a map control is loaded and a snapshot of the tour loaded on the basemap is generated and integrated into the roadmap.

The last one is a location search function. The implemented feature allows a repositioning of the map at the position of the desired location. To do this, the user must enter the name of the desired location, a function search if some of maps objects have a name which corresponding in their metadata and return the results. Then, if results are found they are displayed and the map can be repositioned on a found location.

7 INTEGRATION AND OPTIMIZATION

Finally, once the alternative mapping solution was built, the final step is its integration in the business application.

Following the integration of the mapping solution in Biotour, it appeared that the map is refreshed at every addition or modification of data in a layer. This behavior leads to waiting time due to a large number of refreshment called when adding or editing multiple data following. To optimize this operation and prevent unnecessary map refreshment, additional functions were set up in the library to disable and enable the map events. So before we add or edit data, events are blocked. When we will reactivate it after acting on the data, all events will be queued up and the map is refreshed only once. This greatly reduces the waiting time of the user when he acts on the map data.

To avoid loading several times the data of the basemap the map control used in the application is unique. But even by doing it this way, loading the map data is still required at least once. This time is about 1 to 2 minutes, which may seem long for a user. To avoid having a visible latency that time will be masked by loading data in a dedicated thread.

We can see the result of the integration in the 3 following figures. In figure 3 we can see the window of Biotour network drawing in which the Biotour network can be modified over the basemap. Figure 4 is the window of manual management of generated tours which allows to adjust manually the generated tours. In this figure, we can see that the symbology applies to the basemap data is not the same as in figure 3 to have a better readability. Finally, figure 5 shows the window of pick-up points selection before tours generation.

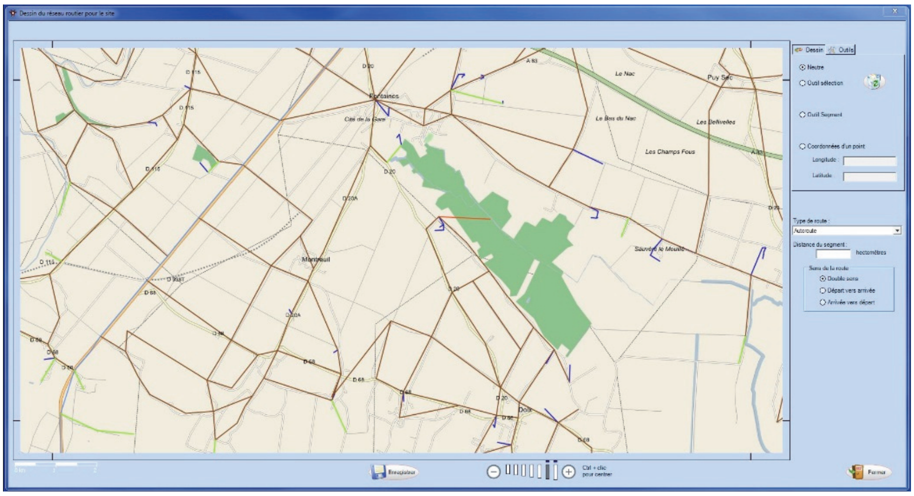

Figure 3: Window of Biotour network drawing.

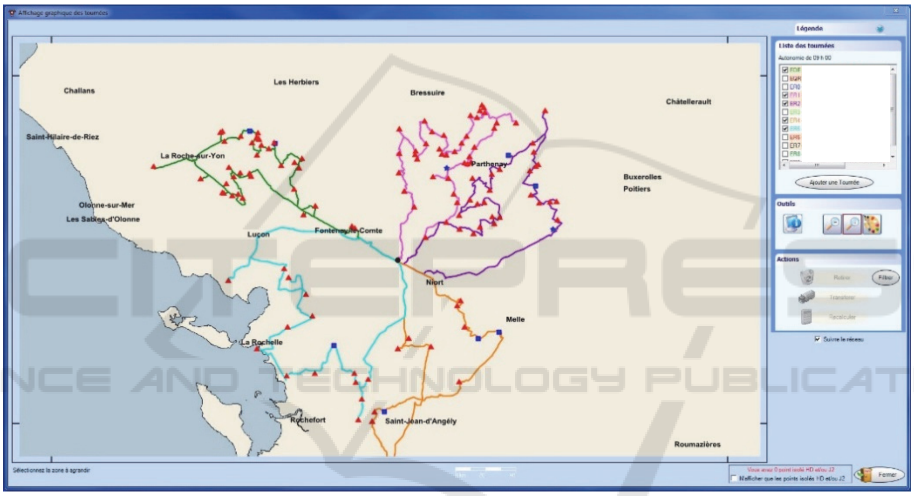

Figure 4: Window of manual management of generated tours.

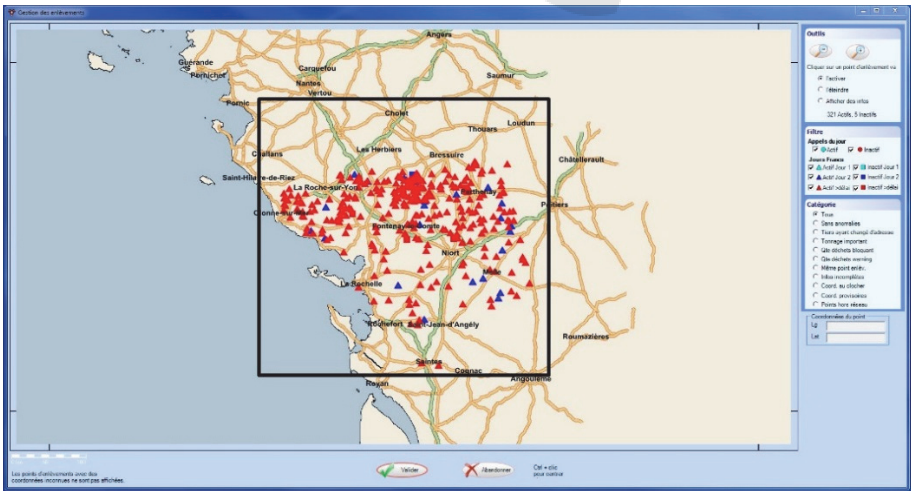

Figure 5: Window of pick-up points selection.

8 CONCLUSIONS

To conclude, an innovative alternative mapping solution which is offline and open source was built. It has much more flexibility than MapPoint and others existing online mapping solutions. In each screen of Biotour, the implemented solution allows the user to see only layers that he needs to see. Further, unlike MapPoint, data of the basemap can be daily updated from OpenStreetMap to always having quality data ensuring two features completeness and correctness. Finally, the new solution is much more stable than MapPoint so the user experience is improved.

A key point is that the project takes place in the case of a real business application, with customer constraints. The flexibility of the new solution allowed to implement customer needs that can't be implemented before with MapPoint, so the interest of the map in the application is reinforcing. Moreover, the application is more stable and offer important development opportunities. Therefore, its sustainability is now ensured.

The new version of Biotour using the new mapping solution has been evaluated and compared with the previous version which is in production. The results show that the new solution is better in all criteria : flexibility, rapidity, stability, ability to work with large amounts of data and especially sustainability. Indeed, the new Biotour application works without MapPoint now, so all the defects of the application, which are inherent to MapPoint, were removed.

This new version is now deployed in all Saria sites and users' feedback is very good. They all noticed a significant improvement of stability and quality of the application. So, beyond the scientific success to build an innovative mapping solution with specific constraints, it is also a business success. These successes show that another way to integrate a mapping solution is possible.

ACKNOWLEDGEMENTS

This work was carried out thanks to ESEO, Spécinov and Saria Industries.

REFERENCES

Saria Group (2015) – Specialists in the recycling of animal and vegetable products and waste products. http://www.saria.com/

Spécinov (2015) – IT services company. http://www.specinov.fr/

Microsoft (1999) – Software program created by Microsoft that allows users to view, edit and integrate maps. https://www.microsoft.com/mappoint/en-us/home.aspx

OpenStreetMap (2004) – Collaborative mapping project. http://www.openstreetmap.org/about

Girres, J. F., & Touya, G. (2010). Quality assessment of the French OpenStreetMap dataset. Transactions in GIS, 14(4), 435-459.

Haklay, M. (2010). How good is volunteered geographical information? A comparative study of OpenStreetMap and Ordnance Survey datasets. Environment and Planning B Planning and Design, (37), 682-703.

Geofabrik (2007) – Company providing shapefile extractions of OpenStreetMap data. http://www.geofabrik.de/geofabrik/geofabrik.html

DotSpatial (2010) – Open Source Geospatial Framework in .NET. http://dotspatial.codeplex.com.

Cao, Y., & Ames, D. P. (2012). A strategy for integrating open source GIS toolboxes for geoprocessing and data analysis. In Proceedings International Environmental Modelling & Software Society (iEMSs) 2012 International Congress on Environmental Modelling and Software, Sixth Biennial Meeting.

Idaho State University (2015) – Members from the Geospatial Software Lab developed DotSpatial. http://www.isu.edu/

Ames, D. P., Michaelis, C., & Dunsford, T. (2007). Introducing the MapWindow GIS project. OSGeo Journal, 2(1).

Sameen, M. I., Ali, A. A., Wahid, N. O. A., & Kubaisy, M. A. A. (2014). An Approach to Develop a Geographic Information Database Using Dot Spatial Open Source Platform and Google Search Engine. *J Comput Sci Syst Biol*, 7, 217-220.

Wang, R., Liu, N., Xu, M., & Kong, X. (2014). Research on the Open Source GIS Development Oriented to Marine Oil Spill Application. *Journal of Software*, 9(1), 116-120.