Suitability of a Mapserver from a Cartographic Perspective

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Abstract

Until now the only possibility of accessing cartographic applications via the Internet was to develop and program individual applications. Recently, most of the producers of commercial GIS-software have expanded their products with so-called "mapservers". These mapservers should not just easily permit access to geo-databases via the Internet but also allow the development of web mapping applications in a cartographically correct way.
The topics discussed in this paper are:
- *Basic functions of a mapserver*
- *Functions and characteristics of different types of mapservers*
- *The use of mapservers versus individual programming*
- *The advantage of accessing geo-databases via mapservers*

In the course of a co-operation project between the University of Vienna, Department of Geography and Regional Research and the Austrian Institute of East and Southeast European Studies, a prototype of a multinational Internet Atlas (AtOS) is being developed. Based on a preceding product analysis of various maps and atlases accessible on the Internet, the aim of this paper was to evaluate the use of mapservers from a cartographic perspective.

Introduction

In the last few years, the worldwide availability of digital cartographic products in the Internet has increased exponentially (Peterson 1997,1999). One of the first possibilities of offering interactive (statistical) maps in the WWW was the production of clickable maps. This technique, however, was mainly used at the beginning of the Internet mapping era and – like most of the new Internet technologies (e.g. Flash, SVG etc.) – was not really adjusted to the cartographic visualisation of maps (Richard 1999). A new tool by the name of "mapserver" is beginning to establish itself. In contrary to other technologies, mapservers support the production and distribution of maps on demand (Dickmann 2000). The advantage of this method is that web-maps are available for every Internet user immediately after they have been processed on the webserver. While it took weeks or even months to publish classical print media, only seconds lie between the production and the publication of a webmap today (Grebe et al. 2000).

In this paper the basic functions of a mapserver that is the visualisation of geodata and tools for navigation and query as well as the functions and characteristics of different types of mapservers will be explained. Furthermore, distinctions between hard- and software mapservers, economical factors as well as the differences of programming within a cartographic Internet application will be discussed. Finally some conclusions using mapservers that have been made during the development of the prototype Internet Atlas AtOS will be pointed out.

The basic functions of a mapserver

In its basic function a mapserver is an interface between a geodatabase on the side of the webserver and a WWW-browser on the side of the client. A mapserver offers basic spatial and thematic navigational functions with certain possibilities for query. The following three points represent the basic functions of a mapserver:

- **Visualisation of geodata:** A mapserver creates the desired map from geodata (available as vector or grid data) and converts them into an Internet usable format (e.g. GIF, JPEG, ...). In this process, no existing maps are used, but instead the webmaps are created automatically according to the thematic conditions and rules defined by cartographers. These dynamically created webmaps are then forwarded to the user's browser.
- **Navigation:** A mapserver offers certain functionalities that are necessary for navigation in a cartographic Internet application. These are tools for spatial navigation (e.g. zooming for changing the scale of a map section or panning for moving it) on the one hand and tools for thematic navigation (e.g. blending in or out of single map layers) on the other hand.
- **Query:** A mapserver also offers query functions, whereby the user is given access to further information such as to the geodata behind the maps.

The functions mentioned above represent the basic structure every mapserver usually includes. Producers of GIS software particularly offer mapservers with a broader spectrum of functions. These extended mapservers often provide the analysis functions of conventional desktop GIS applications (e.g. buffering, intersecting, calculating the shortest distance etc.). A comparison of the functions of different commercial mapservers can be found at
www.geoplace.com/gr/webmapping/

Functions and characteristics of different types of mapservers

The Internet user does not communicate with the mapserver directly, but indirectly through the webserver. The user sends a query to the webserver, which forwards it to the mapserver. The mapserver then creates the "answer" – generally a map – and sends it back to the user through the webserver (see Fig. 1). It is the task of the webserver to ensure the correct transfer of information - HTML files, graphics, JavaScripts or similar results from programming languages - to the client's browser via the Internet. The mapserver, on the contrary, locally creates maps from geodata (e.g. ESRI shape files), from databases or grid images (e.g. TIFF). Webservers and mapservers can run on the same computer or be installed on different computers (Cammack, 1999).
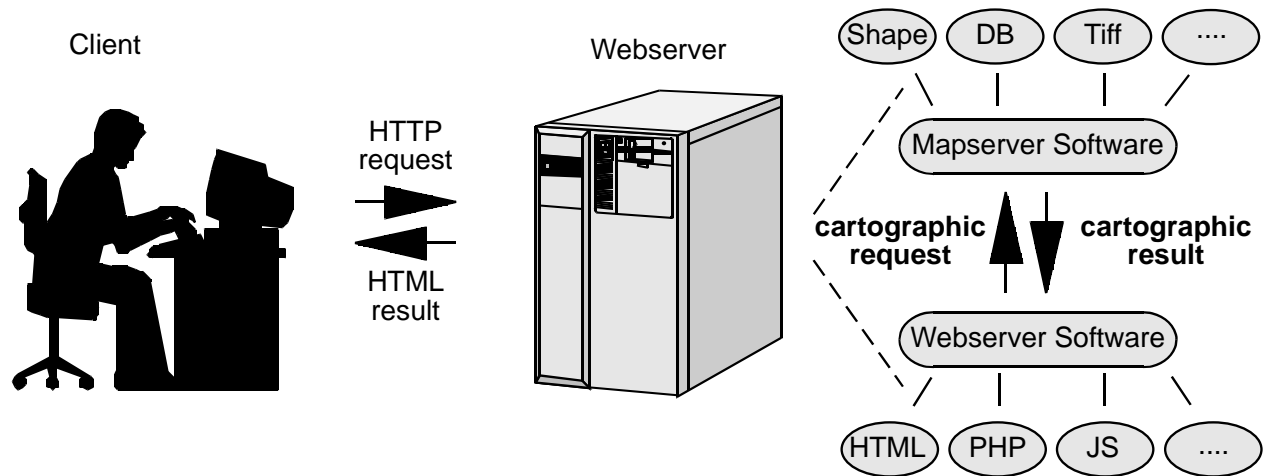

Figure1: Schematic model of a mapserver

The term "mapserver" is not defined clearly; it is used differently in different circumstances. First of all, the distinction between a mapserver as a computer, that is hardware, and a mapserver as a program, that is software, has to be made.

- **mapserver as hardware:** In systems with more than one unit. When a mapserver is running on a particular computer that has been configured for this purpose only and is independent of the webserver (Dickmann 1999, 2000).
- **mapserver as software:** In systems with only one unit. When webserver and mapserver are running on one and the same system, the software that is responsible for the creation of maps is called mapserver.

According to the functions provided, mapservers as software can be further distinguished in online-GIS and mapservers for pure visualisation:

- **online-GIS:** Mapservers that – in addition to the basic functions – have a GIS in background with all spatial functionalities offered via the Internet.
- **visualisation mapservers:** These are mapservers without GIS in the background; they consist of the basic functions only and thus are mainly responsible for the transformation and cartographic visualisation of geodata via the Internet.

Another possibility of distinction of software mapservers is by economic criteria:

- **commercial products:** Commercial mapservers are distributed by all GIS producers and often provide all functions of a GIS, which is why they usually are very expensive (Cecconi et al., 2000). Most products of this kind belong to the category of online-GIS.
- **free mapservers:** Free products often are available even with source code and can be obtained via the Internet. They are often the outcome of research projects and are then further developed as open source projects. Most of the free mapservers are visualisation mapservers.

Using a mapserver as opposed to doing one's own programming

The utilisation of a mapserver facilitates the publication of maps via the Internet significantly. If the full functionality of an online-GIS is not needed a free visualisation mapserver can be used. Most functions of a mapserver are predefined and do not have to be specially programmed. Other functions can be used for individual applications with little adaptation. Only special functions that do not belong to the basic functionality of a mapserver have to be programmed individually. For programming a mapserver the following cases can occur:

- **using existing functions:** Existing functions correspond to individual notions and thus can be maintained and used without changes, e.g. blending in or out of thematic layers.
- **adapting existing functions:** The source code of existing functions can be changed in a way that the functions correspond to individual ideas, e.g. the zoom factor is changed from magnification two times to magnification one-and-a-half times.
- **new development of functions:** If functions are needed that do not belong to the basic set of a mapserver and thus are not automatically provided by the mapserver, individual solutions have to be programmed. If working with an open source mapserver, the new functions should – according to the idea of open source programming – be offered to other users of the same open source application for free.

Connection of a geodatabase with a mapserver

The saying that maps can only be as good as the data behind them is not only valid for analogous maps, but equally for web cartography. An important additional factor that determines the latter is how and where data are stored. Thus not only correctness of the contents is of great importance in web cartography, but even more so the possibility of transparent, fast and flexible data storage. Transparency is indispensable to recognise structures and connections in the data. Quickness is essential because with every query to the mapserver, new maps have to be created from the data. Flexibility is necessary to be able to change the structure of the database without greater effort. In general, a geodatabase fulfils these criteria. From these databases a mapserver selects the data that are necessary for the creation of the desired map.

A GIS also partly consists of a database that has been extended with various geographic analysis functions. In an online-GIS the user can access these functions via the Internet. When a visualisation mapserver is used and analysis functions are needed additionally, they have to be programmed individually. To be able to do a query about which points lie within a polygon (point in polygon query), the geometry of the surrounding polygon can be stored in the database. Thus this typical GIS query can be provided with a simple SQL-statement.

The following diagram (figure 2) shows how the problem mentioned above has been solved in the AtOS project. The table "Staaten" was connected to most of the other tables with the key field "StaatenNR". In that way it is possible to make the query about the position of the element with every table linked through "StaatenNR". Through the additional storage of the field "StaatenNR" in other tables (which is superfluous in an online-GIS), a visualisation mapserver can reach the functionality of ordinary GIS-applications.
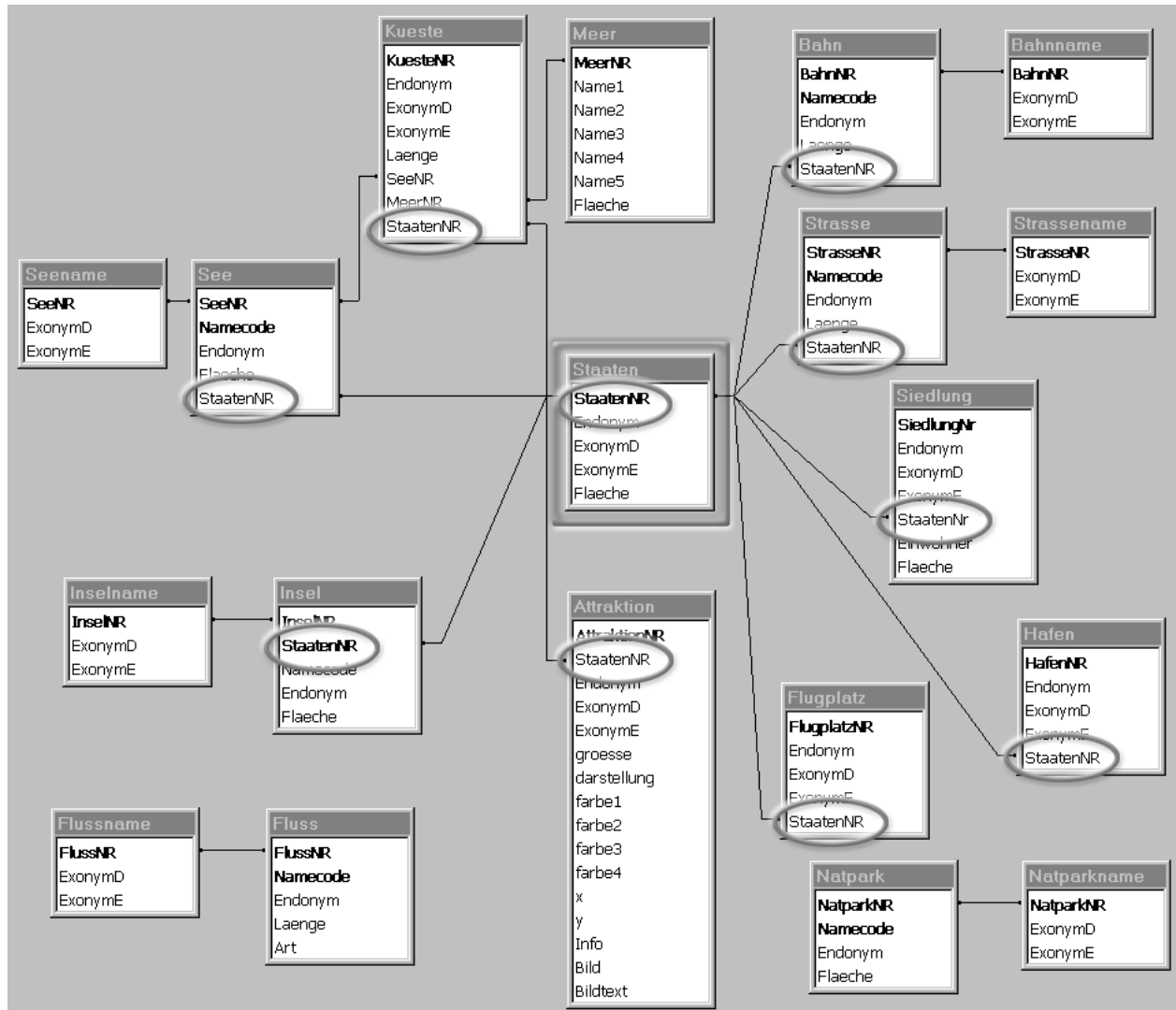

Figure 2: Diagram of the AtOS database

AtOS – Prototype of a modern Internet atlas

In this chapter the prototype of a modern Internet atlas of East- and Southeast Europe (project title: AtOS), developed in a project of the University of Vienna (Department of Geography and Regional Research) in co-operation with the Austrian Institute of East- and Southeast European Studies, is described. The contents of the maps "International tourist attractions in Central and Southern Europe" and "Ecological problems in Central and Southern Europe around 1995" from the print atlas of East- and Southeast Europe functioned as basis for the prototype Internet atlas. The final product of AtOS is designed to allow using the whole contents of the print atlas of East and Southeast Europe on the Internet.

In the following the components of AtOS are presented; special emphasis is put on the programming language PHP. Subsequently, two important functions of the prototype are explained in an exemplary way, namely the multilingual characteristic of the application and the presentation of dynamically created circular charts.

Components of AtOS

The development of the Internet version of the atlas of East and Southeast Europe was restricted to certain general conditions. The hardware existing in the Department of Geography had to be used. The geodata existed in geometric-topological form at the Institute of East- and Southeastern Studies and did not have to be refined further for use in the mapserver. As for the software, it was not obvious from the start of the project which solution was to be followed. When it became clear that the costs for software were restricted and that a flexible modular interchangeable system was desired, open source products were taken into consideration. The following components were finally used for the prototype AtOS:

- **Hardware:** As for the computer on which the application should run an Intel Pentium 3 with 700 MHz processor and 500 MB RAM was available. The webserver and the mapserver as well as the database are running on this computer.
- **given supply of geodata:**
    - The vector data (attractions, borders, states, etc.) of the print product were available as ESRI shape files and needed no more preparation for use in the Internet prototype.
    - Grid images (hill scaling, height levels) were computed from the USGS GTOP30 Model and are now available as georeferenced TIFF images.
- **Software:**
    - As operating system for the server Linux (www.linux.org) was chosen in combination with an Apache webserver (www.apache.org).
    - For the production of dynamically created HTML sites, the webserver had to be extended with the programming language PHP (www.php.net).
    - The open source mapserver of the University of Minnesota (mapsever.gis.umn.edu) is being used as a visualisation mapserver, because it fulfils all required criteria for the prototype.
    - For the database MySQL (www.mysql.com) was chosen, which provides all advantages of a relational database, manages queries from more than one user at the same time and is fast, stable and simple in use. It works together with the webserver and the mapserver without problems and – as open source solution – is available without further costs or license fees.

- Free open web tools provided by the Canadian company DM solutions (www.dmsolutions.ca), e.g. the "PHP MapScript Module", the "ROSA Applet" and the "OWTChart Engine" were used to extend the technical and the visualisation functions of the mapserver.

The whole system thus consists of several free open source software modules that can be exchanged individually without having to change the overall concept of the prototype. This configuration is very economical on the one hand and easily allows the further extension of the project on the other hand.

Details about the script language PHP

PHP is a script language that is embedded in HTML and interpreted by the server; its syntax is similar to C, Java and Perl. Special features such as commands for the integration of databases extend PHP. When PHP is used, an interpreter on the webserver translates the PHP commands - that are inserted into the HTML code - before the HTML file is transferred to the client's browser. On the side of the server, the document to be sent is partly recreated every time it is accessed, while the client only receives pure HTML code. In that way, greater variability on the side of the server can be obtained with one single file, while the client does not even notice this. The PHP MapScript Module by DM Solutions provides all functions of the mapserver in the script language PHP. In this way the functionality of the mapserver can be navigated by PHP commands that are embedded in HTML code. The following figure shows a simplified example of how PHP works (figure 3).
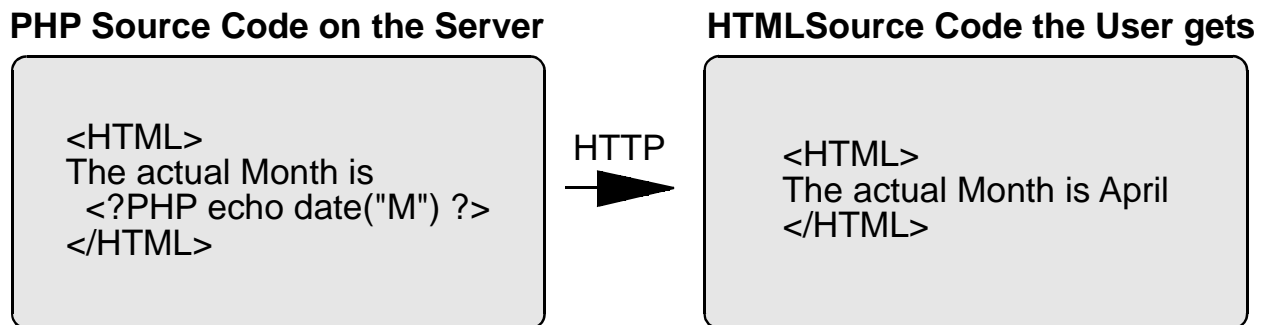
PHP Source Code on the Server　　　　**HTMLSource Code the User gets**

```
<HTML>
The actual Month is
  <?PHP echo date("M") ?>
</HTML>
```
HTTP →
```
<HTML>
The actual Month is April
</HTML>
```

Figure3: How PHP works

By means of the script language PHP it is possible to create the essential parts of the Internet application dynamically and as a result offer existing functionalities to the user.

Modular extension of the multilingual quality

The prototype is available in an English and a German version. The basis of the multilingual quality of the prototype is a special "language file" that can be accessed via PHP. In this file all phrases that occur in the application are stored in all languages. By calling a PHP function, the right language is inserted into the HTML code. If there is a need to extend the application with one or more new languages, only few modifications are necessary. On the one hand all new phrases have to be added to the "language file", and on the other hand the function responsible for the change of language has to be modified in the HTML files. In this way the HTML code is

delivered to every user in the desired language without the necessity to create and store the HTML pages in multiple versions.

Dynamically created circular charts

In the print version of the atlas tourist attractions are presented by circular signs in different colours; their size signalising the rank of the attraction. In AtOS all these attributes are stored in the database. By means of the programme OWTChart by DM Solutions dynamic circular charts are created from these attributes. These diagrams are not stored on the server, but are produced on demand – OWTChart can create dynamic circular, bar or line charts via the CGI interface. The advantage of producing the circular charts dynamically is that it is not necessary to reproduce all diagrams when the tourist attractions change or new ones arise. Furthermore, the creation of the circular charts takes only very little time. What takes up most of the time in a query about tourist attractions is the transfer of the raster images to the user's browser.

Figure4: A selection of the more than 2200 different circular charts

Conclusion

By using a mapserver as a tool for the visualisation of spatial information in the Internet, cartographers have received a powerful tool for the worldwide distribution of their maps. In commercial as well as in non-commercial fields, the significance of mapservers is constantly increasing. "The advantages of mapservers lie in the graphical processing and presentation of spatial data, which allow a fast and visually attractive transfer of information in the Internet." (Dickmann 1999).

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Free Mapserver of the University of Minnesota: http://mapserver.gis.umn.edu/
Geoplace Geographic Information Systems: http://www.geoplace.com/gr/webmapping
Linux: http://www.linux.org
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The Apache Software Foundation: http://www.apache.org
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