Management of Data and Services in the Environmental Information System (UIS) of Baden-Württemberg

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Abstract: In the Environmental Information System (UIS) of Baden-Württemberg, an extensive collection of information and knowledge is accumulated in the form of data, methods, and multimedia documents on a variety of computer platforms. A service-oriented approach based on meta-information and WWW technology has been chosen to bring this treasure of information and knowledge to the workplace of every employee in the environmental administration. The guiding idea was to identify data, functionalities, and multimedia information that can be used in multiple ways and to supply them as self-contained network services. This helps to make the use of the available hardware and software resources more economical and, in addition, allows for a relatively unrestricted and easy access to the information sources offered by the UIS.

1 The UIS Baden-Württemberg

UIS is the environmental information system of Baden-Württemberg, a state in the Southwest of Germany. The main objectives are [Mayer-Föll et al. 1996]:

- to support the planning and executive tasks of the environmental administration in an efficient and economical way,
- to provide methods for collecting and analyzing data on the environment as well as forecasting future developments,
- to protect investments by coordinating existing methods and integrating them into an advanced system architecture,
- to support the management of emergency situations, and
- to provide politicians, administration, and the public with timely and reliable information on the environment.

The UIS thus contributes to an effective assessment of the state of the environment and the impact of humans on their natural habitat. It forms a basis for controlling this influence on the road towards a sustainable economy and long-term protection of the environment.

Since the mid-eighties, the state government has installed UIS component systems for a broad variety of special tasks, including spatial data management, measuring data management, and high-level decision support [UM B-W 1995]. By now, these systems have proved their practical value. As a result, an extensive collection of information and knowledge has been accumulated in the form of data, methods, and multimedia documents on a variety of computer platforms.

We now must pay increasing attention to the task of bringing this treasure of information and knowledge to the workplace of every employee in the environmental administration – whenever this promises to increase productivity. For more than three years, this task has been the subject of major research activities, particularly in the projects INTEGRAL [Riekert 1995] and GLOBUS [Mayer-Föll, Jaeschke 1995]. Based on the new architecture designed in these projects, we are developing a fundamentally revised version of the *Environmental Management Information System* (UFIS II) [Riekert et al. 1996]. The purpose of UFIS II is to provide decision-makers in the executive branch with comprehensive information on the environment (see figure 1).

In these projects it has become clear that the installation of TCP/IP-based Intranets within the Baden-Württemberg administration allows us to integrate the individual UIS resources and to combine them in a distributed information network. This facilitates the economical usage of hardware and software resources throughout all UIS sites. A large supply of information can be made available to the users without having it stored or maintained locally. Thus reasonably priced and easily maintainable PC systems can be used as UIS working platforms.

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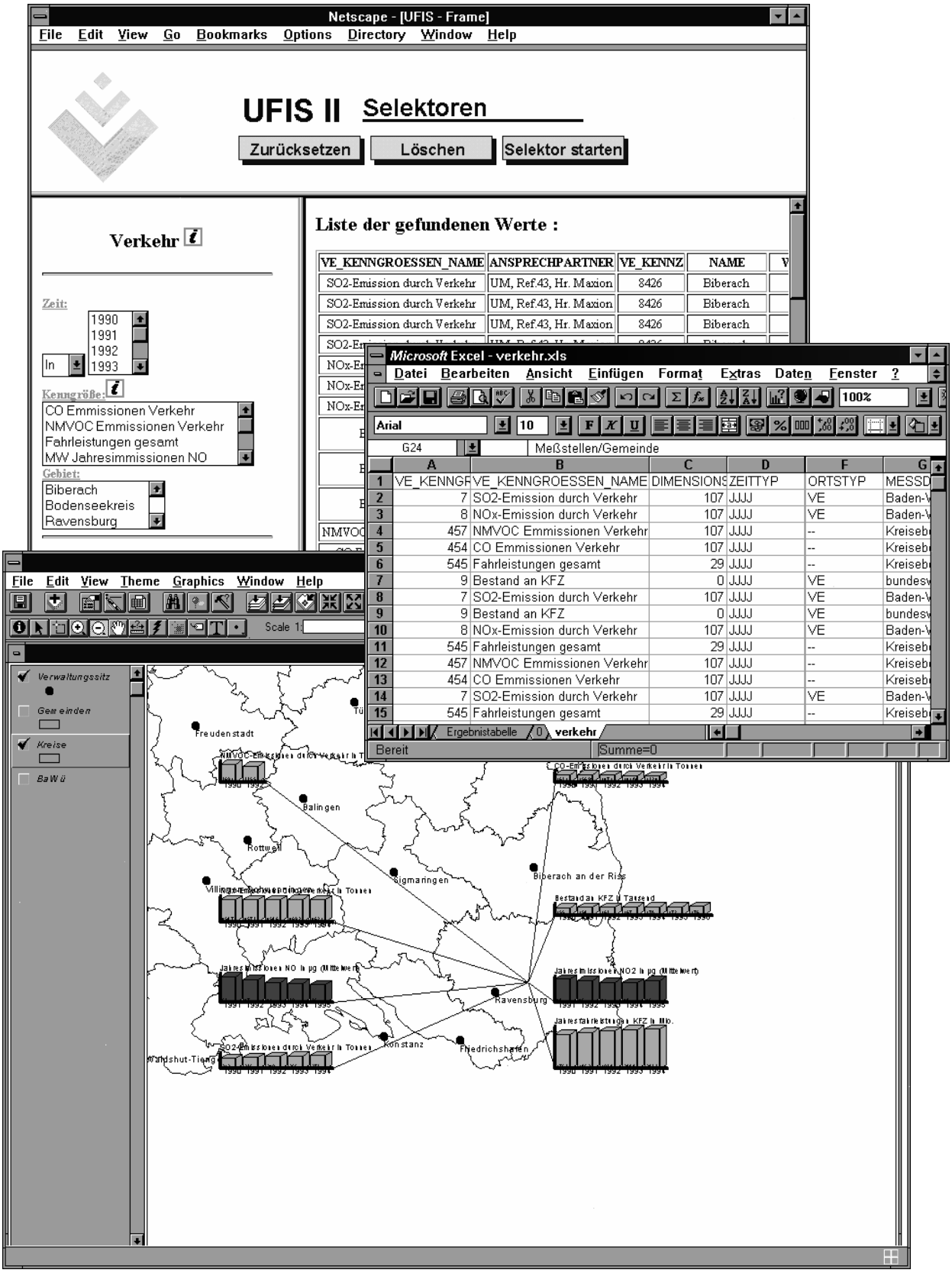

Figure 1: The UFIS II system supports the supply and usage of information from environmental databases.

2 Information Sources in the UIS

The existing UIS components offer basically three kinds of information sources: data, methods, and multimedia documents.

- The primary sources of information in the UIS are *data* on the environment, e.g., measurement series, census data, or data from surveying activities. These data can also exist in edited form as corrected data, aggregated data, or complex data (such as geodata).
- Many government agencies have developed computer-based *methods* for the interpretation of environmental data. These methods serve as sources of information by generating information from the existing data. Examples of these are environmental simulations, database application programs, statistical analysis functions, or presentation functions (e.g., to generate reports or maps).
- Rather than fall back on the original data, it often makes sense to consult the results of earlier interpretations of the data in question. These results are usually available in the form of reports and maps, i.e., *multimedia documents*. Reports and maps are very important sources of information because – implicitly – they contain also those metadata which are necessary for interpreting the original data that underlie the document in question. Especially for the public and for high-level decision-makers, this kind of information source is indispensable.

In order to supply these sources of information – data, methods, and multimedia documents – in an efficient and decentralized manner, a service concept was designed and implemented. The available UIS components are being decomposed into individual functions which can be addressed as self-contained network services in a wide-area network. The WWW technology was chosen for implementing these services. WWW provides transfer services for typed data through the Multimedia Internet Mail Extensions (MIME) facility, allows for the activation of methods through the Common Gateway Interface (CGI) and Java applets, and is especially designed for the presentation of multimedia documents.

3 Supporting the Contribution of Environmental Information

An important objective of the research activities described here is to support the supply and usage of information from environmental databases. Towards this end, we designed a software solution called *WebQuery*. It is used in the UFIS II project for accessing data from existing relational databases in the UIS. WebQuery makes possible the installation of network services, also referred to as *selectors*, which allow for the retrieval of information on specific topics from a database. These selectors are presented to the user as data entry forms through a WWW browser. WebQuery transforms the content entered on the form into a database query. The result of such a query is a text file representing a table. This table is shown by the WWW browser as a dynamically generated hypertext document and, optionally, can be transferred (as data) to the client system. There it can be used in a spreadsheet system, a desktop mapping system or a word processing system, thus forming a building block for generating studies and reports (see figure 1).

One does not have to know a procedural programming language to define selectors for an environmental database. To link a database to the WWW, it is sufficient to create a set of description files. This task only requires knowledge of the WWW's hypertext definition language HTML and the database query language SQL. The WebQuery interpreter uses these descriptor files to process the user's queries. WebQuery comprises – independently of the database connected – general functions concerning session management, multi-user mode, user management, statistics, management of intermediate results, download, etc. without the necessity of additional programming. The existence of these features is particularly important for the provider of the database since their implementation is not easy due to the stateless Hypertext Transfer Protocol (HTTP) that underlies the WWW.

The selectors generated by WebQuery are network services that are self-contained, individually addressable, and independently executable. Different privileges can be given to various user groups for activating these services. Thus the database can present itself to each specific user group (individuals, departments, institutions, the public, etc.) in a customized appearance in order to fit their needs concerning both content and desired query complexity.

4 Supporting the Retrieval of Environmental Information

The increasing number of environmentally relevant services in the Internet leads to the problem that individual sources of information are often difficult to find. What is needed, therefore, is a *Locator* facility on the basis of meta-information, which enables users in the administration and the public to search for relevant information. We have developed a prototype of such a locator as part of the UFIS II project. A multilingual version of this locator is also in use for the German Environmental Information Network GEIN [Seggelke 1996] and forms the German contribution to the pilot

Figure 2: The *Locator* of the German Environmental Information Network. Sources of information can be searched for by specifying various search criteria. Geographical references may be entered by using a *Gazetteer*.

project ENRM (Environment and Natural Resources Management) of the G-7 initiative for a Global Information Infrastructure (GII).

The locator contains an index of all sources of information available (data, service programs, documents, etc.). These sources can be searched for by specifying keywords, geographical references, and temporal references, as well as the suppliers or the type of the desired information sources (see figure 2). The data descriptions available in the database of the *Environmental Data Catalogue* (UDK)[2] are included in the locator. The result of a search is a list of information sources. By simply using the mouse it is possible to activate detailed descriptions for every source in the list. For this purpose, the locator offers a simplified view of the UDK data stock. It is also possible to access the original information, as long as it is offered by a server in the WWW.

For entering keywords, we use the polyhierarchical environmental thesaurus of the German Federal Environmental Agency [Batschi 1994]. Semantic relations between keywords (such as associations with synonyms, broader, narrower or related terms) are evaluated and used by the system during the search for information sources. In addition, the GEIN locator is equipped with a multilingual thesaurus extension for the retrieval of information in foreign languages.

[2] For more information about the UDK, see [Kramer et al. 1997] and [Günther et al. 1996].)

Entering geographical references is supported by a structured geographical index known as *Gazetteer*. With the help of this gazetteer a geographical search for environmental information is possible either by giving a rectangle defining the area of the search or a geographical term or name. Geometric-topological relations between geographical references are represented in the gazetteer, thus allowing the search for information using an enclosing, enclosed, or, in the most general case, overlapping geographical reference.

The entry of meta-information on information sources can be done best by the suppliers themselves. The locator offers services concerning entry and maintenance of this meta-information. These services can be used via the WWW. The extraction of the meta-information from the information sources is to be increasingly automated. The current solution already associates keywords with textual documents automatically by comparing the texts in question with the environmental thesaurus. The indexing of geographical references with the help of the gazetteer is planned to work analogously. Further requirements arise when, apart from the textual information, data and service programs are to be subjected to the indexing process. Here, too, we are planning to introduce automatic methods, e.g., via the evaluation of database contents and schemas, or the analysis of description files used to define selectors through the WebQuery tool.

5 Summary

To date, a comfortable and rapid solution has been realized that supports the supply, distribution, and usage of environmental information. It can be used by decision-makers in politics, government, and industry as well as by scientists and the general public. Distributed sources of information from various supplier sites are combined in an integrated network. Implementation is based on WWW technology and the utilization of meta-information. Recent software developments in the Internet could easily be adapted, often without additional cost. As a result, the amount of project-specific developments remained reasonably small.

The service-oriented approach which has been chosen in the UIS of Baden-Württemberg, resulted in promising steps towards the management of heterogeneous and distributed sources of information. The guiding idea was to identify data, functionalities, and multimedia information that can be used in multiple ways and to supply them as self-contained network services. This helps to make the use of the available hardware and software resources more economical and, in addition, allows for a relatively unrestricted and easy access to the information sources offered by the UIS.

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