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Web Collaborative Tools for Geospatial Data Management

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Abstract: The systems that are able to work with data from remote sources are becoming more and more important. Management and the usage of data stored on remote sources (external servers) without the necessity of data replication give us the chance to try to solve some of the problems that requirements for fast and easy data usage present. This solution is based on the principles of remote data retrieval through data management systems. The main objective of the paper is a present unique web solution for spatial data management in a form of integration using different kinds of spatial web services together with internal data sources (files, databases). A very important point is also the collaboration of this tool with other web tools in the same portal solution. Map Project Manager and the Uniform Resource Management system are the programmes able to provide geo-data integration and SW tools collaboration within a web environment.

1. Introduction

Present society is “data dependent” on all counts – data accessibility is necessary in business, for internal data usage within official government bodies, public free time activities as well as basic conditions for good government-public communication. The expanse of data sources also demands far better information management facilities and publication systems are increasing more and more. Technical solutions covering these general requirements is important mainly for institutions dealing with data processing and data publication or for institutes which provide information on other subjects. New systems should have the possibility of faster access to updated information, better search options, publication and sorting facilities for data, and using other systems or subsystems.

Thanks to the progress in the development of web services, users (people, institutions) now have the possibility to work not only with their own geographical data saved on their computers, but they can also use the data stored on external servers. Users are now able to include much more information in their ongoing work and the data is continually kept up to date (that means that the data in the user's application will be as up to date as the data on the source server).

The systems that are able to work with data from remote sources are becoming more and more important. Users can combine their own data with the newest available data on the Internet, thereby they have an up to date information base for decision support processes, analyses and evaluation. Currently, external geo-spatial data sources management systems, which work on the web service basis, are mostly implemented into desktop applications.

2. Objectives

The problem of how to solve the management of the external remote sources on the web is one of the main goals of the technological research being carried out by the Czech Living Lab association. The main idea of the work has been to find solutions based mainly on web server technology. The solution should cover the requirements for functionality which has not been implemented on the server side or implementation (and usage) of which is too expensive for smaller users.

This objective has been split up into 3 main groups:

- how to gather together data from different sources (files, databases, web services), that are stored on different external or internal servers
- how to make results easily available to users
- how to create a link between web tools used for geospatial data operation

One of the solutions to the above-mentioned problem is the Map Project Manager (MapMan) web tool and its integration into the Uniform Resources Management portal.

3. Methodology

New technology tools have been developed by several international projects, where experts from the Czech Living Lab have participated – NATURNET-REDIME, AMI4FOR and C@R. The general objective of NATURNET-REDIME project (NNR) is the improvement of knowledge and the provision of education concerning all aspects of Sustainable Development. The project has been developed and has demonstrated prototype technology and educational programmes towards implementing the European Union's Strategy for Sustainable Development (SSD). The components of the project will focus on building an interoperable Internet architecture, through which users can access and visualise much of the data on sustainable development that currently exists in a scattered, non-integrated form throughout the world. The AMI4FOR project has been focused on integration of a Spatial Data Infrastructure as part of a forestry and agriculture knowledge system on the base of standards and recommendations of OGC (Open Geospatial Consortium).

The next aim of the AMI4FOR has been the usage of new methods for data mining, modelling and analysis for improving forestry and agriculture management. Collaboration@Rural (C@R) is an Integrated Project, funded by the IST Priority of the European Commission's 6th Framework. The main goals of the C@R project regarding technology development are to provide a collaborative platform for rural communities, defined in cooperation with other Collaborative Working Environment communities; demonstrate the use of the same platform integrating various tools for various rural user communities; promote the user centric Open Collaborative Architecture (OCA) in the industrial, new business opportunity and emerging rural sectors, demonstrating its affordability and usability.

A proposed system for the integration of different sources is being developed on the basis of open web services, mainly on web services agreeing to Open Geospatial Consortium standards. OGC (a non-profit, international, voluntary consensus standards organization) is leading the development of standards for geospatial and location based services. This organisation enables other organisations that adhere to the same standards, accessibility to data sources. The communication between web tools inside of the portal is provided by XML or sometimes directly through TCP/IP protocol.

An openly available Internet site guarantees that no installation on a user's desktop is needed. The main installation is placed on servers separately for each project and access to the application is supported by an independent authorization service.

The design of the Spatial Data Management system has been created on the basis of requirements to make data easily available, which is not stored on the user's own servers, but which is available through Web Map Service or Web Feature Service.

This remote data can be combined together with data saved on an internal server (database or files) into new map compositions. Composition publication is provided using standard web visualization clients (Java, DHTML, GoogleMap, and Google Earth) or as a new web service. The combination of different types of data sources on the web and follow-up publication of new web services are the most important recent innovations in this field.

Strong emphasis is placed on metadata functionality. Each new map project contains its metadata label, which is registered in independent metadata systems. The Czech Living Lab uses the Micka metadata system, which meets ISO 191XX standards regarding INSPIRE directives.

Communication between several independent tools is provided either directly (one to one communication) or through integration into a Uniform Resource Management (URM) portal solution, which is described below.

4. Technology Description

A system for the management of geospatial data MapMan has been created to cover requirements for the integration of data which is available through geospatial web services (WMS, WFS) and internal user's data stored in different data formats (databases, shp or dgn files). The data sources are used for the creation of new map compositions using web technology. These new map compositions can be published in different map visualization programmes or can be offered on the web as a new web map service. Some of the most important developments in information management facilities and publication systems are the utilization of a web environment and the follow-up publication of new web services.

Map Project Manager works together with UMN MapServer – to create an environment for building spatially-enabled Internet applications. The MapServer project is hosted by the TerraSIP project, a NASA sponsored project between the UMN and consortium of parties with land management interests. Map Project Manager uses the common function ability of MapServer and creates a user interface for the easier creation of multi-source maps.

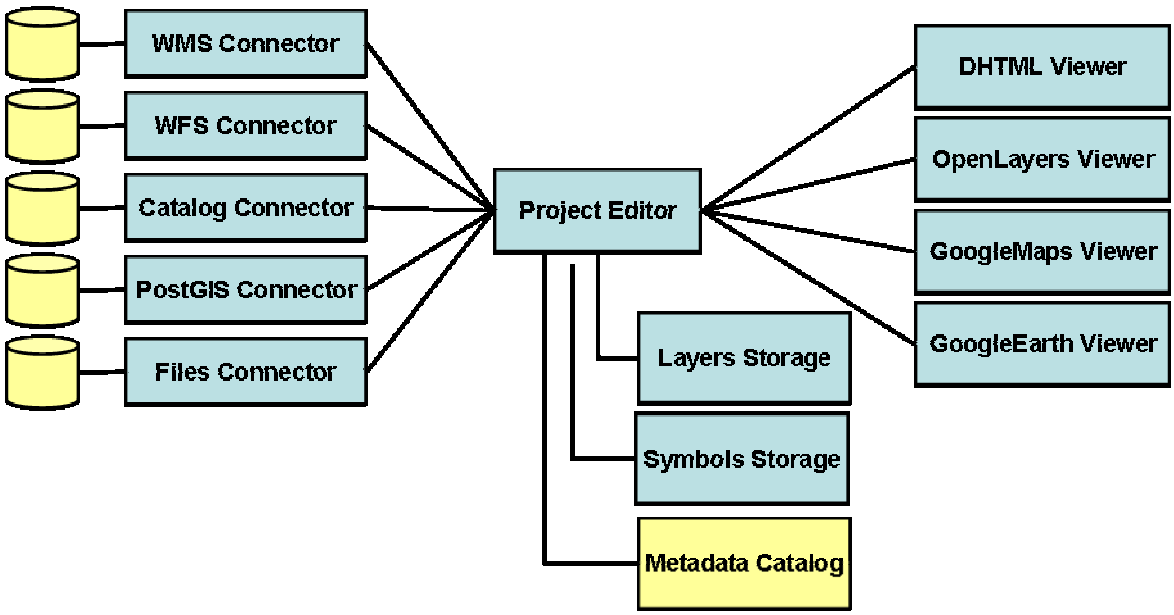

Figure 1: Map Project Manager Components

The core component of the spatial data management system is the Project Editor (Figure 1), which brings together connectors of data sources with the publishing functionality of the system and provides an interface for users. Project Editor is linked to Layers and Symbols Storage (where it is saved in the Layer and Symbol libraries) and also to the external Metadata Catalogue. Data sources can be connected in different ways depending on the type of available data. Internal data sources can be stored on databases or files. Database data is available through database connectors; currently a PostGIS database connector is implemented, but also other databases can be joined for relevant tasks. From data files, SHP files are supported.

Data files have to be stored in pre-defined server folders which are available for MapMan. External data (data stored on remote servers) can be connected through standard web services. (Web Map Services, Web Feature Services). Catalogue connector link metadata catalogues, enable data searching possibilities and make it available without the knowledge of fixed data source addresses. The final map composition is displayed using a map visualization client (e.g. DHTML client, GoogleMap, Google Earth or Open Layers). This new composition also contains metadata labels and can be published as a Web Map Service.

5. Developments and Results

5.1 Generating of Map Compositions

Map Project Manager is able to work with different coordination systems. If a User wants to create a new map composition, he first of all needs to define a coordination system and specify an area of interest. Next, the User must define the data sources available through Web Map Services (WMS), Web Features Services (WFS), Metadata Catalogue or data stored on an internal data server (Figure 2). The data would be in raster or vector form. (In vector the colour and symbol of objects can be altered). If the user does not know the addresses of an external data source he can use the search function of the metadata catalogue.

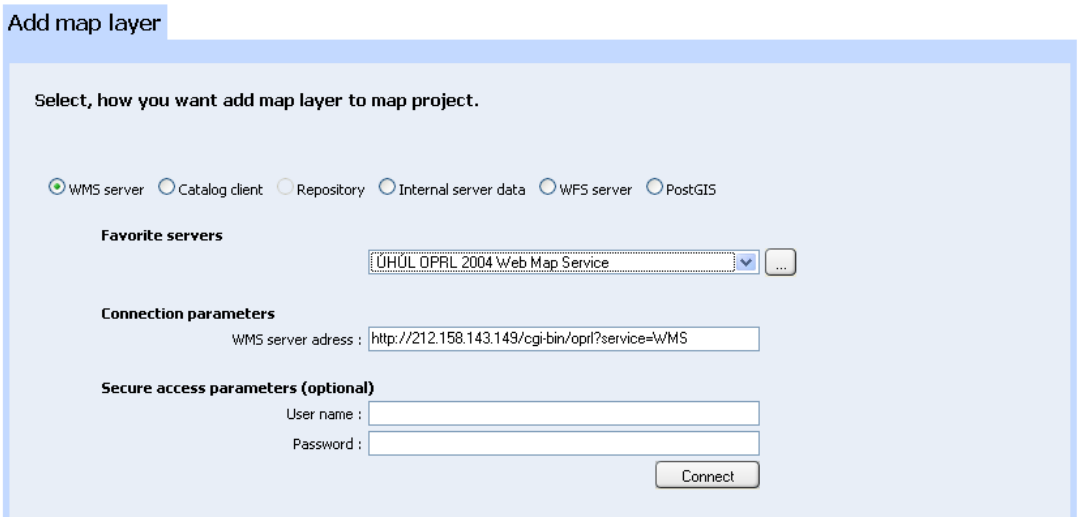

Figure 2: Data Sources for Map Project Manager

For the presentation of the final map composition, the MapMan can be closely linked to different map visualization clients - DHTML or Java clients, Google Maps, Google Earth and others (Figure 3). One of the main advantages of this system is the possibility to have actual up to the minute data. When the source data is updated on one or more data sources, all changes are directly shown in this new map composition.

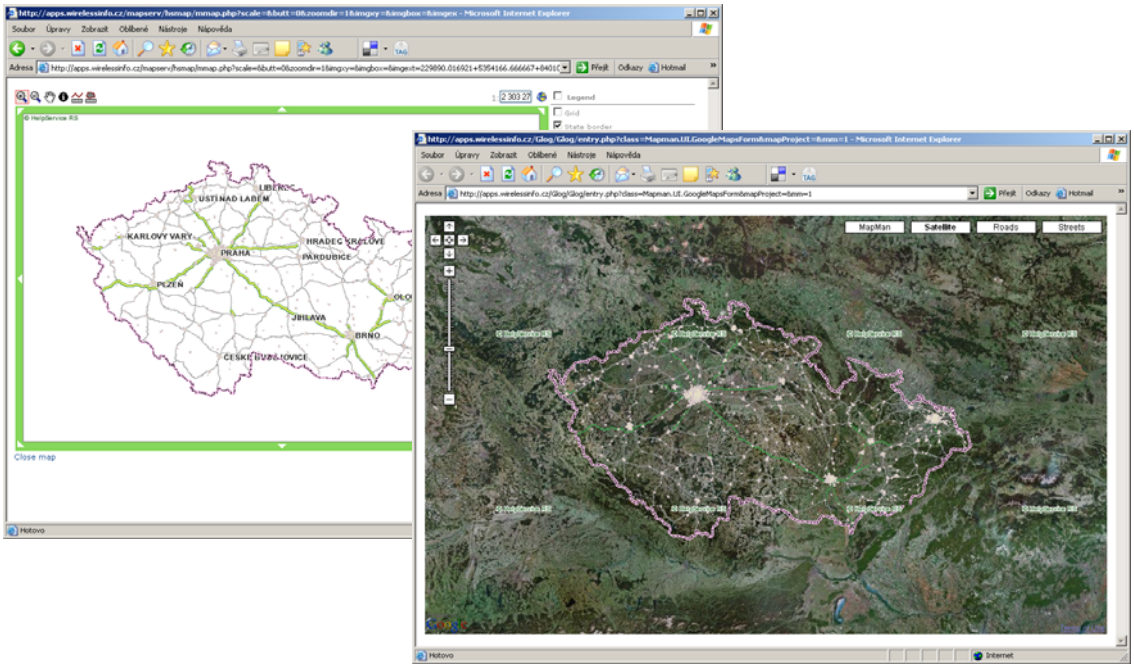

Figure 3: Map Visualisation Clients

As mentioned above, new map compositions can be published as a new web map service WMS. This functionality is really helpful for users who want to use this composition for background or referential data in their own applications. If one user creates new thematic compositions from different layers and publishes it as a new web service, other users do not need to look for several different data sets on the Internet or work together for each task. They are able to take this pre-prepared composition and use it in their own work.

5.2 Example of Composition

The idea and technological possibilities of Map Project Manager should be clearer in the following example (Figure 4):

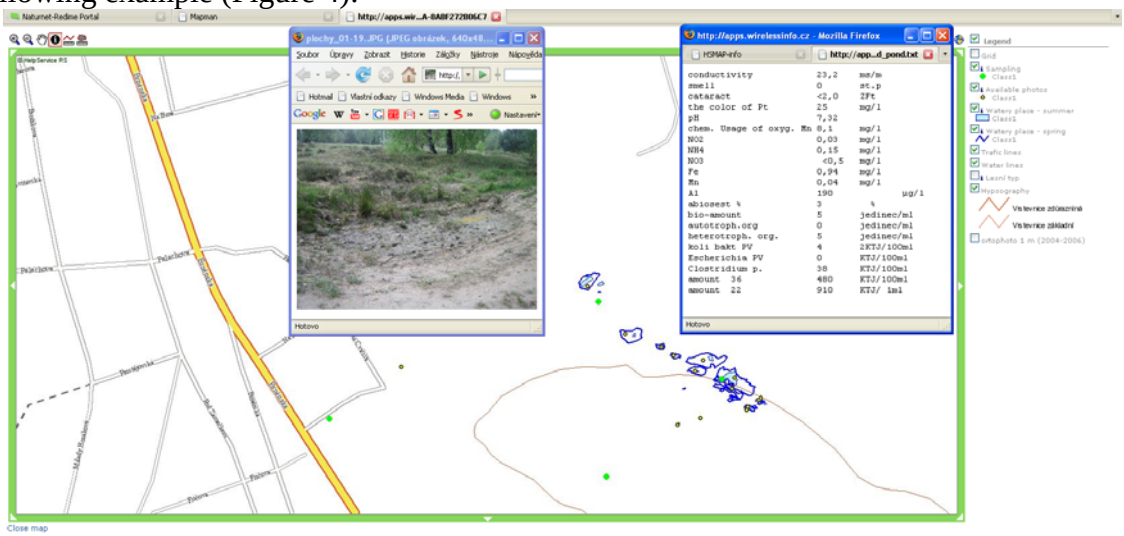

Figure 4: Example of a New Map Composition

This map project shows a small locality near the city of Hradec Kralove, where students from the Grammar school provided biotope research of protected plant and animal species. The map composition consists of data stored on different servers:

1. Public WMS layers (these reference layers come from different external servers that created a background for a new map composition). This kind of data cannot be up-dated by a common user.

- "Ortophoto" is stored on the Czech environmental agency's CENIA (not displayed in the figure)
- "Traffic lines" and "Water lines" are stored on the server of the HSRS company
- "Hypsography" layer is stored on the Forest Management Institute Vector data files
- "Watery place" layers show what the water level in lakes is during different seasons (spring, summer). The data files are stored on internal servers in a pre-defined directory. This kind of data can be up-dated by users who have the authorisation to edit the data on the internal MapMan server.

2. Vector data through WFS

- "Sampling" and "Available photo" layers are stored on the server of the Help forest company. These layers are available through Web Feature Service (WFS). These layers contents point to descriptions of samplings and descriptions of the locality with reference photos. The data can be edited remotely, e.g. from PDA – in this case, the map composition which has been created in MapMan still shows the current data.

5.3 Integration with Other Web Tools

Map Project Manager can be used as a single tool, but it is integrated into URM portal solutions in many cases. Uniform Resource Management (URM) provides a simply understood, well designed and user-friendly framework within which communities can easily share information and knowledge. In order to effectively share information and knowledge, there has to be a standardized system, which will enable a uniform description of information.

The basic components, of URM can be divided into the followings areas:

- Metadata scheme, which defines a universal structure, which can be used for the giving of information
- Thesaurus - represents a database or list of semantically orthogonal topical search keys.
- Geospatial thesaurus – The Geospatial thesaurus supported search tools for geospatial objects (for example gazetteers, GeoParcers, Geocoders)
- Catalogue service - defines common interfaces to discover, browse, and query metadata about data, services, and other potential resources.

URM is generally presented in web portal form, which contains the main search functions mentioned above and several supporting tools available for registered users. These tools support direct publishing of information through a URM portal.

5.4 Examples of Other Tools Integrated into URM Portals

Metadata extractor

Metadata extractor is a tool that gives access, editing and publishing possibilities to metadata directly from different files through URM portals (documents, presentation, etc.) Users can also extract and edit metadata directly from existing URL addresses and store metadata on URM portals. Information a is available through direct URL addresses.

Moodle

A course management system (CMS). Moodle is an Open Source software package which helps educators to create effective online learning courses and websites. The software is used all over the world by universities, schools, companies and independent teachers.

Video lecture
The objective of video lecture modules is to support on-line lectures given by tutors using video streaming. The technology was developed by a Naturnet-Redime project using VLC library and currently is published under Open Source license. It supports on-line training.

6. Business Benefits

Common problems of spatial data infrastructure have come to light also during the technology development. The following were found to be important problems that need to be solved during preparation of new map composition:

- Identification of the geo-spatial data available through web services
- Lack of data available through web services (only WMS available, not WFS or WCS)
- Lack of datasets description
- Problems with data in different projections
- Non-performance of standards for geo-spatial web service
- Problems with object customizing (colour, symbol)
- Lack of harmonisation between datasets at different geographical scales
- Duplication of datasets from different sources

Most of the problems mentioned above could be solved by uncompromising application of uniform standards and principles – in the case of geo-spatial data for example INSPIRE directive.

7. Conclusions

Source exploitation through web services will become more important in the future. The possibility of utilizing existing web services to help establish new web services, represents a chance for meaningful and efficient data source usage.

Map Project Manager is a web tool for the management of geo-spatial data where data can be stored on different external or internal servers in different data formats. Data from external servers is made available through standard web services WMS, WFS and can be easily found thanks to a connected catalogue system. New map compositions created in Map Project Manager can be displayed using several map visualization clients (Open Layers, GoogleMap, DHTML) using standard internet Browsers or can be offered to other users as a new web map service WMS.

The collaboration functionality between these geo-spatial web tools is provided by a special web portal system, which is called Uniform Resource Management (URM). URM enables open searching facilities for information, a uniform description of information and the integration of various web tools into one system

The developed technologies have been tested on simple use-cases which demonstrated the possibility of the creation of new services for the end-user – in this case, the creation of new map compositions compiled from external and internal data and their publication through web service. Also communication with some other web collaborative tools (metadata and catalogue system, Moodle, Videolecture) and their integration into web portal solution have been successful. Future development and potential market implementation is planned after detail tests from users and the processing of their comments regarding technological functionality and user-friendly interface. These activities are currently being carried out in the framework of current projects Collaboration@Rural and also EarthLookCZ - one of pilot projects developed in the Czech Republic in the ERA-STAR regions framework focused on verification of spatial data infrastructure quality for GMES support in the Czech Republic.

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