Methods For Creating an Open-Source Web-based GIS: A Case Study Using Underground Pipeline Data

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Introduction

The purpose of this project was to explore the best methods for creating a web-based GIS solution for pipeline industry geospatial applications using open-source software and hardware. The software technology that is mostly used by professionals and students is proprietary and has high associated costs. A completely open source solution was developed to explore the ability to perform geospatial analyses using non-proprietary software (Figure 1). For this study the underground pipeline business was used as a model.

Data and Data Sources

The geographic locations of pipelines, valves, ETS, and cathodic rectifiers were captured in the field. These datasets represent the key components of what would be required for a GIS visualization that would be useful for those in the pipeline business. However, due to the sensitivity of these particular datasets, particularly related to public safety, the data used in the application is not the actual field data (Table 1).

Table 1. *List of data and data sources used in the project*

Dataset	Source
Pipelines	Personally collected
Valves	Personally collected
ETS	Personally collected
Cathodic rectifiers	Personally collected

Figure 1.
These logos represent the open source software used in the project. Clockwise from the top left: Ubuntu, QGIS, Apache, and Leaflet logos.

Timeline

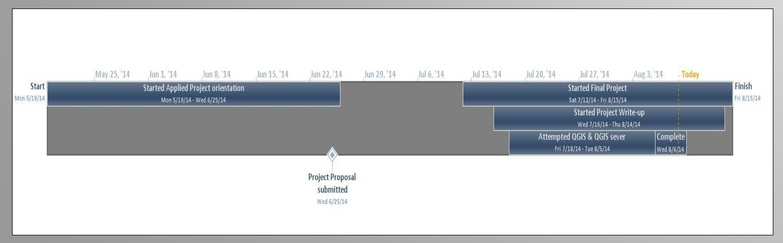
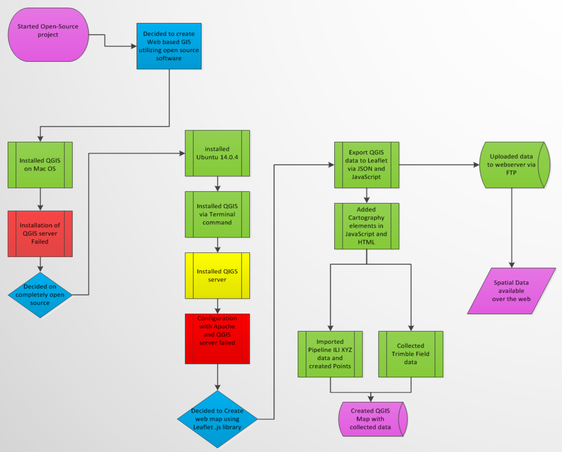


Figure 3. Project Timeline

Methodology

To create a truly open-source GIS web-based solution a completely open-source computer was built, including the operating system (OS). After building the machine the *nix-based Ubuntu OS was installed on a blank hard drive. An open source GIS software called QGIS was installed via terminal commands. Initially the goal was to setup up QGIS mapserver on the machine as well but, after many attempts it was apparent that more time or another method would be needed in order successfully complete the task. As an alternative, the open-source JavaScript library found on Leaflet was used in to display the spatial data created in QGIS on a web-based map. After the map was created and edited locally it was then uploaded via FTP to the webhost to a domain that was previously purchased called "*thedailycommute.info*". Through this website, individuals can navigate the project map to see the location of the pipelines and the associated data. The methods for collecting the pipeline data included the use XY data collected from a high precision in-line inspection tool and, a Trimble Geo7X handheld unit with VRS technology.

Figure 2. *Spatial model of project progression*



Results

This project resulted in the successful use of open-source solutions to display geospatial data over the web. This study demonstrates that using open-source software for geospatial data is a viable alternative for anyone looking to create web-based GIS solutions without the use of proprietary software. For this particular case study, spatially accurate pipeline and associated data was successfully displayed over the web so that users in the field can view the data by phone or tablet with added features such as a scale bar and north arrow in order to conform to cartographic standards. The point features that were collected along the pipeline route were converted to a line feature using the QGIS Points2One plugin. The maps created below display the data collected in the field at an accuracy of 3cm. After the data was created in QGIS it was successfully converted to display with JavaScript.

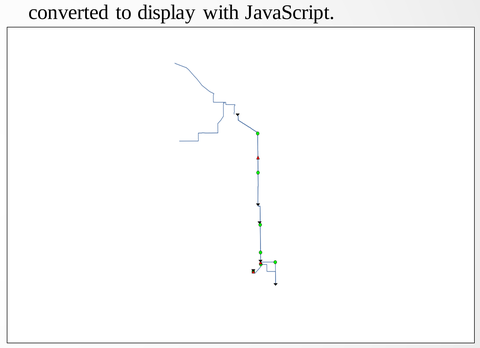


Figure 4.
QGIS desktop map with no background And basic symbology.

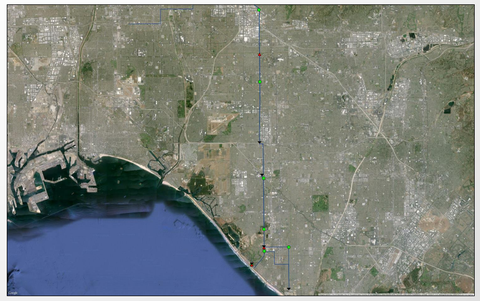


Figure 5.
Same data on QGIS desktop map with OpenLayers Google Earth basemap

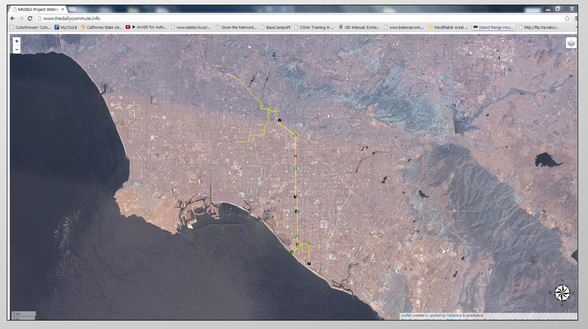


Figure 6. *Final web-map displaying geospatial data. Used JavaScript code to add north arrow and scale bar.*

Discussion

Although this study proves that utilizing open-source software is an option, it also proves that utilizing the available open-source technology is not an easy task without a high degree of technical expertise in programming and computer science. If an individual is looking to accomplish creating a fully functional web-based GIS system, particularly on the server side, there is definitely going to be a steep learning curve. The QGIS program is easy to navigate, but the available functionality currently does not compare to ESRI products. When dealing with web-based GIS systems, the open source community is lacking the necessary support that non- programmers would need. Software such as ArcMap and ArcGIS server have built-in support, and are designed for easy configuration. This makes learning how to use those programs a relatively easy task when compared to what is available in the open-source community. However, the costs of attaining this software is so high that individuals lacking the required financial resources may only have the option of using open-source software.

Conclusion

The use of open-source software is a viable option for individuals looking to create web-based GIS systems. However, the lack of support makes learning how to use the software an extremely challenging task that most geographers would more than likely want to avoid. In order to utilize open-source web-based GIS solutions, the user has to have a high level of technical expertise. In comparison, proprietary GIS software has a much larger user base, with much more support for training and solving technical issues. In addition, robust functionality is offered out of the box in proprietary software, so setting up a comprehensive web-based GIS server is much easier. With open-source software, users have to add functionality in a piecemeal manner from a variety of software repositories, and the quality and quantity of supporting documentation for configuration is uneven and at times unreliable. Thus, if an individual or organization is seriously evaluating open-source GIS solutions, these factors need to be taken into consideration before deciding whether going the open-source route is indeed the most feasible path.

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