

Integrated Analysis and Reporting of Environmental Data Through Cooperation and Technical Innovations – Despite Organisational Changes, Increasing Requirements and Decreasing Budgets

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Abstract

Almost all state and federal level environmental authorities in Germany cooperate by joining their financial resources and competences, making new dimensions of software solutions for environmental protection possible. The cooperation was initiated in 1994 by Baden-Württemberg, a German state with an outstanding environmental information system. disy Informationssysteme GmbH is, among other companies, working in the related umbrella projects. disy is a spin-off of the Universität Karlsruhe, one of the leading universities in computer science worldwide. The know-how and the platform disy Cadenza for data integration, analysis and reporting is a result of the ideas and requirements developed by the customers – German environmental authorities with very high standards – and of a top R&D and technical competence in information systems, geographic information systems, decision support, databases, human-computer interaction and software technology. This paper gives an overview of the two issues: the organisational background of the cooperation and the innovative technical solutions at disy.

1. Introduction

In order to improve the state of the environment, during the last years a main focus is put on comprehensive, cross-medium monitoring and comprehensive analysis and reporting of environmental data. These trends are present in national and international legislation, in the activities of the environmental authorities and also in the software systems supporting their work. Parallel to the increasing requirements, budgets are generally decreasing and reorganisations take place, leading to additional difficulties in short and medium term.

How can these challenges be tackled successfully? A cooperation, initiated in 1994 by the Ministry of Environment and Transportation in the German state of Baden-Württemberg and today comprising more than 30 members, has become very successful in all parts of Germany. The cooperation also includes leading universities, research institutes and some private companies. Through this, a large potential for innovations – essential for non-traditional tasks typical in environmental protection – combined with industrial strength and pragmatism has been present in the cooperation, representing a second and additional cornerstone for successfully mastering the challenges.

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2. Innovations on the Organisational Side

2.1 The Environmental Information System of Baden-Württemberg

The environmental Information System of the German state of Baden-Württemberg (UIS; Mayer-Föll et al., 2004) comprises organisations, contents and software systems for collecting and using information. It covers all bodies in the public sector – from the communal up to the state level. It comprises strategies, concepts, personal and technical resources, software systems and the available data. As such, the UIS has a much wider scope than in most other German states.

The primary goal of the UIS is to support the public sector in fulfilling their legal obligations (including providing information to the general public) appropriately, economically and on time. The UIS covers a broad range of environmental issues, corresponding to EU directives on environmental information. As a result of this, a number of authorities, including the municipalities, are part of the UIS project organisation. This is another major difference to most other German states.

The reporting system in the UIS is an information system allowing a read-only access to the data for a very wide user group in all areas of public administration (and also for the general public). The data made available originates from heterogeneous data sources and is presented in a way that users without a deep knowledge of the data can interpret and make use of it. The reporting system is based on *disy Cadenza*, as described later.

2.2 Cooperation, R&D on the State and Federal Level in Germany

The requirements on information systems in environmental protection, traffic and public administration resemble each other to a large extent in all German states and also at the federal level due to their common obligations. Therefore, a cooperation in the form of an agreement called *KoopUIS* (Kooperation von Bund und Ländern für Konzeptionen und Entwicklungen von Software für Umweltinformationssysteme – Cooperation on Developing Concepts and Software Systems for Environmental Protection) has been initiated. In the meantime, all state-level environmental authorities and many federal agencies participate in *KoopUIS* (Figure 1). In the executive committee all state and federal level organisations are represented. The costs and the copyrights of the concepts and systems developed in a project are shared between the partners participating in the specific project. Nevertheless, all projects are documented in the *KoopUIS*. Workshops and other meetings are organised in order to support the work and to gain new partners.

Several related R&D umbrella projects have been initiated by Baden-Württemberg's Ministry for the Environment in Stuttgart, Germany. The goal of these projects is to develop innovative, economically advantageous and powerful applications by bundling financial and human resources. The developed concepts and systems are available to all project partners – contracting bodies, universities, research institutes and private companies – free of charge. The assignment of the projects and the financing are agreed on separately between the contracting bodies and the contractors of each project. The contracting bodies coordinate their work in *KoopUIS*. The umbrella projects have a long history: the project *GLOBUS* (Globale Umweltsachdaten – global environmental data) ran between 1994-1999 and the project *AJA* (Anwendung JAVA-basierter und anderer leistungsfähiger Lösungen in den Bereichen Umwelt, Verkehr und Verwaltung – Application of Java-based and other powerful technologies in environment protection, transport and public administration) between 2000-2004. The current project *KEWA* (Kooperative Entwicklung wirtschaftlicher Anwendungen für Umwelt und Verkehr in neuen Verwaltungsstrukturen; Cooperative development of economically advantageous Software Solutions for Environment Protection, Traffic in Re-structured Public Administration) started in 2005.



Fig. 1: Organisations in the cooperation KoopUIS

3. Technical innovations

The platform disy Cadenza has been developed since 1996 in the organisational framework presented above and is currently used as the core of a large number of information systems across numerous organisations (Figure 2). The origins of the platform go back to research projects at the Computer Science Research Centre in Karlsruhe, Germany, and at the University of Karlsruhe. It is now developed by their spin-off disy Informationssysteme. Also, from a series of projects, a large body of know-how is accumulated on building integrated environmental information systems at the company.

3.1 Architectures for Integrating Data and Geographical Data

One major technical challenge is the integration of factual and geographic data from a large number of sources – a major research issue a few years ago –, whereby in most cases a read-only access is sufficient. Approaches reach from (1) layer-based integration of geographic data, through (2) database-level data integration (Lukacs et al., 2003) to (3) service level integration. Although all three approaches have their advantages and disadvantages, experience shows that database level data integration is very useful for



Fig. 2: Systems based on disy Cadenza and related technologies in use

integrated environmental information systems. Its main advantage is the support of wide-set, powerful and flexible analysis of data. Also, with appropriate design decisions and tools – e.g. data warehouse approach, naming conventions or metadata accumulated in a number of projects – data level integration can be very flexible and open for extensions and modifications. As an extension to this, layer based-integration can be useful for geographical background themes and service level integration for supporting workflows.

3.2 Exploring and Visualizing Information, Including Geographic Data, Decision Support

Analysing complex data, such as environmental data, requires powerful methods to select, prepare, analyse, visualise and report data. Searching for data in a database the user is not familiar with, is a frustrating and time consuming task. Explorative data analysis (Schneiderman/Plaisant 2005) gives the answer to the challenge. Processing and visualising topical, temporal and geographical data in the form of business diagrams, maps and map-based diagrams is the next challenge, requiring innovative solutions in user interface and functionality. Many of these solutions are used in business-intelligence applications. However, experience shows that they are not appropriate for environmental issues. disy Cadenza, our product, comprises the joint know-how of many high-level environmental authorities, recent research results and our own R&D efforts.

3.3 Flexible, Configurable Platform

A very broad spectrum of relevant data is covered in integrated environmental information systems. The database schema may contain up to a thousand database tables, not to mention the geographical layers. Extensions and modifications to the database occur regularly. Changes and new requirements about how the data should be queried and presented are even more frequent. Therefore, writing a computer software handling all these issues on the code-level is neither technically nor economically feasible.

The solution is a configurable system general enough to offer a solution for almost all tasks. The configuration must be simple enough so that experienced users can cope with the configuration. Less experienced users can use the information prepared by the experienced users.

The platform *disy Cadenza* is designed exactly in such a way: the platform can be configured by means of graphical tools that write configuration files for a specific database schema, for query forms and result representations. In fact, *disy Cadenza* is similar to the World Wide Web in many ways, with the major difference that it handles structured and geographic data as opposed to hypertext.

3.4 Software Technology

Developing a very complex software system as *disy Cadenza* is a technical challenge, too. Modern and powerful technologies, such as Java, XML, WebStart, etc. are required. Concerning the software (development) technology, the *disy* team uses elements of extreme programming, design patterns, test driven coding (Link et al., 2005), etc. – all allowing to reduce and manage complexity and increase functionality and software quality.

4. Conclusions

The German state of Baden-Württemberg initiated a widely set cooperation covering the whole of the public sector relevant to environmental protection in order to develop an integrated environmental information system. Also, it initiated a cooperation covering the state and federal level of the whole of Germany. Over the last 11 years, the joint mental and financial resources allowed achievements that otherwise would not have been possible.

disy Cadenza is a software platform having been developed in the cooperation and already being utilized by most cooperation members and some other users. Technical innovations at all levels are made possible by the cooperation and by the outstanding Faculty of Computer Science at the University of Karlsruhe.

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