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The Hydrological IT Framework of the Federal Waterways and Shipping Administration, Germany

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Abstract

The Federal Waterways and Shipping Administration (WSV) in Germany provides as main tasks the safe and easy of inland and coastal shipping transport. To assure these main tasks information technology (IT) solutions and their operation are playing a major role. As central IT support and development section the Federal Waterway and Research Institute with their Information Technology Division are in charge for these developments. Beginning in the year 2000 the hydrological IT framework was redesigned to generate a structured data flow combining the elements of data acquisition, data processing and data distribution providing a standardised intranet solution and an e-Government application. The data acquisition using different telemetric systems as well as on- and offline components were standardised introducing a simultaneous online data transfer system which is connected to regional hydrological data storages. The regional hydrological data storages are grouped in three Citrix Metaframe terminal server farms split in seven server locations and providing the hydrological application software. For the data acquisition the WISKI workbench systems of the Kisters AG is used; existing of different modules for data validation, standardised reporting, stage and flow regulations, tidal and stream flow analysis. Using the Citrix Secure Gateway technology and web interface the internet access for the operation of the system is guaranteed and all components can be used from variable access. Server balancing and WISKI backup database servers provide a high working performance and security. The regional hydrological data storages provide the raw and analysed data to a central hydrological information system for the flood and storm tide warning service, e-Government applications, archiving of historical data and further distribution services.

1. Introduction

The Federal Waterways and Shipping Administration in Germany (WSV) is a division of the Federal Ministry for Transport, Housing and Building with about 12,000 employees, 3 major institutes and technical divisions, 7 regional Waterway and Shipping directorates and several sub-regional Waterway and Shipping offices. The WSV is in charge of 7 700 km of natural and artificial waterways as well as coastal water engineering. It provides a safe and easy of inland and coastal shipping transport. The traffic volumes (in tons per km) are comparable to those of the railways.

As a central consulting division and one of the three major institutes the Federal Waterway and Research Institute (BAW) is in charge to plan technical development, give on-site advice, operate in the creation of national and international standards, conduct practical research and development work, collect and disseminate knowledge and experience and operate IT systems. Especially the demand to design and operate IT systems was increasing extremely in the last years, and is covered since 1999 by the Information Technology Division of the BAW in Ilmenau (BAW F-IT). The BAW F-IT co-ordinates the IT developments and infrastructure for the entire administration of the WSV. IT offers services and products in the

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fields of IT operations and infrastructure of hard- and software as well as the co-ordination of software development of engineering and business applications. Concerning the engineering applications the developments concentrate in the fields of hydrography, hydrology, design/CAD and GI- and metadata system.

This article focuses on the hydrological applications showing the development of an IT framework that provides users a structured data flow of data acquisition, data processing and data distribution. Within the framework and the above mentioned functions the hydrological systems provide:

- water level, discharge and stream flow measurements for a safe inland and coastal shipping transport, hydro-numerical modelling, information purposes (G2C application) and flood/ storm tide warning services,
- groundwater level measurement for maintenance issues of the artificial waterways and constructions along the waterways,
- integrated water resources management including the above parameters as well as precipitation measurement for planning water transfer between the river systems of Rhine, Elbe and Oder,
- morphological measurements to monitor and analyse soil erosion within the stream bed,
- statistical analysis of all measured parameters for monthly, yearly and long term evaluation as needed for the German hydrological yearbook (DGJ).

Regarding these issues part 2 of this article describes the technical design of the IT framework which was started in the year 2000 and is still in implementation. The following part 3 gives examples of the functionality of the hydrological WISKI workbench and its elements. The final part looks at the use of metadata and GI-Systems in the Web to guarantee data reporting as formulated in national and european-wide initiatives.

2. IT framework

The technical IT framework can be split concerning its needs of data acquisition, data analysis and data distribution into three technology groups. The different groups are the interface structure to the telemetric systems, the terminal server infrastructure and the web technology.

2. Interface structure to the telemetric systems

The WSV is using a variety of different telemetric systems for data collection of various parameters. Examples are the sensors and systems of the companies Ott, Seba, Comtex and Aanderaa.

Typically the parameters water level and discharge (if not generated over rating curves) are implemented as online data acquisition systems. Over 600 stations are integrated in this kind into the framework. They assure the data availability for the warning services. The data communication is done via modem using the telecommunication network and seven multi-protocol Linux servers (SODA = **s**imultaneous **o**nline **d**ata **ac**quisition). The SODA servers guarantee using push- and pull-technology the automatic import of all the individual telemetric protocols. The functionality of the systems allows the configuration of remote call jobs, a protocol overview of the data transfer via internet browser and a job stati display. Additionally the system uses a standardised protocol for time series and descriptive data. Semantic XML is used to communicate with the hydrological software hosted in the terminal server infrastructure. A project evaluating the use of internet technologies such as XML, SOAP and web services in the telemetric network is in preparation. Its success will be technology-driven and could lead to the decision to restructure the telemetric network as IP network.

Concerning the parameters stream flow, groundwater as well as the morphological parameters, their collection is done offline using different types of data loggers. The import takes place directly into the hydrological databases in the terminal server infrastructure and is done by special import servers.

2.2 Terminal server infrastructure

The central component of the hydrological IT framework is build by several terminal servers grouped into different farms using the server based computing technology of Citrix Metaframe as shown in figure 1. The different farms integrate the SODA servers, the database servers and the applications servers hosting the hydrological software (see regional server clusters in the figure).

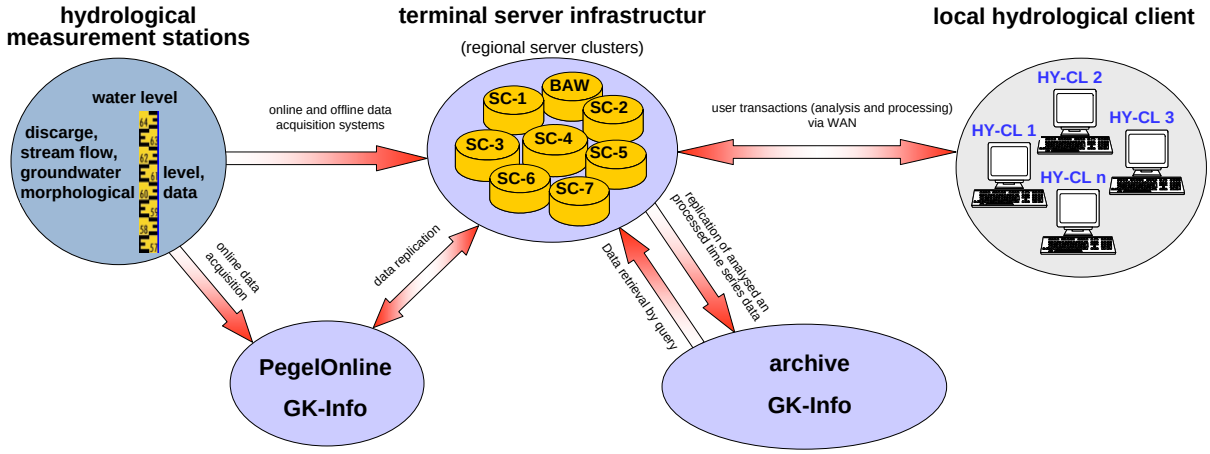

Fig. 1: Schematic overview of the different hydrological IT framework components

Each location exists additionally of a life- and a fall back-system. A central fallback-system for all the regional server clusters exits in the BAW F-IT in Ilmenau, also allowing internet access for registered users. Within the terminal server network all hydrological applications (see chapter 3.) are administrated and configured for about 150 different users. The functions of shadowing, software distribution, user handling and server balancing within zones and complete farms are applied. The systems is design to allow 10 to 15 user per terminal server (by a server RAM with 4 Gbyte). All server locations are integrated into a wide area network operated by the German Weather Forecast Service. Hard-and Software monitoring is done by a central user help desk. To assure the availability of the different services the ITIL concept (IT infrastructure library) is applied and service level agreements are implemented.

The experience after one year of life performance shows that the infrastructure is very effective and robust. It improved the user support significantly and lead to very short response times. The infrastructure is seen in the WSV as an excellent example to implement fat client server applications without redesign. The benefit is financially significant.

2.3 Web technology and information systems

The data distribution to different experts in the WSV via intranet and users in other administrations as well as citizens via internet is achieved by web based information systems (see data flow to GK-Info - hydrological information system - in figure 1).

The GK-Info development is based on a multi-tier-architecture (client, middleware and backend) and the standards for the architecture of e-government applications in Germany. The web-client uses HTML and JavaScript in standard browsers such as the Internet Explorer and Firefox to display the hydrological

information. The middleware organises the data import, the database connectivity and several different data transformations via Java servlets and Java Server Pages (JSP) within a servlet Tomcat container or special Java applications. The communication with the central RDBMS informix is done by the Java database connector (JDBC). The graphical data display and data transformation is done by using XML, XSL and the XML based scalable vector graphics (SVG). The data distribution using the system GK-Info is shown in chapter 4.

3. Hydrological applications

The data processing and analysis is based on the hydrological WISKI workbench system and run within the terminal server network (see figure 1). The system is able to track different hydrological parameters such as water level, discharge, stream flow, groundwater level, temperature, wind, precipitation, snow, water quality, morphological data and tidal data. Based on a RDBMS it collects and manages data in time series with spreadsheet functions and provides a variety of tools to manage time series like the calculation of automatically derived values. The WISKI user interface consists in the main parts of a station explorer, an interactive graphical time series editor and special analysing tools such as a rating curve editor and a tidal modul. The management of all basic station data (location and detailed information) builds the basis for the metadata description.

4. Distribution of hydrological data

The distribution of the different types of hydrological data is impossible without metadata. The majority of (mostly web-based) applications use at least four metadata elements to describe time-series data; the name of the measurement station, the name of the river or waterway and the name of the parameter which is observed. Sometimes the temporal extent is also available. Many corresponding web services uses the station number instead of the station name so the user can get immediately the most current time-series data.

As shown in figure 1 the project GK-Info is the core element for data distribution and publishing within the hydrological IT framework. The underlying data model defines measurement categories and their corresponding measurement station. Both data model elements were complemented by further descriptive data; the time series data by temporal and vertical extent (like minimum and maximum values, vertical reference height) as well as the measurement station by name, location, responsible party and adjacent waterway/ catchment area.

The publishing of hydrological data has different key aspects in relation to the *amount* and *content* of information as well as to the different *knowledge* of the *user or customer* of the data. On the one hand the amount of metadata can be considered as a web-service oriented minimum of descriptive data with focus on services like geographic overview, visualisation or download of one or more time series. This type is offered in GK-Info in connection with a user-administration. On the other hand there is a need of descriptive data in a more standardised form which includes further links to web services. Figure 2 presents the data model to describe measurement data. Besides the well-known metadata format information about instruments, methods and data quality will also be given.

Similar to the different needs of the amount of information are the different categories of user or customer. A power user, who knows the station number, the correct name of the measured parameter and the surrounding environment, would rather use a customisable (adaptable) web service than a geodata warehouse. Non-expert-users otherwise have a demand of general information like available time-series data and contact information. A third user group need a mixture of both. They are interested in a comprehensive, service-oriented system with data, reports and maps for regular, mostly yearly tasks.

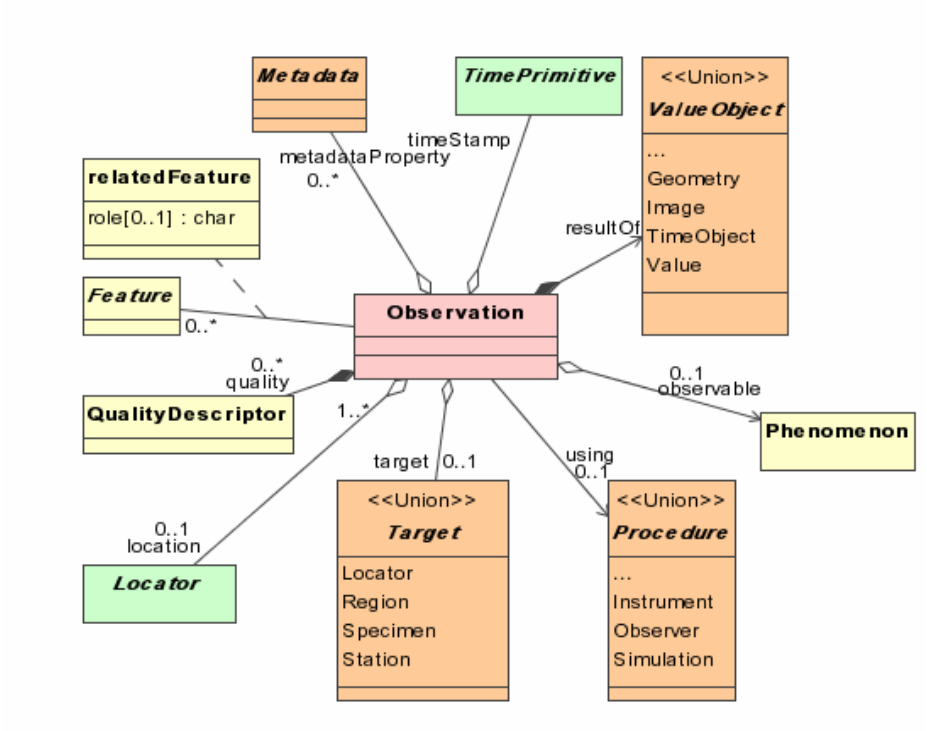

Fig. 2: OGC Specification for observation and measurement

GK-Info is delivering hydrological data inside and outside the administration. It exists of an online modul (PegelOnline) to distribute actual water level information to systems like ELWIS (‘electronic water management system’, WSV). Information regarding the warning services (like flood or storm tide warning) are directly served by PegelOnline. The second modul is a central data archive and distributes the analysed and processed data to GI- systems like WaGIS (geodata warehouse, WSV), WSV.Datenkatalog (meta data information system with cart module, WSV) or “NOKIS” (‘North and Baltic Sea coastal information system’, BAW Hamburg).

These examples show that hydrological information, acquired and analysed by hydrological experts of the WSV within the demonstrated infrastructure, can be found in many different applications; in web-based gauging station information systems, in geographical information system as well as in water management systems. The mentioned systems are offering map- based searches, graphical and tabular overviews and user-right managed downloads.

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