10th International Conference on Hydroinformatics
HIC 2012, Hamburg, GERMANY

INTEROPERABLE MARINE WIND DATA FOR THE GERMAN SEA

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For many environmental models, wind data is an important parameter. This has been well-known for a long time, but data acquisition and transfer could be quite problematic. Thus in 2007 a digital wind atlas for the German sea was established. Unfortunately the technology did not age well, leading to a relaunch, using sustainable web service technology. In the course of this article we will recap the original design and show our efforts to reestablish the wind atlas in its new garb as well as outline our future plans for enhancing the application and integrating it in vaster information networks.

MOTIVATON

Digital wind data is a vital input parameter for marine and climate modeling as well as for engineering projects such as harbor design, dike planning or coastal defense works. Pre-calculated wind scenarios can be used as a fast alternative for time consuming on-demand modeling. A former research project concluded in a digital wind atlas that consisted of pre-calculated coastal wind scenarios well documented with metadata.

Wind fields in the German Bight at a height of 10m above sea level and the corresponding shear coefficients have been calculated, which can be used as input data for further analyses. The input parameters for this systematic study were specified at a height of 800m at the upper boundary of the wind model. Here the wind velocity, wind direction and water elevation were prescribed in typical ranges, see Niemeyer 2005 [4].

When this work was conducted, data infrastructures and spatial web services were, of course, still developing concepts, so the previous implementation with stand-alone java clients and Java Webstart applications can rightfully be called dated.

Still being convinced by the concept and our hand being forced by a fatal server crash which took the application offline for good early last year, it has been decided that the digital wind atlas should be reborn in the shape of an up-to-date and sustainable web mapping application, that can be integrated into spatial data infrastructures (SDI). This naturally leads to the use of OGC (Open Geospatial Consortium) web services as foundation of interoperable spatial data infrastructures.

MAKING THE TECHNOLOGICAL TRANSITION

When the digital wind atlas has been designed in 2007, digital atlases were a quite challenging exercise due to the turn-around times for map creation from extensive datasets. Software design always reflects current trends in software engineering and must take into consideration the contemporary hardware. This applies especially for software solution tailored to govermental agencies, as these tend to use a wide range of soft- and hardware, from high-end computers and up-to-date programs to rather outdated machines and products at the end of their life cycle.

Original Architecture

For these reasons, a platform indepent software was the aim of the original approach, with a server shouldering the main workload. This led to a three-tier client-server architecture, see Figure 1. The technology of choice on the client side was Java as it is platform independent by definition. It was used to create Java applets as well as stand-alone applications to access the wind data and execute user-defined data manipulation operations such as interpolations.

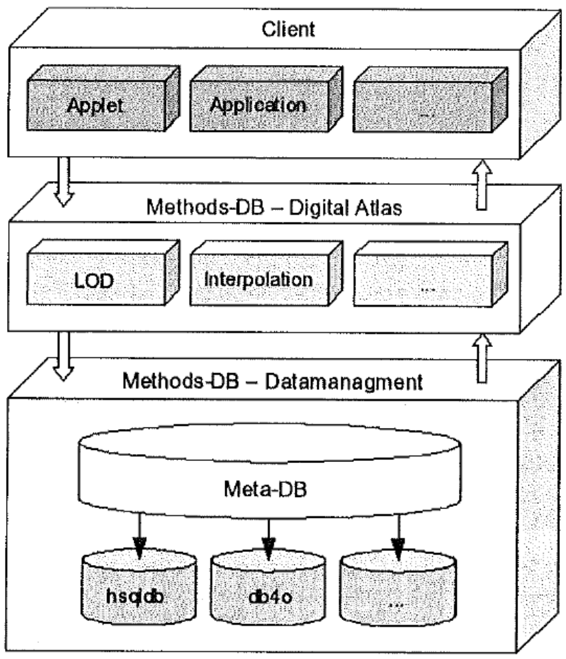

Figure 1. Original Architecture Lehfeldt R. 2008 [2]

These operations were handled in the application layer, situated between the client and the server that also took care of secure communications between client and server by utilizing the Remote Method Invocation (RMI) standard.

Heart of the system was the object-oriented db4o database on the server side, see Paterson 2006 [7]. It hosted the model metadata and simulation data as well as the selection and interpolation methods.

New Architecture

For the new installation of the wind atlas we profit from the advancements in web technology, such as Javascript and HTML 5 as well as the accompanying improvements in browser software, thus eliminating the need for such a complex architecture or client software.

In the new installation, all the visualizing and interaction components are accessible through the browser, relying on free and open source libraries like GeoExt [1] and OpenLayers[2]. Generally we opted for open source software and the use of open standards to ensure a sustainable software environment. With the use of freely obtainable open source tools, the wind data could be migrated into a modern spatial database (PostGIS[3]) and made available via OGC Web Services.

The OGC (Open Geospatial Consortium) is a formation of the most influential corporate, academic and governmental bodies with the goal to define open and interoperable geo-standards. Their main objective is the standardization of services for geo-data access, management, manipulation, representation and sharing over computer-networks.

For the implementation of a new wind atlas, we utilized two of the most basic OGC services: the Web Map Service (WMS) and the Web Feature Service (WFS), see La Beaujardiere 2002 [1], [5]. A Web Map Service, as the name indicates, provides maps over a network. In order to do this, it accesses the data in a database, shape file or other geo-format, computes a map thereof and renders it as an image. This image can be influenced by providing the WMS with styling information in form of a Styled Layer Descriptor (SLD) document, see Y. Coene et al. 2007 [8]. While the WMS renders the data into a geo-referenced image that can be viewed in a browser window or appropriate viewer, a WFS provides the download functionality for the underlying data.

The metainformation is stored in NOKIS, a separate, metadata management tool, developed especially for marine data that provides a Catalogue Service for the Web (CS-W) interface, see Lehfeldt et al. 2008 [3]. Our choice for NOKIS is rooted in its availability in German coastal zone agencies and a long term development cooperation with the software-producer. There are several open source products in existence that can handle the necessary operations.

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[1] http://geoext.org/

[2] http://openlayers.org/

[3] http://postgis.refractions.net/

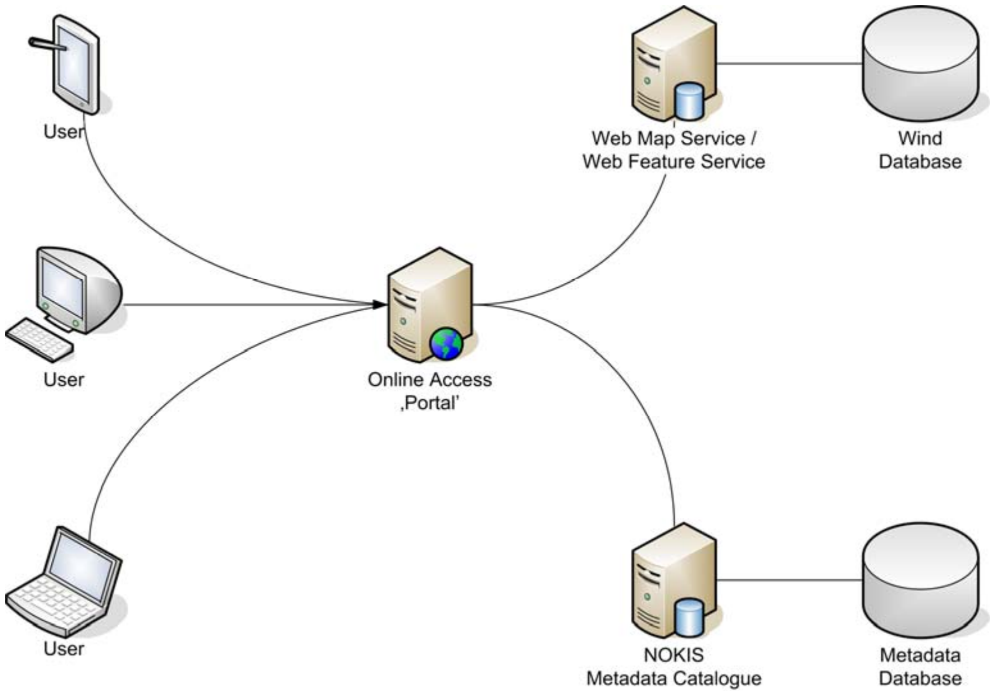

Figure 2. Revised Architecture

The WMS, WFS, and CS-W services provide the basic functionalities for map creation, data downloading and metadata provision in a standardized way, see Figure 2. For easy access a small web portal will be set up, where data can be searched via the metadata, displayed as interactive maps and downloaded for further use.

The transition

As mentioned above, the original system worked on a custom-made architecture and proprietary tools while the new incarnation focuses on using open standards and standardized interfaces. So apart from NOKIS, which is a running stand-alone application also employed in other contexts, little could be re-used. The wind data itself was salvaged in the form of Fortran-generated text files. These had to be converted by a tool, especially written for this purpose.

It consisted of several Java classes, parsing the text files and transferring the data from a complex, multidimensional storage matrix to simple geo-objects. While the original format was densely packed and needed some logic to extract the exact wind values according to the boundary conditions, the new data model consists of a geo-object for each possible combination of boundary conditions. This leads to a significant increase in storage space needed but also enhances the performance, especially for the WMS if a tile cache is used. With the decline in prices for storage media and the performance requirements imposed by the European spatial information infrastructure INSPIRE and other directives, this is a trade-off worth paying.

USING THE DIGITAL ATLAS

Users of the digital wind atlas usually have two goals: to visualize a certain state and/or to download one or several datasets. Therefore a web interface catering to those needs doesn't have to be overly fancy.

The interface of the digital atlas therefore will be rather simple and consist of only few fields to choose the boundary conditions from pre-set values for wind velocity, wind direction and water elevation. Once the choice is made, the user has the options to view or download the data, inspect more datasets, view the model metadata or download all of the wind data in a compressed file format.

If the user chooses to view the data, it will be provided by the WMS and displayed on-site in a map viewer powered by GeoExt and OpenLayers. Does the user opt to download datasets, the WFS then provides different file formats like gml [6] and shapefile for the user to save onto his local machine.

SUMMARY

Thanks to the above described overhaul and relaunch, the digital wind atlas is again up-to-date on the technical side, while the data itself never lost it relevance. Thanks to the use of standard compliant tools, the pre-calculated wind scenarios from the German North Sea coast are now ready to be integrated in data infrastructures or downloaded for local processing. Data acquisition procedures are simplified for those in need of wind as an input parameter for numerical models.

This new, standardized implementation provides interoperable data access on a sustainable technology as required by current national and European spatial data infrastructures.

ACKNOWLEDGEMENTS

The work presented here is funded by the Federal Ministry for Education and Research (BMBF) through Project Management Jülich (PtJ) under grant number 03KIS089 (Marine Information Infrastructure for Germany MDI-DE). The authors gratefully acknowledge this support as well as the contributions from co-workers and other partners to this research project.

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