

Network computers at the Dutch Cadastre

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ABSTRACT

Computer networks are crucial for providing access to cadastral information. This paper focuses on two projects which concretize the possible role of internet technology for searching, delivery and visualization of products of the Dutch Cadastre in the future. The first project is the development of a National Clearinghouse Geo-information (NCGI), in which the Cadastre participates. It aims to provide a national entrance to geographically referenced datasets by means of their metadata. The user searches through the internet by specifying text-based or in a map the criteria of the needed geo-dataset. These criteria are matched with the descriptions of geo-datasets in a central metadatabase. Internet GIS-functionality is developed for manipulation and analysis of selected datasets, possibly from decentral servers of various data suppliers. Conditions are a secure communication, support of both raster and vector data and realization of a real open solution.

1. INTRODUCTION

One of the challenges of the Cadastre is to provide customers fast with the reliable and up-to-date information they need. Information technology and in particular computer networks play a crucial role in this. Because of the potential of internet as distribution channel and as a gateway to GIS in the future, the Cadastre wants to gain experience with the delivery of data over internet. At this moment there are two projects with the aim to find out how internet can contribute to the service of the Cadastre: the National Clearinghouse Geo-information (NCGI) and Geoshop.

The NCGI is a national metadata service for geographic information on internet in which the Cadastre participates. The NCGI aims to provide an entrance in a national and international context where professional and non-professional users can find geographically related datasets. This clearinghouse can offer direct links to geo-shops owned by all sorts of organizations, among which the Cadastre. In the project "Geoshop" an internet service to visualize the real data is developed. Geoshop offers the users GIS-functionality to manipulate and analyze the selected datasets, possibly provided by different data suppliers.

This paper emphasizes on the NCGI and on Geoshop. In section 3 the functionality of NCGI is described in relation to other European clearinghouses. After a short overview of the current commercial internet GIS developments, section 4 describes how the Geoshop of the Cadastre might be organized. First, in section 2 the development of current computer networks at the Cadastre is outlined briefly.

2. CURRENT COMPUTER NETWORKS AT THE CADASTRE

The Dutch Cadastre and Public Registers Agency is supplier of both administrative and geographic data. The administrative data from the cadastral registration provides information about real estate like ownership, sizes of parcels, land-use and purchase prices. Geographic data from the cadastral map supplies boundaries of parcels and buildings.

The Cadastre started to automate the cadastral registration in the early eighties. Since 1990 this administrative information of the whole country is stored in the Automated Cadastral Registration (AKR). It is updated daily and can be accessed via a data communication network. This network has about 2500 subscribers with on-line and real-time access via networked terminals at our customers' offices (Molen, 1996). With this network it is possible to get information about mortgages and order plots of the digital cadastral map containing a certain parcel. At the moment we are investing in a client-server architecture to make it easier to connect the customers' networks to our databases.

Large scale topographic maps and cadastral maps in the Netherlands are stored and maintained in one integrated system (LKI). The cadastral map will be completely digital by the end of 1997. By means of advanced indexes for geographic databases (Oosterom & Vijlbrief, 1996) a quick response to inquiries is guaranteed. Now all administrative and most of the geographic data is digitally available, query facilities and data supply to our customers can only be improved by a redesign of our information system. For this reason the IT2000 program is started which includes an integration of both administrative and geographic data. Related is the development of a geographic query tool (Oosterom & Maessen, 1997) which can visualize the result of queries in both cartographic and administrative format. An internet version of this tool is used in the Geoshop project.

3. NCGI: NATIONAL CLEARINGHOUSE GEO-INFORMATION

A geo-clearinghouse uses communication networks, e.g. the internet to link computer nodes which contain geographically referenced data in order to enhance the accessibility, communication and use of geo-data. Although many technical problems still have to be solved, internet seems promising as a distribution channel which can improve the existing service to customers and can also open the way to new customers. A clearinghouse allows data providers such as the Cadastre to make known which geo-datasets exist. On the other hand it assists users to find out what geo-datasets are available, find the data they need, evaluate the usefulness of the data for their application and obtain or order it as economically as possible (Radwan et al., 1997). Besides of the benefits of a clearinghouse as an order and distribution channel, an improved accessibility by means of a clearinghouse makes integration and combination of datasets of different users possible yielding new value-added products.

Not only the Netherlands, but many countries have initiated projects to develop a national geographic information structure including clearinghouses. European examples include the Portuguese National System of Geographic Information (SNIG), the Danish infodatabase on geodata (Jacobi & Lind, 1997), the Spatial Information Enquiry Service "SINES" of Ordnance Survey in Great Britain, the French CNIG, the Swedish Geographic Information Retrieval "GIR" and the European Geographical Data Description Directory "GDDD" of MEGRIN. Most of the projects are still at the pilot project stage and involve only a limited number of organizations and data sets.

3.1 Aim of the NCGI

The aim of the NCGI is to make digital geo-datasets in the Netherlands available on internet. There is a large quantity of geographic information present in the Netherlands, including cadastral information. For this reason the Dutch Cadastre and Land Registry Agency is one of the participants of the National Clearinghouse Geo-information (NCGI), which is initiated by the Netherlands Council for Geo-information (RAVI).

A bottom-up strategy was chosen to realize a national clearinghouse in order to get an optimal involvement of the various participants of the geo-sector (Kieft & Kok, 1997). In the first stage pilot projects were initiated resulting in the realization of a prototype for a clearinghouse, named Idefix. Experiences with this prototype lead to ideas about further improvements of the NCGI. Now we are in the second stage of the project. The aim of this stage is to establish before December 1997 a national (meta) data service providing to professional and non-professional users information free of charge through the internet. On the long term the goal is to realize a national infrastructure which provides digital geo-data, if necessary at cost, to various user groups.

3.2 Concepts of the NCGI

The basic assumption of the NCGI is that the user does not know in advance which dataset he needs. Especially in a national and in the future in an European or even world-wide context this becomes more and more a valid assumption, since the number of datasets grows. For this reason a concept is chosen in which the user specifies the criteria which the dataset he needs should fulfill. In NCGI the datasets are searched which match with these specified criteria. A list with titles and summarized information of these datasets is shown. The user can select one of these datasets in order to get more detailed information or, more likely, he might want to search further. This will result in an iterative process of adjusting search criteria until the user has found a dataset useful for his application.

For searching and evaluation of datasets, the metadata of these datasets needs to be utilized. Metadata can be defined at its simplest as 'data about datasets' (CEN/TC 287, 1996). In order to exploit these datasets successfully in the clearinghouse, every organization needs to describe its datasets in a standard (formal) way. If the same properties of a dataset are described, these properties can be used for searching in the NCGI and will enable the user to compare different datasets. The European standard on metadata, CEN/TC 287 provides such a standardized description of datasets. For this reason the NCGI is based on this metadata standard.

The metadatabase, in which the descriptions of the data sets are collected, is the core of the NCGI and the entrance to the geo-data itself. Because of its importance for realizing the ordering and retrieving datasets by internet in the future, the NCGI starts with the supply of metadata only, free of charge, to (professional) users. In this way it is prevented that issues like billing, security and privacy become obstacles in the realization of the NCGI.

In the Idefix prototype a *central* concept of a clearinghouse is chosen. The metadata of the geo-datasets of all participants of the NCGI is collected in one central database. As a result the technical infrastructure is rather simple. However, many other problems occur:

- participants have to deliver their (changed) metadata in a pre-defined format;
- the task of the manager of the NCGI becomes very comprehensive e.g. regular updating of changed metadata, supervision of the quality of the metadata to ensure successful search;
- the involvement of the suppliers of the metadata decreases resulting in less up-to-date and low-quality metadata;
- the additional storage of all real geo-data together with the metadata in a central database is no realistic option for the future.

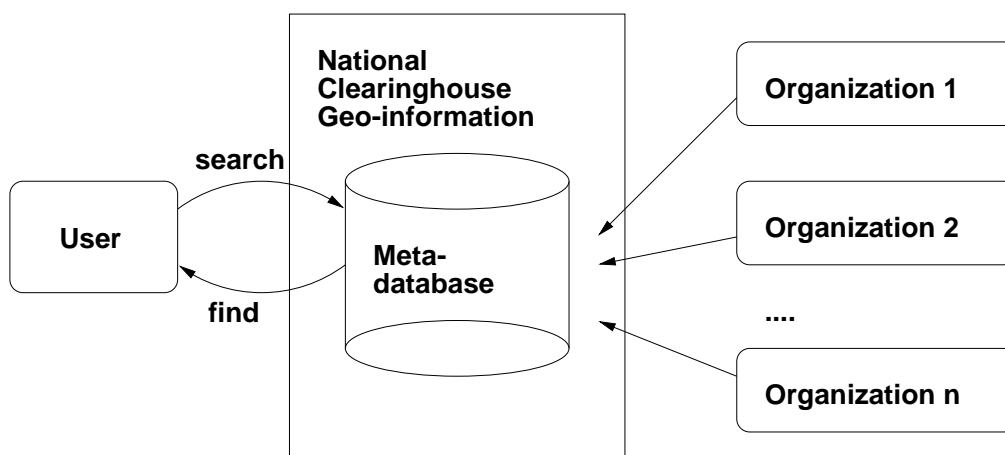


Figure 1: The NCGI concept.

A *decentral* concept with metadata located at the sites of different suppliers can solve these problems at the cost of a more complicated infrastructure. In the current further development of the prototype, the centralized concept is maintained, but the growth towards a decentral concepts will be prepared. Main issues in the technical infrastructure of the NCGI are the metadatabase, search and query facilities and the presentation of found datasets. In the next sections these issues will be described in more detail. Figure 1 shows how these issues relate to the NCGI concept.

3.3 Metadata

Several years of standardization on European level resulted in the draft of a standard for metadata (CEN/TC 287, 1996). Because this standard is new and there is not yet much experience with implementation of it, many questions and problems arose corresponding with problems addressed in (Jacobi & Lind, 1997):

7. Despite the accurate description of the metadata variables in the metadata standard, there is still a wide range of interpretations possible. Especially if metadata variables are used as a criterion for search in the metadatabase, the format and possible contents of the variable need to be well defined in order to make matching possible. The interpretation differences in what is called a dataset have much influence because the individual datasets are primary objects in the metadata standard and are discussed in section 3.3.1;
8. Some metadata variables are difficult to apply on the different types of datasets of the Cadastre. For example, doubt arises if the spatial sub-scheme type should be described for administrative cadastral data like a list with relationships between owners and identifications of cadastral parcels or lists with the average purchase prices of real estate in a region;
9. The large number of metadata variables in the standard are all included in the metadata model of Idefix, which enables metadata suppliers to give a very detailed description of their dataset, but also results in a complex data model. The implemented metadata model contains 36 tables. The standard discriminates mandatory and optional variables. However, it is allowed to describe a mandatory variable as "not applicable" or "not available". Because some of the metadata variables are used for searching or are very important for the user to evaluate if the dataset can be used for a certain application, the participants agreed that these variables will always be described meaningfully.

3.3.1 What is a dataset?

The large cadastral databases with both administrative and geographic data are used to generate subsets or combinations of data, which are delivered to our customers. We define the products delivered to the customer as datasets and not the main database in which the data is stored. Customers can order datasets for the geometric area and time period they need. As a consequence the extent, both geometric and temporal, of the delivered dataset is customized and cannot be described in the metadata. For this reason the geometric extent of these datasets is described as covering the Netherlands completely and have a temporal extent from the date the Cadastre was established in the 19th century until today. On the other hand other participating organizations describe large collections of data of which the geometric or temporal extent differs as separate datasets. As a consequence a general search over the Netherlands as a whole can yield one hit for the cadastral map, which is considered as one dataset and almost 200 hits for all the map sheets of the soil map. Because more uniformity is desired, further appointments need to be made about what is defined as a dataset.

For some delivered datasets the contents slightly differs per region because of agreements made with the customers. The user might be interested in detailed descriptions of regional datasets because these

differences are important for his application or he might need only a global impression of the dataset. We believe that hierarchical offer a solution to moel regional differences. The metadata standard includes subset and superset relationships. These could be used to connect general description to detailed descriptions for specific regions or time periods. The specific datasets can inherit common properties of the general dataset. A challenge will be to supply the user with the level of detail he needs.

3.4 Search and query facilities

An efficient search mechanism is an important critical success factor of a clearinghouse (Radwan et al., 1997). The more datasets are included in the clearinghouse, the more the scenario emerges in which the user lacks specific knowledge about the dataset he finds and the characteristics needed for the task. Searching will be an iterative process of adjusting criteria. This is called exploratory spatial access (Schenkelaars & Egenhofer, 1997).

One of the aims of this stage of the project is to improve the geographic search facility. All clearinghouses have more than one entrance for searching, but the criteria are combined differently. In the Danish infodatabase, the French CNIG, the Portuguese SNIG and MEGRIN's European GDDD only one entrance can be used at the same time. In the English SINES and Dutch Idefix search criteria are combined with a logical "and". In the Swedish GIR it is possible to choose whether the criterion are combined with a logical "or" or "and". In table 1 an overview is given of the entrances for searching in European clearinghouses. Possible entrances for search are:

- *by dataset*, which is one of the simplest entrances. The user can choose directly from a list with titles of a dataset. If one assumes that the user knows what type of dataset he is interested in and the number of datasets is small, this is a feasible option. Especially in a European context this is not a valid assumption;
- *by organization*, which is also a simple entrance. The user gets a list of the suppliers of the geo-datasets and if he chooses one, subsequently a list with datasets of the selected supplier is presente. This is only feasible if both the number of suppliers and datasets are small;
- *by theme*, which is good criterion if a user does not know which dataset he needs. The problem is to make a non-overlapping list with themes to which all datasets can be linked. From a designers point of view this list should not be too long;
- *by keyword*, which can be implemented as searching by choosing a keyword from a predefined list or by a free text string. The second is a very powerful mechanism, because in this way values of all metadata variables can be used as a criterion. Even better results could be obtained if a ranking is applied based on the weight of the metadata variable in which the text string is found;
- *by time period*, which is especially useful for thematic maps. As stated in section 3.3.1 datasets of which only the time periods vary should be considered as one dataset. In this case this entrance is only useful if the choice for a certain dataset is made;
- *by geographic location*, which is widely used in various implementations. The easiest option is to select a geographic region from a predefined list, which may have a hierarchy from the whole country to provinces and municipalities. Another option is to choose from a list with types of direct and indirect spatial reference systems. Geographic searching is possible by selecting predefined regions from a map.

Entrance	Great Britain SINES	France CNIG	Portugal SNIG	Denmark Infodatabase	Sweden GIR	Holland Idefix	Europe GDDD
organization (nr.)	Y(50)	Y(23)	Y	Y(47)	N	N(36)	Y(36)
dataset (nr.)	N	Y(71)	Y(39)	Y(123)	N	N(1552)	Y(12)
theme (nr.)	N	Y(19)	Y(67)	Y(13)	N	Y(14)	N
keyword	Y(900)	N	N	N	Y(free)	Y(free)	N
time period	N	N	N	N	Y	N	N
geographic location	Y(17 on list)	Y (14 ref. Systems)	Y(8 on list+map)	Y(43 ref. Systems+11 on map)	Y(map)	Y(list of map)	Y(22 on map)

Table 1: Types of entrances used in European clearinghouses (Y = yes, N = no).

Searching can be done administratively, i.e. text-based or geographically by means of a map. In the NCGI the functionality to zoom in on a region will be further improved and it will be possible to select a region by indicating a bounding box in the map. One of the problems that arises are the transformations that have to be done between different coordinate systems in the metadatabase in order to match the selected coordinates. Another problem is to decide which datasets will be returned as the datasets of a certain region. In other words: if a province is selected, are datasets of municipalities inside, datasets of the whole country or only datasets of the province itself returned? Some users might also be interested in datasets of municipalities, other in datasets of the whole country in case a province is selected. The last option will be desirable if datasets of multiple regions are considered as one dataset like our cadastral map. On the other hand there are also thematic maps of the whole country without enough detail for a certain province. The metadata standard does not provide variables which discriminate both types. Because it is not clear which option is preferable, GIR and Idefix both have the option to choose if the dataset covers at least part of the search area, matches exactly the search area or lies completely inside the search area.

3.5 Presentation of the found datasets

Three implementations for showing found datasets (Schenkelaars & Egenhofer, 1997) are:

1. (Prioritized) list of resulting databases together with key properties. By scrolling through this list, the user can examine the characteristics of the found datasets. In all reviewed European clearinghouses searching yields a list with titles of datasets and the option to see more details. Only in Idefix a short summary of each dataset is shown. A prioritized list would help the user to find a suitable dataset, especially because the number of found datasets can be very large.
2. Small representative subsets can give the user an idea of the contents of the dataset. Such subsets are part of the detailed information shown in Idefix. The aim is to increase the number of subsets in this stage of the NCGI.
3. Display the datasets outline over reference map gives a good idea about the location and extent of the dataset. This is only possible if the number of datasets is not too large. Therefore it is not feasible for the NCGI.

In general the presentation of the detailed information of a chosen dataset is very elaborated. In GIR the number of results per page and detail of the description (summary, standard, detailed) can be chosen.

4. GEOSHOP

After the customer has found, through the clearinghouse, the supplier(s) of geo-information, data transfer can take place; see subsection 4.1. Another scenario is viewing the geographic data over the internet, which needs GIS-functionality for selecting, presenting and analyzing the data. The solutions provided by the main GIS vendors are listed in the subsection 4.2. Possibly the user wants to combine geo-data from different suppliers, which is not feasible with the GIS vendor solutions. Therefore, this is an important goal of the Geoshop project; see subsection 4.3. Other goals are realization of a real open solution (not limited to a specific client platform), supporting both raster and vector data at the client side, and secure communication. Note that the Geoshop customer only needs an internet connection and a browser, and no additional GIS software.

4.1 Internet data transfer

For many years standards have been developed with respect to the data model, contents, and transfer; e.g. SDTS (Morrison, 1989), DIGEST (DGIWG. DIGEST, 1992), ISO SQL 3/MM (ISO/IEC JTC1/SC21/WG3, 1996) and OpenGIS (Buehler & McKee, 1996). At the national level in the Netherlands, the reference terrain model NEN3610 (NEN-3610, 1995) and the spatial data transfer standard NEN1878 (NEN-1878, 1993) are important. When a customer is satisfied with the spatial data, he can order the data with an option to have regular periodic updates (Lemmen & Oosterom, 1995). The data is usually transferred in the physical form of files on a tape, CD-ROM, or floppy disk. The general and world-wide acceptance of the internet as a part of the IT infra-structure enables new delivery methods. Files can now also be delivered using ftp (file transfer protocol) or email or http or EDI over the internet without physical transfer of a medium. This method is especially suitable for the relatively small update files compared to the full data sets. After receiving the data, the customer converts and loads the data into his database/GIS.

4.2 Available geo-data viewers for the internet

Instead of transferring the data, it is also possible that the user only views the remote geo-data using his web-browser. Several main-stream GIS vendors are now developing GIS solutions for the internet, usually in the form of plug-in's (for the Windows/Intel platform) or more general in the form of Java applets (Arnold & Gosling, 1996; Campione & Walrath, 1996; Hoff et al., 1996). Some examples hereof are:

- ESRI: MapObjects Internet Map Server
Active X control (OCX), works with shapefiles, coverages and SDE layers. (only raster GIF/JPG data in browser)
- ESRI: ArcView Internet Map Server
Java applets, works with shapefiles, coverages and SDE layers. (only raster GIF/JPG databrowser)
- Intergraph: GeoMedia Web Map
ActiveX (component called Active CGM plug-in), browsers on Win95, WNT. Data in MGE or FRAMME database format

- Autodesk: MapGuide
Plug-in required (Win3.11, Win95, WNT) vector data (format mlf=map layer files), distributed (multi-server), encrypted data transfer (secure)
- MapInfo: ProServer
Server only n WNT or Win95 (only raster GIF/JPG data in browser)
- Bentley: ModelServer Publisher
Based on Bentley design files (.dgn), which can be transferred to other formats by the server (JPG, SVF, CGM, VRML), which requires SVF or CGM plug-in (only in Netscape, and on Win3.11, Win95, WNT)
- Softsource: SVF (Simple Vector Format) plug-in
vector graphics, only Win95 and WNT¹. (same is true for other plug-ins, sometimes support for Win3.11, Mac)

4.3 Geoshop project overview

One of the main purposes of the Geoshop project is to demonstrate visual map integration over the internet. Therefore, several partners participate in this project and will deliver data: the municipality of Almere, a utility company in the same region (NUON), a cable TV company (Casema), and the Cadastre. The software is developed mainly by Professional GEO Systems (PGS). In principle, the partners have their own servers (connected to the internet) providing spatial data on request. However, two partners will initially not run their own server and their data will be provided by the PGS server. The geoshop software is quite similar to a geographic querytool, such as, GEO++ (Oosterom & Maessen, 1997; Vijlbrief & Oosterom, 1996) for data browsing, but now over the internet. The system is divided into two main parts:

- The Magma server: this is a server process, which handles the requests from outside (formulated as geo-extended SQL like requests encapsulated in the standard web cgi script invocation, transmitted through http-messages) and returns the result in a binary format.
- The Lava browser: this is a client tool to perform GIS-like operations running on top of a web-browser with a Java interpreter.

4.4 Magma server

The Magma server is written in C++ and currently runs on several hardware platforms; e.g. Sun Solaris (at the PGS and Casema site) or Digital Unix (at the Cadastre site). It supports selecting data from spatially enabled databases; e.g. Illustra/Informix at the PGS site and CA-OpenIngres with SOL (Spatial Object Library (CA-OpenIngres, 1995)) at the Cadastre site. It is also possible to select data from geographic files; e.g. Intergraph design files (.dgn) at the site of Casema. A Magma version serving flat files is available for the Windows/Intel platform. For the client server type and database type are completely invisible. Both raster data and vector data can be selected from the database and passed to the clients.

Of course, we do not want to make all data (and all databases) on the server available to the outside world. The Magma server can be configured by adding tables and entries to these tables in a specific database called magma. The table `magmadatabases` specifies which databases have spatial data available. Also the additional information, such as rane and projection is specified, and the maximum number of records transferred per query. Every database (e.g. `almere`) contains an additional table

¹ Note this solution is used in the NewMetropolis project.

`magmaLayers` which declares the tables with accessible information. A table in the database now corresponds to a map layer. Map layers can be grouped in maps by storing this into the `magmaMaps` relation in the general magma database. General magma server information is stored in the table `magmawelcome` in the general magma database. This information is needed by the Lava browser in order to inform the users about the data.

4.5 Lava browser

Lava is a geographic information browser and could be regarded as a simplified version of GEO++ with respect to the functional selecting and viewing possibilities. However, it is completely implemented in Java, which enables it to run in web-browsers over the internet (or intranet). After loading the required Java applets in the browser of the client, the Lava main window will appear and the user can start selections; see Figure 2. Many other Internet GIS solutions either use plug-ins, only for the Windows/Intel platform and are therefore not open/portable, or just use raster GIF/JPG images which are produced at the server. The raster approach does not allow efficient interaction in the browser; e.g. pick and highlight individual objects.

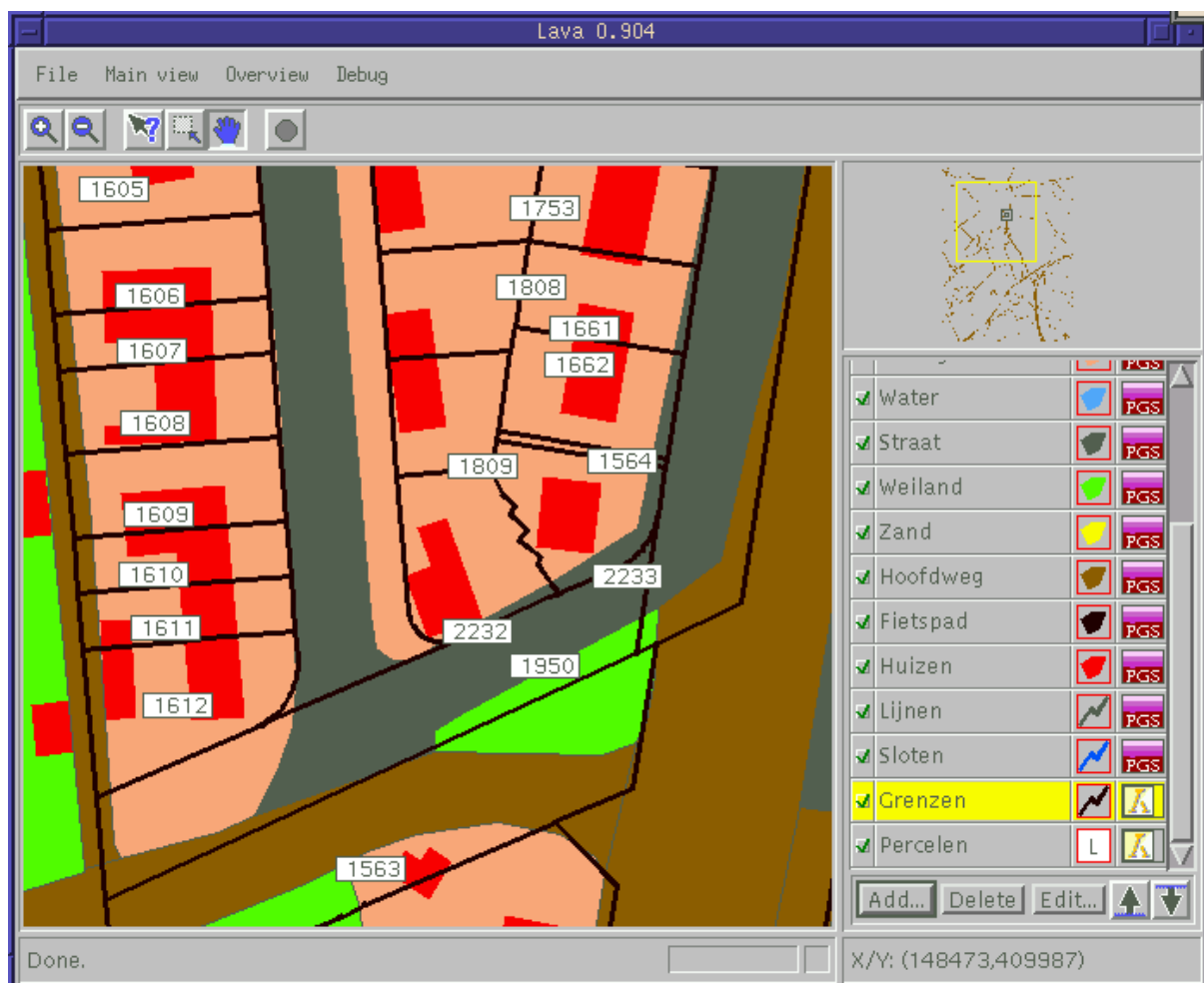


Figure 2: The Lava main window with layers from different servers.

Most functionality of the user interface can be seen in the main Lava window, see Figure 2, and is described below. The 'status/message' area at the bottom of the Lava window shows progress information and other messages. The X/Y indicator is located at the lower right of the Lava window.

It shows the coordinates currently pointed at with the mouse pointer. The OverView map is located at the upper right of the Lava window. This map is used mainly for orientation purpose, but can also be used for easy zooming and panning. The double rectangular box shows the location of the area shown in the main map. The menu bar and control buttons are located at the top of the Lava window. These allow, among others, zooming and panning of the map, jumping to a specified coordinate position, canceling selection/drawing tasks, and putting Lava in pointing mode. The latter option allows viewing the administrative information related to the picked geographic object; see Figure 3.

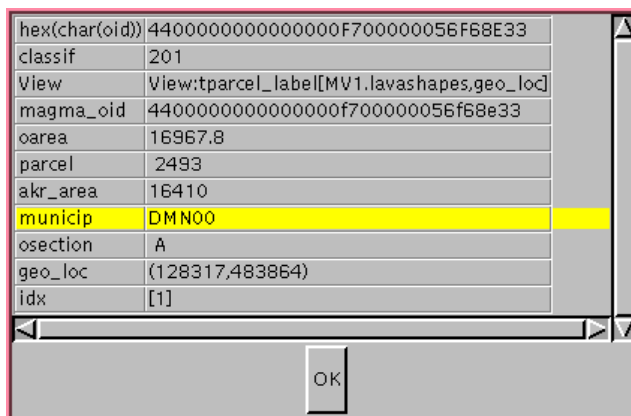


Figure 3: The Object information in Lava.

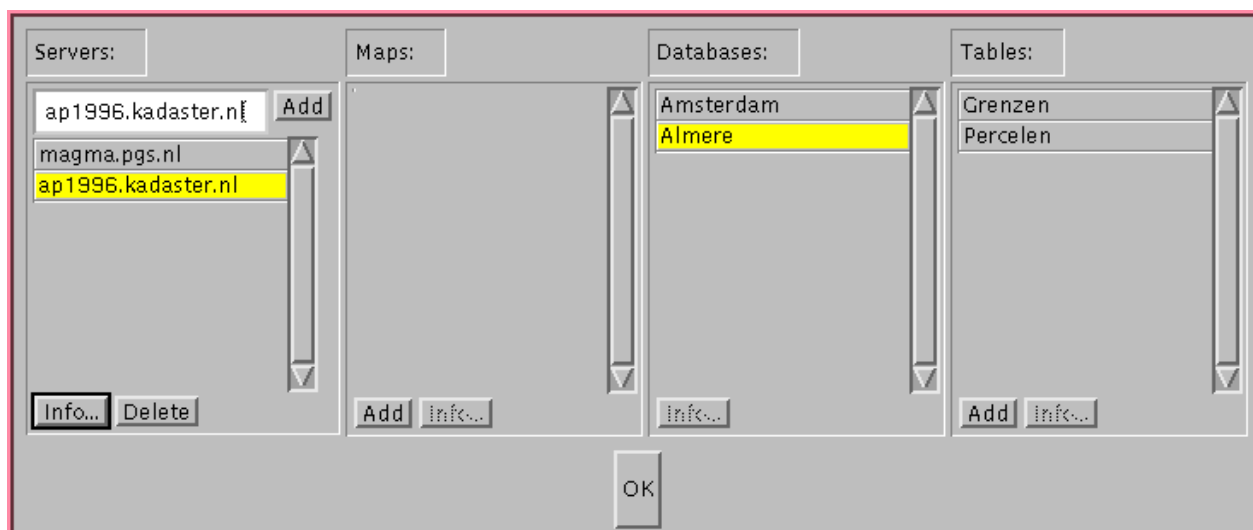


Figure 4: Selection of Map Layers from different servers.

The user can add map layers from different sites / servers with the interface form shown in Figure 4. On the left hand side of this form the available servers are displayed. When selecting one of the available servers, the user gets an overview of the maps and databases. When selecting a map or database, the associated tables (or map layers) are shown on the right hand side of the form. The user can add complete maps to his selection or individual map layers (tables). In the main Lava window (see Figure 2), the active layers are shown at the right side: this list shows per layer, the name, source (a small icon with a logo), type (point, line, area), and status (drawn or not drawn). The user can determine some basic visualization options; e.g. color, line style or symbol type, width, etc. There are two options to start Lava:

- From the server: in this case the Java applets (compiled Java code) are first transferred from the server to the client browser. In this manner the client can only select data from this server.
- From the local file system at the client side. This avoids sending the Java applets over the internet all the time².

4.6 Security

An important aspect in the Geoshop project and other commercial internet applications is security. This has several aspects, first of all the partners have to be sure of each others identity, which can be implemented through a certificate mechanism. Further, the communication has to be safe: others are not allowed to eavesdrop or to change the transferred information. Encryption is a good technique for this. Finally, when the client has received the product, the server wants to bill him. In summary, the following options are available:

- no security measurements: this is only acceptable in a prototype phase where already many other new technology aspects are tested, such as Java GIS browsers, and map integration from different servers.
- server authentication: for example used by the Wall Street Journal (<https://wsj.com/>)³. The browser verifies that this is indeed the server of the Wall Street Journal and that the communication is encrypted. Outsiders can not change the transmitted information and the client knows for sure he is communicating with the requested server.
- client authentication (digital signatures, trusted partners): there are a few organizations who will provide several levels of authentication (comparable to digital accountants); e.g. VeriSign, Inc. The clients receive a kind of 'digital signature' (certificate), which is usually valid for a limited time interval. The server can check this encrypted certificate and can then be sure of the real identity of the client⁴.
- payment by both known clients or unknown clients: the known clients can be billed in the normal way. Provided that the used services are somewhere registered and there is a contract for billing. For unknown clients some other method has to be created, based on new chip (credit) card technology or based on new software technology, comparable to the certificates (and which does not need additional hardware; e.g. DigiCash).

5. CONCLUSION

The GIS and internet development are all very fresh. These same is true for electronic commerce. By early-on participation in advanced projects, such as the Clearinghouse and the Geoshop, the Cadastre prepares itself for the future, when the mentioned technologies are matured. As indicated in this paper the potential effect can be enormous. Further integration of national clearinghouses to one European clearinghouse is, in principle, no technology problem due to the internet, but an organizational one (Wood & Cassettari, 1997). Geoshop is based on the Network Computer (NC) principle. The NC downloads (Java) software from a server on the net and then executes or interprets this. The NC will have an enormous impact on platform independent software development: it does not matter if the client platform is a NC, Unix, Mac, Windows 95, Windows NT, VMS, or another platform (as long as

² The latest version of web-browsers allow automatic installation of the LAVA software by means of CAB files (Microsoft Explorer) or JAR files (Netscape Communicator). These versions also allow access to various Magma servers.

³ https stands for secure http.

⁴ It is also possible that organizations create their own certificates and hands them out to their customers; e.g. for billing purposes. Instead of using the certificate server of another trusted organization.

there is a web-browser). Also the same techniques (applications) as used over the internet can also be used on the local net (internet), resulting in a uniform solution.

Acknowledgments

We would like to thank our partners in the Clearinghouse and Geoshop projects for cooperating in very stimulating way. The paper was reviewed in order to avoid gross errors by Ernst-Peter Oosterbroek and Ingeborg Absil-van de Kieft. Finally, Tom Vijlbrief read the Geoshop section and was very helpful in preparing the (first Lava) Geoshop figures.

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- France, CNIG: <http://www.cnig.fr>
- Great Britain, Ordnance Survey, SINES: <http://www.ordsvy.gov.uk/sines/index.html>
- MEGRIN, GDDD: <http://www.ign.fr/megrin/gddd/gddd.html>
- Portugal, SNIG: <http://snig.cnig.pt>
- Sweden, GIR: <http://www.ssc.se/gir>
- The Netherlands, Idefix: <http://idefix.geodan.nl>
- ESRI, MapObjects: <http://maps.esri.com/ESRI/esri.htm>
- Intergraph: GeoMedia: <http://www.intergraph.com/iss/geomedia/webmap>
- Autodesk: MapGuide: <http://www.mapguide.com/>
- MapInfo: ProServer: <http://www.mapinfo.com/>
- Bentley: ModelServer: <http://www.bentley.com/>
- Softsource: SVF plug-in: <http://www.softsource.com/>
- PGS, Geoshop/Lava: <http://www.pgs.nl/>