EnviroInfo 2005 (Brno)
Informatics for Environmental Protection - Networking Environmental Information

Monitoring the Environment on the Internet with Open Source Software and Open Standards

Per Henrik Johansen[1], Geir Oscar Bakke Nielsen[156] and Hans Einar Thorset[2]

Abstract

Open Source software and Open Standards have been gaining in popularity the recent years. We will show how we implemented environmental and agricultural monitoring systems using these tools. Based on technology developed and explored in the APNEE and APNEE-TU projects run under the 5th Fifth Framework Programme of the IST, we present how we managed to glue together software components from several different open source GIS and map initiatives and projects, into full-fledge web-applications.

2 cases will be used as examples; a khlong and river pollution monitoring application installed in Bangkok, Thailand, and an agricultural application for making state-of-the-art maps of farms in Norway, which in the future also will include wild life preservation, cultural inheritance, etc. The first is an example of a traditional web client-server application directly based on the APNEE core components, while the latter is a completely distributed system which only relies on external data sources, i.e. it contains and maintains no data on its own, and thus serves as an example on how Open Standards affords inter-application interaction.

Both applications are based on a common core of software components and technology. We have deliberately chosen these specific cases so that the knowledge presented will be as broad as possible - both in the technological and the standardization dimensions.

1. Introduction

The use of open source software has increased over the last years, especially in the public sector. Initiatives have been launched to promote the use of open source products, for example the *info*Dev program has published a report on how to explore open source software (Dravis 2004). The APNEE and APNEE-TU (APNEE 1999) projects showed, amongst other results, that it is possible to use open source software to build mature and stable solutions to present environmental information on the Internet. Based on the know-how and the software components from those projects, we are now able to take a step further and use them in new solutions and projects.

2. The APNEE architecture

The results from the APNEE and APNEE-TU projects were a conceptual and technical umbrella for the distribution of air-quality information and an early warning system in case of episodes (Peinel/Rose/Sedlmayr 2003). The technical solution is made up of several modules, each providing functionality for dissemination over different communication channels. For example, there are different modules for providing air-quality situation reports and forecasts on WWW, email, WAP, SMS, etc.

[1] COWI AS, PO Box 123, N-1601 Fredrikstad, Norway,
email: {phj,gbn}@cowi.no, Internet: http://www.cowi.no
[2] Norwegian Institute of Land Inventory (NIJOS), PO Box 115, N-1431 Ås, Norway,
email: het@nijos.no, Internet: http://www.nijos.no

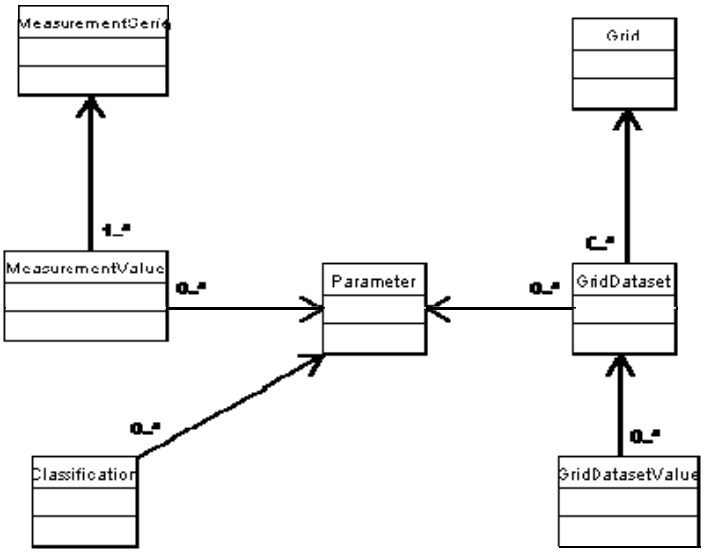

Fig. 1: Simplified APNEE data model

In the centre of the system architecture is the database model. The APNEE architecture does not try to replace existing air-quality (AQ) expert and forecast systems with a new, but relies on these systems to supply the APNEE database with the information to be disseminated. Usually this will take the form of an export from the AQ-system into the APNEE database. Two types of data series are supported in the data model, measurements (time series) and grid-datasets (results from forecast models), all linked to a parameter and classification. Figure 1 shows the core tables of the data model, a full description of the database can be found in (APNEE 2000) and (APNEE-TU 2004).

The main goal of the database design was to keep it as simple and generic as possible, so that it could be easily adapted at new sites; most AQ systems would be able to populate the database, and in keeping the database uniform across installations, modules could be exchanged and expected to work with minor modifications.

APNEE and APNEE-TU also had a strong focus on data visualization. One area that was given emphasis was map presentation (Johansen/Lindberg/Karatzas/Peinel/Rose 2001). The focus was to implement a solution that conformed to the standards provided by the Open Geospatial Consortium and that the software should be based on open source projects.

3. Metropole Watch

In Bangkok, the capitol of Thailand, the Bangkok Metropolitan Administration has launched a project to monitor the environmental situation of the Choa Praya River. The aim is to improve the overall conditions of the river itself and the surrounding khlongs[3]. Part of the project was to develop a web-based map client to show the collected data from monitoring stations. The main target group for the application is the decision makers, sectoral authorities and the general public (Bakken/Bjørkenes 2003).

Data collection is done from approx. 200 manual and automatic stations set up on the Choa Praya river and in the khlongs. Parameters monitored include BOD, NO3, NH3, etc., measured both in khlongs and the river.

[3]a khlong is a small river or canal.

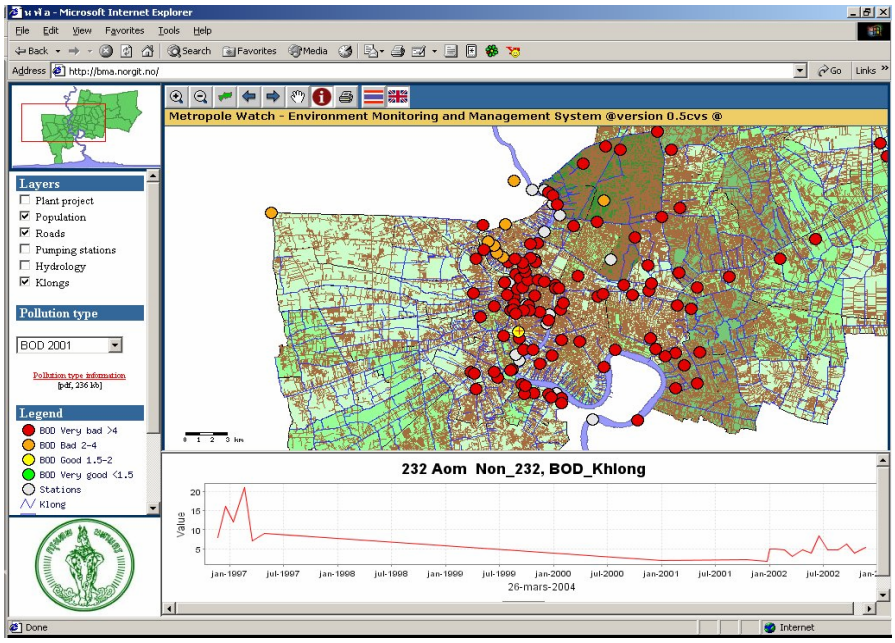

Fig. 2: The Metropole Watch web map interface.

Even though the main monitoring application, ENSIS, is a commercial environmental surveillance and information system, it was decided to base the web-module on the APNEE model, and thus on open source software. The reason for this decision, was the fact that the project had proven itself successful during it field trials, and that it is highly adaptable and extend able should the need for additional functionality arise.

The main component used from APNEE was the data model. The standard model was used and some additions was made to accommodate the need for additional meta data. However, we chose to remake the map interface, although it is based on the know-how and the technology used in the APNEE projects.

A screen shot of the final web interface is shown in figure 2.

4. Farm maps

The task of the Farm maps project is to produce accurate and printer-ready farm maps in Norway. The main audience is national and local agricultural authorities, and the individual farmers. The latter uses the information on land use provided by the application, to apply for funding from the Norwegian government. The introduction of this tool will give the farmers an easier task of gather information about their property, but also improve the knowledge on land use, improve the data quality and accuracy, and modernize the government procedures (Thorset 2005).

Various scenarios were discussed prior to the launch of the project (Skog 2002), and the final architecture is quite unique: it has no local data. That is, all data are collected from already existing databases external to the farm maps solution. It uses an already existing infrastructure of data providers amongst different institutions, to collect the information needed to compute the land use and the geography for any given farm in Norway. A typical request for a map generation consists of the following steps:

1. look up in the central repository for registered farms and collect the individual properties
2. find the geography for the properties in the central digital property map database

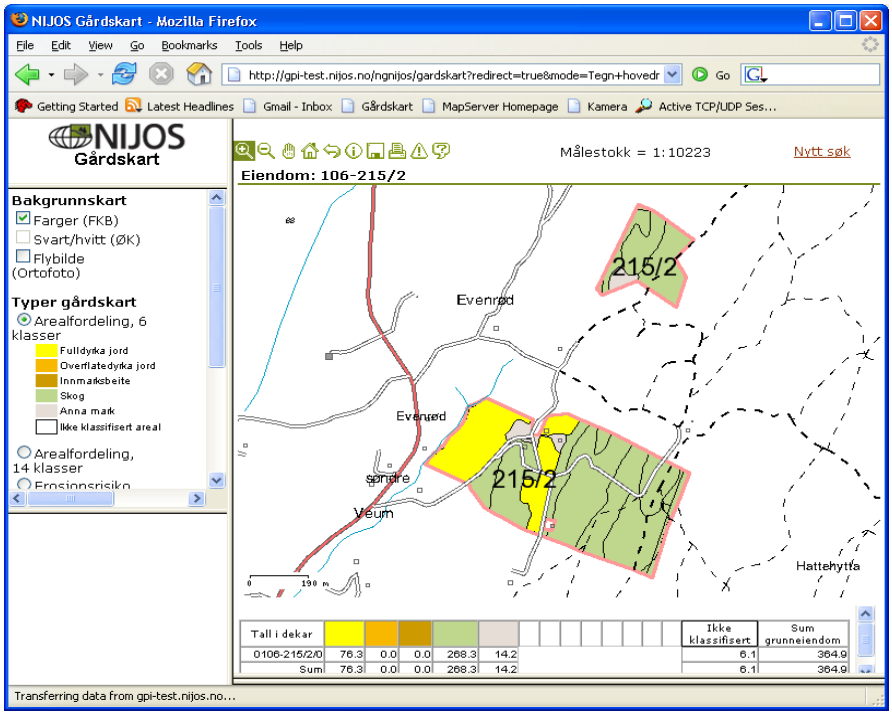

Fig. 3: An example farm map

3. find the land use for the area intersecting the farm from the digital land use database
4. and finally compute the land use and all geographical objects needed to generate a present the final map, as seen in figure 3

Since the application is completely distributed, it relies on a set of well-defined communications protocols, such as SOAP, SQL, ArcXML, and WMS. The solution is based only on open source components.

5. Lessons learned

The use of open source software includes some challenges an considerations that must be taken into account before it is being used in a new product or project, such as license evaluation quality, user base, etc. (Hubbard 2004). Starting with the APNEE project, we have explored several open source packages for the task of developing environmental monitoring software. We have found that the combination of MapServer, PostgreSQL/Postgis, the use of GeoTools for GIS functionality, and Mapsurfer as web client, have proved to be quite successful based on the two projects described. Coupled with the APNEE database, we feel we have a good alternative for developing environmental presentation application.

With the development of the OpenGIS standards by the OGC, and the adaptations of those standards, both in open source applications and software libraries, and in commercial available equivalents, we are now able to combine data from multiple sources in a distributed environment, as shown in the Farm maps project.

Since all of the software used in the projects described in this paper also are free of charge, it is possible to build advanced mapping solutions without paying licence fees, but other costs, such as man-hours, must be taken into consideration. In the Farm maps project, we experienced that after the application was ready,

that NIJOS – the project owner – managed with their own resources to take over the maintenance and development of new features.

6. Further work

The open source projects are in constant development, and need close monitoring to see whether bug fixes have been made, and if new features are added, we need to keep a close look at the development. Also, new projects appear now and then, and these need to be tested if they show promise to replace or complement components already in the portfolio.

Plans are also made plans to release some of the technical components from the APNEE and APNEE-TU projects under the open source community, but at the time of writing it is still work in progress.

In the pipeline for further implementation is the national election in Tanzania 2005. Technology described in here, will be used to make the map presentation on the Internet of the electoral results available on the Internet. This is part of what seem like a current trend, more and more data owners are requesting that open source products and standards should be used in online data presentation.

7. Acknowledgements

APNEE has been supported by the European Commission DG XIII under the 5th Framework Programme, IST-1999-11517. APNEE-TU has been supported by the European Commission under contract IST-2001-34154. Metropole Watch is funded by the Bangkok Metropolitan Administration. The Farm-maps project is funded by the Norwegian Institute of Land Inventory.

Bibliography

APNEE (1999): Air Pollution Network for Early warning and on-line Information Exchange in Europe, IST-1999-11517 and APNEE-TU (APNEE Take-Up) IST-2001-34154, project, http://www.apnee.org

APNEE (2000): System Design – Functional and technical specifications of an online air pollution warning and information system, APNEE Project Deliverable 3, internal project deliverable

APNEE-TU (2004): Final APNEE-TU system, APNEE-TU Project Deliverable 2.5, available from http://www.apnee.org

Bakken, T.H., Bjørkenes A. (2003): Development of a Web-based information system for Bangkok, Thailand. Report on the development of user requirements. NIVA, ISBN 82577-4352-6

Dravis P. (2004): Open Source Software – Perspective for Development, *info*Dev, The Dravis Group joint publication, http://www.infodev.org/content/library/detail/837, visited 29.06.2005

Hubbard J. (2004): Open Source to the Core, in: ACM Queue, Vol. 2 No. 3, pages 25-31

Johansen, P.H., Lindberg J.E, Karatzas K. Peinel G., Rose T. (2001): Citizen-centered Information Dissemination with Multimodal Information Channels, 15th International Environmental Informatics Symposium, Zürich, Switzerland

Peinel P., Rose, T., Sedlmayr M. (2003): APNEE – Air Pollution Network for Early warning and information Exchange in Europe, 3rd International Symposium Digital Earth, Brno, Slovakia

Skog K. (2002): Utredning av LGIS klient – tjener arkitektur, Report 2002: IT748/1, Norut IT, ISSN 0802-2011

Thorset H.E. (2005): Gårdskart på Internett, Presentation held at the 16th Norwegian ESRI User Conference, Oslo, Norway