NATIONAL ATLAS METAPHOR IN THE ACCESS TO THE GDI

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ABSTRACT

A National Geospatial Data Infrastructures (NGDI) coordinates and facilitates sharing mechanism of geospatial information of the nation. The NGDI are often organized according thematic principles, based on the nature of participating organisations that make geospatial data are available. Clearinghouses do offer metadata descriptions of these data. Current interfaces to the NGDI allow searches with the use of locational, attribute, and temporal definitions in searching for a required data. Related to the usability issue, user-interface in the NGDI should provide an easy environment to support the user goal in finding, selecting, and making use of framework and thematic data. Presently, the search results often provide bunches of metadata descriptions that should be examined carefully by the user, while the users tend to have a quick and accurate solution for the submitted keyword. This research suggests using national atlas as the key metaphor to access the NGDI. People are used to pick up an atlas when it comes to find geographical information. The project intends to expand the current functionalities of national web atlases. The atlas will not only have its traditional capability to represent the country, but will also give an access to the data sets behind the map. The atlas maps are the key elements to locate a required geospatial data. Furthermore, as it was applied on the traditional atlases where data providers and experts from different backgrounds in a country are organised to produce a national atlas book, the atlas metaphor can be used as a spatial data organiser. It brings an automatic content updating to the users.

Keywords: metaphor, national atlas, NGDI, metadata aggregation.

1. INTRODUCTION

The awareness of geographic information sharing and the development of Internet technology have been supporting the implementation of the NGDI. The NGDI is containing networked spatial databases and its technologies of data sharing, access and data use across institutional barriers with their complexities through clearinghouse functions in national scope (Groot and McLaughlin, 2000). High-level objectives of this infrastructure are to promote economic development, better government and to foster sustainable environment (Nedovic-Budic et al., 2003). The GDI concept has been a solution proposed for the fast development of geospatial data needs (Groot and McLaughlin, 2000), (Nebert, 2001). The main benefit is the provision of the accessible geospatial data for the users applications. As a consequence, discovery or access function is a must for a GDI. Discovery service in the forms of digital library or clearinghouse (Tsou 2002), is considered as a fundamental component in a GDI environment together with: standards, metadata, framework data, and thematic data (Nebert and Lance, 2002), (Groot and McLaughlin, 2000).

Clearinghouses are the mechanisms used to locate geospatial data based on the provided metadata. A clearinghouse gateway can be seen as a registry service that provides a way to find spatial data on participated nodes that match to given parameters at one time (Nebert, 2001). A node in the GDI's clearinghouses is a server that employs discovery protocol Z39.50 and providing indexing services to the clearinghouse gateway. To locate data required, locational, subjects, and temporal definitions are commonly offered on the clearinghouse interfaces alongside with keyword-based search approach. Another approach is building systematic search interface (Talwar et al., 2003), "NSDI Search Wizard" (http://www.fgdc.gov/clearinghouse/).

The user-interface component (i.e. clearinghouse) is a crucial factor in attracting the users and offering a usable access interface to the framework and thematic data in the GDI. The work of Walsh K.A. et al. (2002) provides extensive results and their analyses regarding to the users perception in making use of the clearinghouses interfaces. This work is also looking for a usable interface for the NGDI. However, we are not working on improving the clearinghouses implementation. We will use the atlas concept as the access tool. Nevertheless, the concepts of clearinghouse and user interfaces materialization are essential in supporting this project. Table 1 and 2 show current review on the user-interface implementation of some clearinghouses.

Table 1. The mechanisms offered to locate data in some clearinghouses

COUNTRY	SEARCH DEFINITION													
	How to define area of interest								Attribute Definition			Temporal Definiton		Provider (Nodes) definition
	Locational Definiton				The Use of Maps		Map Tools							
	Maps	Lat-Long	Geo-coding	Admin. Boundary	Interactive	Multiple themes	Bounding Box	Pan & Zoom	Subjects	Format Definition	Keywords	Time stamps	Temporal Changes	
North-America														
Canada	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N
U.S. FGDC	Y	Y	Y	Y	Y	N	Y	Y	N	N	Y	Y	Y	Y
ESRI Geography Network	Y	N	Y	N	Y	N	Y	Y	Y	Y	Y	N	N	Y
Europe														
Netherlands	Y	N	Y	Y	Y	N	Y	Y	N	N	Y	N	N	Y
Germany	Y	N	N	Y	Y	N	Y	Y	Y	N	Y	Y	N	N
Asia Pasific														
Australia	Y	Y	N	N	N	N	N	N	N	N	Y	Y	N	Y
Japan	Y	Y	N	Y	Y	N	Y	Y	N	N	Y	Y	Y	Y
Malaysia	Y	Y	N	Y	Y	N	N	Y	Y	N	Y	Y	N	Y
Africa														
South-Africa	N	Y	N	N	N	N	N	N	N	N	Y	Y	Y	Y
Regional														
PCGIAP (APSDI)	N	Y	N	N	N	N	N	N	N	N	Y	Y	Y	Y

Y = Yes, N = Not Available.

As it was shown in the table 1, most of clearinghouses try to accommodate locational, attributes, and temporal definitions although some of them provide very basic and low-level location definition, e.g. requiring input of latitude and longitude coordinates value. Mostly, the use of maps in the search definition merely is to define area of interest without providing thematic layers on top of map. Interestingly, the temporal changes and even the events (time of occurrence) are not widely supported. Arguably, these definitions will be attractive for the users that require data for their analyses. Just as an example, in the NGDI, the need of spatial data to assess potential hazard on the specific region will be easily found by indicating the past hazardous events.

Table 2. The metadata presentation

COUNTRY	SEARCH RESULTS			
	Metadata Presentation			
	Ranking	Abstract	Link to Subjects	Link to Map
North-America				
Canada	Y	Y	N	data coverage on map only
U.S. FGDC	N	Y	N	data coverage on map only
ESRI Geography Network	N	Y	N	Y
Europe				
Netherlands	Y	N	N	N
Germany	N	Y	N	N
Asia Pasific				
Australia	N	N	N	N
Japan	N	N	N	N
Malaysia	N	N	N	Y
Africa				
South-Africa	N	N	N	N
Regional				
PCGIAP (APSDI)	N	N	N	N

Y = Yes, N = Not Available.

As shown in the table 2, most of metadata presentations suggest the users to browse the metadata thoroughly. That is time consuming yet difficult to derive the information presented. That is a logical consequence in the interface environment where the user is learning while browsing and need a conceptual framework to guide the selection process (Talwar et al., 2003). In the field of metadata presentation, currently research is ongoing that should assist the user with the visualization of metadata (Ahonen-Raino and Kraak, 2004). The recent architecture connects provider nodes directly to the gateway without any metadata classifications (Tsou, 2002). When participation is getting higher, the search results might provide a lot of metadata links that should be examined one by one. In such setting, the contents and relevance of data itself are difficult to be gained. In addition, generally the clearinghouse implementations do not provide essential tools for exploring their contents with the use of maps (Kraak, 2000). The retrieval systems for spatial data and information will not be effective if they do not support user's interaction through user-perceived spatial and related thematic subjects (Cay G., 2002).

This paper suggests using national atlas metaphor to locate, choose, and make use of geospatial data. First it will provide underlying principles of the atlas metaphor; subsequently design guidelines and implementation of the atlas metaphor as a web application will be presented.

2. THE PRINCIPLES OF ATLAS METAPHOR

The previous section describes the rise of the GDI concept and the need for a usable map-based interface to access. Those findings motivate this work towards the development of the solution using a traditional concept, i.e. national atlas. The on-going project is aiming at developing a national atlas, accessible through the web that can be used to provide a mechanism in managing the process of locating geospatial data within the GDI context for the users. The two following sections present the atlas metaphor definition and its abstract functionalities.

2.1. Atlas Metaphor

User interfaces can be built as a collection of metaphorical references to learn and use the content presented (Marcus, 1988). In metaphor there are always mismatch between predicates in the source and the target domain (Hamilton, 2000). In the human-computer interfaces, to build a metaphor the predicate (attribute) mismatch is significant to provide insights of the metaphor purpose based on the users knowledge (Hamilton, 2000). The object being described is called target, and the concept used to provide insights about the target is called source. In this context, the maps and national atlas are the source while the GDI is the target.

By definition, user interface metaphors can be classified based on their levels, i.e. systemic metaphors and individual metaphors (Marcus, 1998). In many GIS application, icons of "zoom" and "pan" are example of individual metaphor, while a GIS as a set of user-interfaces linked with related manipulation and processing tools is an example of systemic metaphor (Gould and McGranaghan, 1990).

Maps for a certain subject in a national atlas are used to represent the overview phenomena of that topic geographically to the reader. Further Ormeling (1997) defines that the representation of specific areas or themes in an atlas is based on specific objective or narrative together with tools for navigation, information retrieval, presentation, and analysis. In this way national atlas can be considered as a systemic metaphor. Among various methods for searching spatial information, the metaphor in the form of maps have benefits in providing possibilities to explore, navigate and offering an ease of understanding (Aufare and Trepied, 2001). Metaphor for exploring and navigating geospatial data with maps query can be found at work of Aufare and Trepied, 2001; Fabrikant, 2000; Janee and Frew, 2002.

The idea of atlas has been familiar for the GDI users; at least they learned it from elementary and secondary school. Atlas provides capability to organise a wide-range yet big files of geographic related data in a unified framework of map presentations. It can be used to compare between one map to another beneath the same subject or one map to another with different subjects (Freitag 1997). It constructs the mental map for the reader, describing the geographic related matters in the region through the use of maps.

2.1. Atlas Functionalities

Atlas in general can be characterized by its structure in representing several themes (subjects) on a specific region; two special aspects of the structure are the maps arrangement based on area and scale emphasis and the thematic sequence (Ormeling, 1997). In that arrangement, atlas offer analysis and interpretation by comparing composed maps (Freitag, 1997). In addition to its capability as a spatial comparison machine, atlas can be delivered as spatial data organizer, visualization device, exploration device (Ormeling, 1997), (Frappier and Williams, 1999).

Some countries have published the online version of their national atlases. Examples are: Sweden, Swiss, United States of America, and Canada. Web national atlases can be characterized by its performance in presenting geographic phenomena. The intention of publication, data structure used and interactivity offered are few of the important parameters in the web national atlases (Neumann and Richard, 1999), (Carriere and Klein, 2001), (Schnabel, 2002). Apart from their common goal to disseminate their national atlases through the Internet, some are positioning them as the nodes of clearinghouse, e.g.: U.S. National Atlas and Canada Atlas. Thus, their map services are accessible by the GDI users who make use of the clearinghouses (GeoConnections, 2001). On the contrary, this work casts the atlas in the role of the access gateway to the geospatial data. In so doing, the atlas metaphor should be comparable to the common clearinghouse gateway interfaces. This requires the ability in providing a medium knowledge generation towards the access to the NGDI. The knowledge generation here refers to the functions of cartographic medium to help in understanding the setting, to support the abstraction, to provide decision support function (Dransch, 1999). These requirements are implemented in the atlas metaphor using the atlas characteristics: organiser, visualiser, explorer, and analyser. The descriptions are given as follows.

Organiser

The atlas as a visual metaphor can be seen as a potential metaphor to organize an entire line of map products in a way that makes clear to the user their relationships to another (Cates, 2002). It should facilitate provider's participation with the use of map indexing and metadata management.

Visualiser

The atlas metaphor should present thematic mapping to geographically synthesize the national concerns. It should provide high-level description of related metadata distribution. This includes the capability to allow comparison, classification of the metadata (Kraak, 2000), (Ahonen-Raino & Kraak, 2004).

Explorer

This metaphor should offer a tool to understanding geospatial phenomena and the NGDI setting based on the user's knowledge. The important is that it must provide a suitable navigation system for searching and locating the required framework and thematic data through the atlas mechanism. At the advanced stage, the concept of atlas gazetteer and thesauri tool should also be used for supporting spatial data discovery with the use of ontology and the support of interactive mapping.

Analyser

This metaphor should be capable to characterize necessary GIS processing components in a certain subject that are available in the NGDI. Although this is not the focus, the available GIS processing can be chained on top of the atlas towards providing a specific solution at the national scope. (e.g.: visual interface chaining through the atlas that combines buffering and classification functions to mitigate potential flooding area).

3. THE ATLAS METAPHOR DEVELOPMENT

In order to materialize the presented functionalities in the previous section, the metaphor should fit into the GDI setting. Considering the different levels of the providers' willingness in the GDI participation, the wide scopes of the field expertises; this requires simple mechanism that put minimum task for the providers to publish and update the metadata. Simultaneously the interface should be easy to be used for the users. For those reasons, a solid structure of the atlas metaphor as an extension of the traditional atlas structure is required. The following section firstly will describe the atlas use in the GDI setting; afterwards the proposed structure is presented.

3.1. Atlas Metaphor for the NGDI

Area and scale emphasis can show the atlas reader the significance of the region being presented among the other regional units (Ormeling, 1997), (Talwar et al. 2003). Additionally, the advance interactivity techniques on the web mapping support the atlas functionalities (Hurni et al., 1999). Those characters will be used to expose the atlas coverage (depicting region, thematic mapping and temporal changes) for a certain subject. This is to assemble the users mental map towards an interface to ease of locating, selecting, and accessing the required geospatial data (Figure 1).

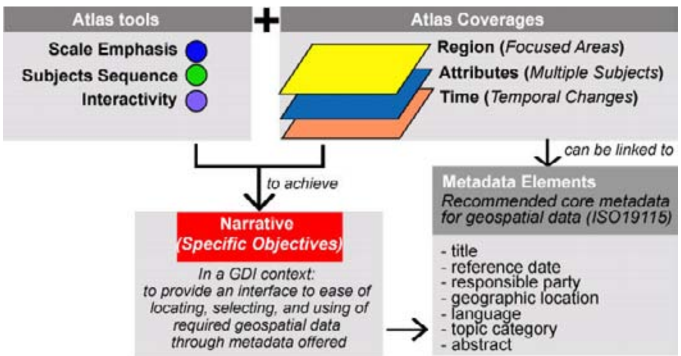

Figure 1. The offered atlas tools: scale emphasis, subjects' sequence, and interactivity and the atlas coverage on region, attribute, and time linked to metadata, are utilized to provide usable interface to access the geospatial data.

The precondition of data sharing and their access in the GDI is the availability of the data. These framework and thematic data are accompanied with information about the data itself to support the need of locating suitable geospatial data for the user's applications, known as metadata. Metadata is the key in data discovery since they provide characteristics of data that make possible for the users to differentiate a specific data from the others (Christian, 2001). Those characteristics will give insight for the users regarding to the suitability of the data, e.g. the fitness use, pricing and the means of accessing data. In general seven information categories that characterize a geospatial data are: identification, data quality, data organization, spatial reference, entity and attributes, distribution, and reference (FGDC, 1998).

Maps and graphics are at the front-end of the interface as the high-level representation of GDI resources. The use of graphics and maps is suitable approach to improve usability of spatial library searches (Gobel and Jasnosch, 2001), (Zhou, Yates, and Chen, 2001), (Janee and Frew, 2002). In this context, maps can be used to convey the spatial relatedness of concepts (Talwar et al. 2003), (Spence, 2000), (Kraak, 2000).

The national atlas as an interface to access geospatial data has benefits because of its capabilities to provide a comprehensive geographical and topical (subjects) overview of the country, to be deployed as a spatial search engine (Kraak, 2000). More essential is, an atlas organizes spatial information and make spatial information are comparable (Ormeling, 1997). These definitions suggest atlas as a visualization device can be expanded as an exploration tool to locate the data required regarding to the geographic coverage, subject, and time definition of the users. It can also be deployed as a GIS analyst interface by making use of available data & processing components in the GDI.

Freitag (1997) emphasize that another essential element of national atlases is that they were made and being made to serve the intended function of those national atlases. As shown in figure 1 the intended function is to provide a usable interface for locating, selecting, accessing the geospatial data in the GDI context.

3.2. Atlas Structure

The first foundation to be built is the atlas structure. It is developed as a unified multiple subjects' representations of the region (i.e. country). Each subject employs one or many maps to give an intended storyline for the users. A presented map utilizes a dataset with their metadata. Next to the atlas structure, the key notion proposed here is the linkage between a metadata and the related maps. Metadata is registered as the map resource. Here is also possible to register a metadata to more than one map, as long as it is applicable to fit into the storyline designed (figure 2).

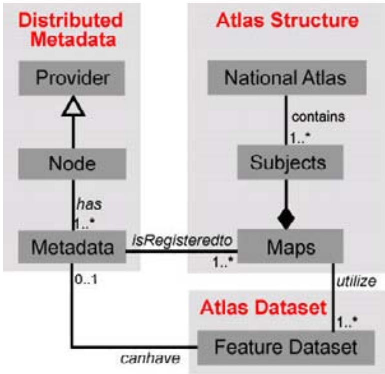

Figure 2. The traditional atlas structure is extended to offer linkage to the distributed metadata.

The atlas is aimed to cover all possible metadata offered. To allow this, subjects and maps in the atlas are oriented to serve the intended function, presented in the previous sections. Traditionally subjects of the national atlas are used to show the distribution of geographic phenomena and their spatial relationships (Salichtchev 1972). In a more advanced, the subjects can be stirred to present major problems and planning in society (Bakker et al., 1987). These descriptions give guidelines for the atlas metaphor to provide subjects that is capable to cover national major concerns and to represent the most GIS data needed. At the same time this is to accommodate the NGDI participation either for the provider that intends to provide free or restricted access.

For enhancing the metadata organization and for its usages in the atlas environment, the maps linkage to the maps and subjects will be supported with the use of ontology. The range of the covered subjects and the semantic distance between the metadata and the related map(s) are the aspects that will be strengthened with the use of ontology (see Talwar et al. 2003 and Finkelstein et al., 2002). Ontology will be used to support a shared understanding of the geographical domains through the maps and subjects presented. The wide spectrum of the users of GIS contributes to the existence of different levels in understanding the geographical domains in the GDI environment (McKee, 2000), (Cantan et al. 2003). Subsequently this fact influences the users approach in searching for a required spatial data. Hence, the conceptualisation of geographical objects should be adjustable depending on the domain expertise and the users experiences.

The personalization concept meets the requirement of adjusting the user knowledge in the context of discovering the geospatial data. The level of detail to be displayed and the level of functions provided can be adjusted to the user needs. In this setting, atlas can be seen as a portal. The web portal is a familiar environment for the Internet users. Portals present a unified and personalized view of the resources and services to the member of the portal enterprise (DeSimone, 2002).

3.2. Usage Scenarios

There are two types of the users in this atlas: registered and unregistered users. First the case for unregistered users will be given. Afterwards, a short description for the registered users case is following.

Unregistered users

An unregistered user connects to the atlas metaphor URL via Internet browser. Application is initiated; the "introductory map" is displayed. As a default, the atlas is designed as a map visualiser. The screen appears as the map board, with the attribute (and statistic-if any-) legend lies on the left side of the map. The task bar on the top of the atlas contains tools for map-navigation (zoom-pan) and commands to define region, subjects, maps.

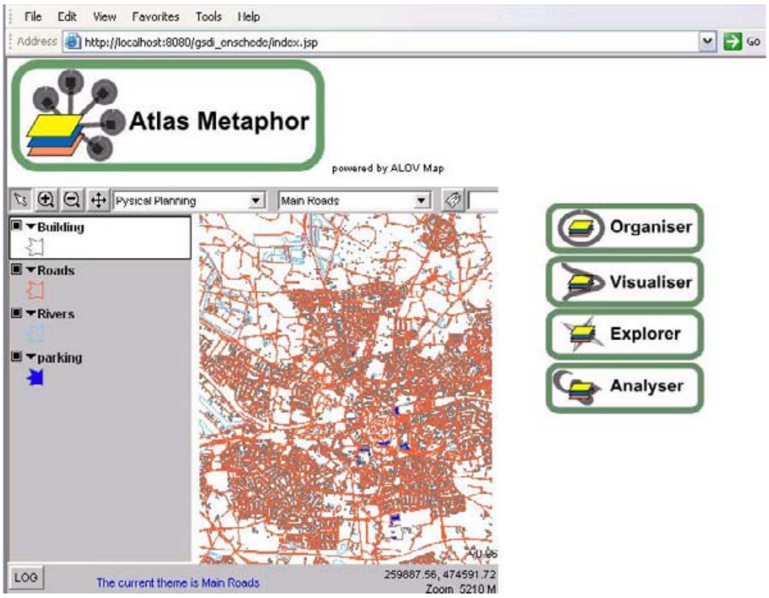

Figure 3. Storyboard of the atlas metaphor.

The introductory map represents the basic data of the country. The considered basic data here are generalised terrain, roads & railways, hydrographical features, landmarks, and cities. This unregistered user would like to examine all available traffic roads data set within the municipality of Enschede published during 1999 – 2002 for pollution research purpose.

The user uses the mouse in browsing the directory of subjects ("Planning" → "Transportation" → "Road Network"); subsequently map definition box is pointed to "recent roads intensity" (next to "roads development", "roads extension" maps). The result of this action is a complete main roads map for Enschede and surrounding on the screen. From its display, the user can differentiate the classes of roads by their colours and their thickness, further the data of roads behind the map can be browsed by clicking the roads line.

To see the available roads data beyond this visualization, the user has 2 options. The easiest way is that the user activates "show related metadata". This command can be found in the one of right-click's context-menu. Once the command is chosen, the coverage areas of registered metadata are shown on top of the map. The outlines colours of the coverage areas (boxes) represent the boundary jurisdiction interest of the metadata. The centroids of the boxes are represented by the symbol of the data type (point, line, area, or tabular data set). These centroids are clickable to provide further information about the metadata presented.

The other possibility for locating the data is activating explorer icon. This brings a new window that appears in the bottom of the map. The window contains 3 tabs of functions. The first tab gives possibilities for the user to define the dataset coverage (bounding box dragging on the screen and boundary definition). Next is to define related attribute required; the simplest form is the keyword definition. The last tab is to define the date of required data (by using time slider). The user then click search button. These definitions are aimed to provide specific searching interface for the users. Before do clicking the search button, the user can store the location, the attribute, and the temporal definition to be used later. To allow this, the user should be member of the portal. This means the user needs to login into the portal to have privileges to use space in the server to store the maps and user preferences and the discovery process definition.

The result of this search is a new map displayed depicting the metadata coverage with their legends with the old map still exists as the background. The result provides the similar setting to the result of activating "show related metadata" as described previously. In addition, a new window appears presenting the alternative solution of selecting metadata. When this window is activated, 2 tabs of metadata presentation will be offered. The first tab is presenting the metadata based on the relevance with the subjects, while the second tab is giving the results as based on metadata abstraction element. Both ways have "link to the map" option that will jump to the metadata mapping as previously illustrated when is clicked.

Registered User

Submitting password into the application is required for case of the registered user. Once login step was done, application is initiated and personal preferences are loaded. As an example the same user of the previous case is used here. In the previous session he already got the link to access the required road data, now he is resuming his work to locate available data of pollution. This time he needs to browse the subjects: "Environment" → "Pollution" → "Air Pollution"; map definition is set into: "air pollution by years", next to "air pollution 2002", "air pollution 1999", in this case.

The map of air pollution by years is shown in the screen. Statistic charts are added on the map now, explaining the air pollution by the years in numbers and diagrams. The user can browse the information and links of the feature selected (for example: related images and texts).

The user is clicking the explorer icon to locate the accessible data. Simply he loads the saved definitions made in the previous case. He would need to change the typed keywords if he requires it, otherwise just make use of the same locational, attribute, and temporal definitions as the previous case. The same type of the result presentations of the previous case can be gained.

Clearly from those usage scenarios presented, atlas setting and interactive techniques are utilized in directing the user to locate the wanted data. The design of this kind of the "knowledge generation" medium (Dransch, 1999) is given in the next section.

4. THE APPLICATION FRAMEWORK

This section will cover the materialization of the presented ideas. We are now working on developing the prototype of the atlas metaphor. As a portal, the prototype defines three major components to be in place. The design framework will be discussed first; subsequently the important parts in this prototype, i.e. metadata feeder and map descriptor are described in detail.

4.1. Design Framework

The design framework of the prototype provides guidelines to implement atlas functionalities. The use of maps and graphics are essential yet supporting the concept. To ease organisation of application resources (maps data sets, metadata, images, text) and to allow frequent changes without affecting the underlying data, the approach of separating content from presentation is used. This approach suggests breaking down the application into three major components of design framework (see figure 4).

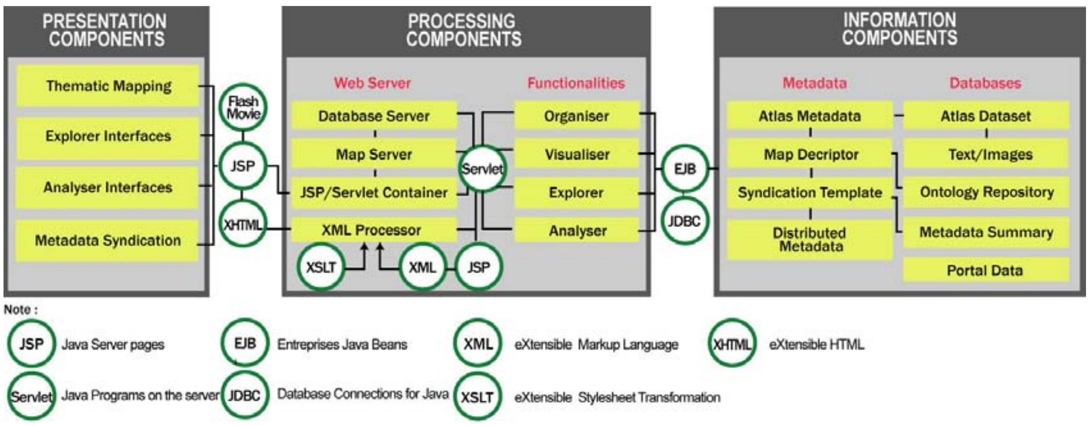

Figure 4. Three major components in the application. The presentation components are presented as web pages. Requests coming from specific interface first will be validated by a controller servlet then will be handled by the corresponding functionality.

Presentation components provide graphical user interfaces to allow the users exploiting the atlas metaphor. The interaction for activating functionalities and the responses can be seen through these components. Information components consist of all involved dataset both locally and distributed stored. Mainly this can be differentiated as the databases (spatial and non-spatial databases) and the metadata (atlas metadata and provider metadata). Processing components are the residing functionalities in the server to supply a necessary response for each request sent throughout the presentation components. The processing components job includes accessing the necessary information components. In the world of web application with HTTP, this kind of interaction is known as MVC (Model-View-Controller) framework (Burke, 2001). Several Java-based MVC projects, e.g. Jakarta Struts, Turbine, including their explanations are available on the literatures and the Internet (see apache.org), thus they will not be discussed extensively here. The MVC framework is suitable to be used for this prototype. This framework is also capable to incorporate the use of XML. XML (and

XSLT) offer solid mechanism in cleanly separating content from its presentation. As shown in Figure 4, JSP pages are used to manage the view (delivering the presentation components). Once the request is sent through the users browsers, the submitted values of variables are forwarded to servlet in the processing components. The servlet, as the controller, will validate the request and forward to the associated servlet to process it. If it requires to access specific data in information components, the EJB will retrieve them. In this way, the EJB can be seen as the model. Once the response is processed, the information to be sent back is changed as the XML data, which will be transformed as an HTML by XSLT.

The required interactivity will be enhanced with the use of client-side animations and interfaces. When interactions on the browser initiate a specific command, then this request will be passed to the related JSP page using POST method. For illustration, the search result of the usage scenarios in the previous section is recalled. Data coverage of the metadata on the map can be examined based on their jurisdiction level. By using slider to select one of options (either national, provincial, district or sub district coverage) the user has possibility to show the only concerning region level in which the metadata cover. The selection on the slider means submitting variables that need to be processed by the related JSP.

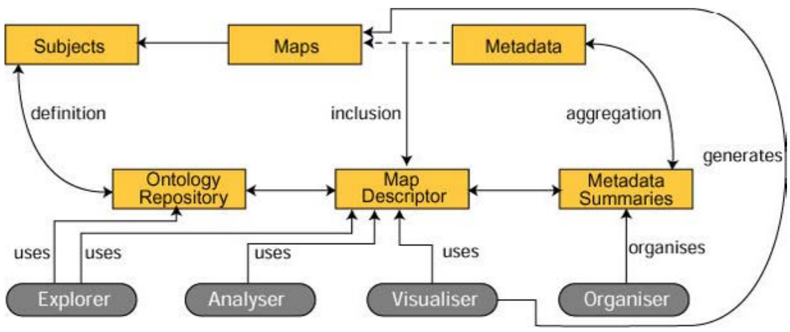

Figure 5. The essential interactions between information components and processing components.

Beyond maps and interfaces presented, dynamic interaction between processing and information components is taking place, shown in figure 5. In more detail, the visualiser function for example, needs to process related map descriptor for a specific map request. The map descriptor defines data set usage (geometry & properties), the map stylesheet, and the metadata inclusions for the map. These inclusions are used to represent the associated metadata to the map. The metadata inclusions are automatically populated after the providers register the metadata (will be described more detail in section 4.2. and 4.3.). Internally in the application the map descriptor is connected to the subjects and defined in the ontology repository, this is to support objective of the atlas metaphor to deliver search in the context and accommodate users knowledge (i.e. explorer functionality). A detail description for this part will not be presented here.

4.2. Metadata Feeder

To set up the participation, the provider needs to register metadata to let the users to locate the data. In this work area, several XML-based registry services have been proposed, including OGC registry services (OGC, 2002). Since the purpose of the interface here is not merely displaying registered metadata, yet making the metadata accessible through the maps in the atlas, hence it requires a suitable approach.

The application offers two ways to publish the data. The provider can choose the simplest way in which the metadata are registered one by one through the publication form. The provider needs to specify several required variables on the form. These variables will be used to create a new XML file for populating related map descriptor. Since the application is oriented to provide lightweight metadata information on top of the maps, hence the registration does not require advanced information of the metadata. However this registration requires specifying the physical URL of the metadata to be published.


```
<map_population_change>
  <item>
    <title>Population Distribution</title>
    <link>http://localhost:8080/demographie/pop_distrib.xml</link>
    <abstract>abstract the population distribution</abstract>
    <ref_date>2001-12-12</ref_date>
    <geographic_location>
      <left_corner_lat>106.75</left_corner_lat>
      <left_corener_long>6.75</left_corener_long>
      <right_corner_lat>108.75</right_corner_lat>
      <right_corner_lobg>7.30</right_corner_long>
    </geographic_location>
    <category>Statistic</category>
    <temporal_coverage>
      <time_stamp>2001-09-11</time_stamp>
    </temporal_coverage>
  </item>
</ map_population_change>
```


Figure 6. The required elements for a single registered metadata.

As shown in figure 6, geographic coverage is expressed by the values of latitude and longitude (in decimal) of the boundary corner. Element category offers possibility to the provider to define category from the provider's point of view. While the temporal coverage element can be expressed either as a time stamp (type: date), a temporal change (type: duration), or an event (type: string). Link element should specify the URL address of the spatial data at least its metadata.

The second method to publish the data is with the use of content syndication notion. Several standards are available for this, for example RSS (RDF Site Summary). The RSS is designed for sharing headline news and other web content. In this work, the elements are lengthened to some extent to suit into the need of aggregating metadata characteristics. This is profitable for visualization purpose in the atlas metaphor. The proposed format can be seen as the template, which is hosted on the provider's side. By utilising the template, the elements aggregation can be done remotely by the application. This way does not force the providers to register a collective metadata in isolation, as offered by the previous method. In the case that the providers need to add or delete metadata items, the providers only need to revise content of the template. The providers have enough control to decide which geospatial data should be published. Technically, this implies a simple responsibility for the providers to keep in touch with the NGDI environment.

As described earlier, for the metadata registration, the atlas metaphor requires simplicity. Only essential elements of the metadata are identified. All required elements in the template have to be filled in. The providers only need to populate the <item/> elements within the designated <map_xxx/> elements (Figure 7). The complete scenarios for making use of this method are described here. *Firstly*, the provider should download the syndication template (an XML file) from the atlas metaphor. *Secondly*, once the template is already gained, the responsible officer of this provider must populate the metadata information. This requires the provider to fill in syndication information. This process defines which map is appropriate to hold the metadata. As soon as the appropriate map for accommodating specific metadata has been chosen, the item element beneath the map channel is populated. Additionally, the syndication information should be filled in as well. The provider can use available map channels to cover all possible metadata that want to be shared. Unnecessary map channels can be erased, to speed up the XML process later on. *Lastly*, the provider must deal with the registration process. This is to specify the address where the template in the provider's side can be accessed by the application.

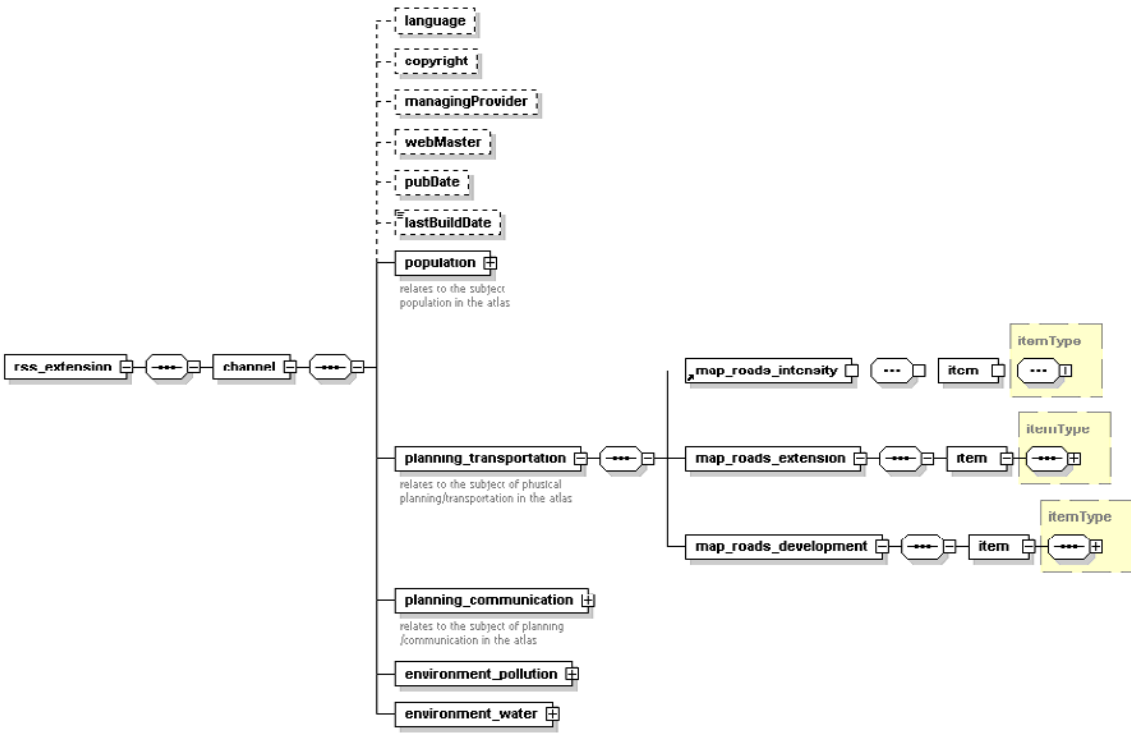

Figure 7. The schema structure of the proposed template for metadata aggregation in this application. The child elements beneath <item/> element are similar to the figure 6 (using *itemType*).

The task of the metadata feeder is shown in the Figure 8. The feeder does processing the submitted URL. One by one the providers are visited and elements are crawled. If the feeder finds some changes or additions, it is going to update the metadata summary databases. Subsequently the feeder must distribute the modified or added <item/> elements to the related map descriptor. This task can be scheduled to be daily-basis or even weekly-basis to avoid inefficiency work, depending on the GDI participation.

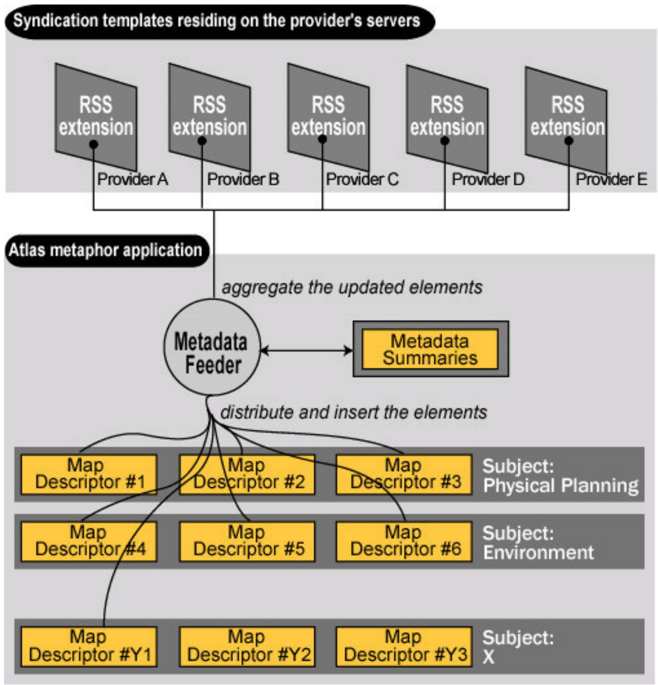

Figure 8. The metadata feeder usage

4.3. Map Descriptor

It has briefly described in the section 4.3. that map descriptor contains elements of metadata to be represented (metadata inclusion). These elements are essential in providing required variables to mapping the metadata on top of a specific map. In addition, when the user specifies the location, attributes, and temporal definitions with the explorer functionality, the map descriptors will be examined. If the given parameters match to the value of the map descriptor's elements, then the corresponding metadata symbols will be shown on top of the map.

The map descriptor described here is developed based on the characteristics of XML map service definition used in several map server products. The XML map service definition is used to encode dataset, map and database server functions. At this moment, we employ a free GIS server (under apache style licence), ALOV Map server. We extend the definition by adding one element, <GDI_metadata/>. The element is intended to hold the elements of related metadata to be represented. Hence the <item/> elements aggregated earlier are inserted into this element.

Another essential role of the map descriptor is to set the map configuration. This includes the definition of the data set usage, symbology, and the stylesheet. The elements of the map descriptor are shown in Figure 9. The map server produce map display on the browsers using these definitions. The discussion on the stylesheet and symbology definitions is out of topic here.

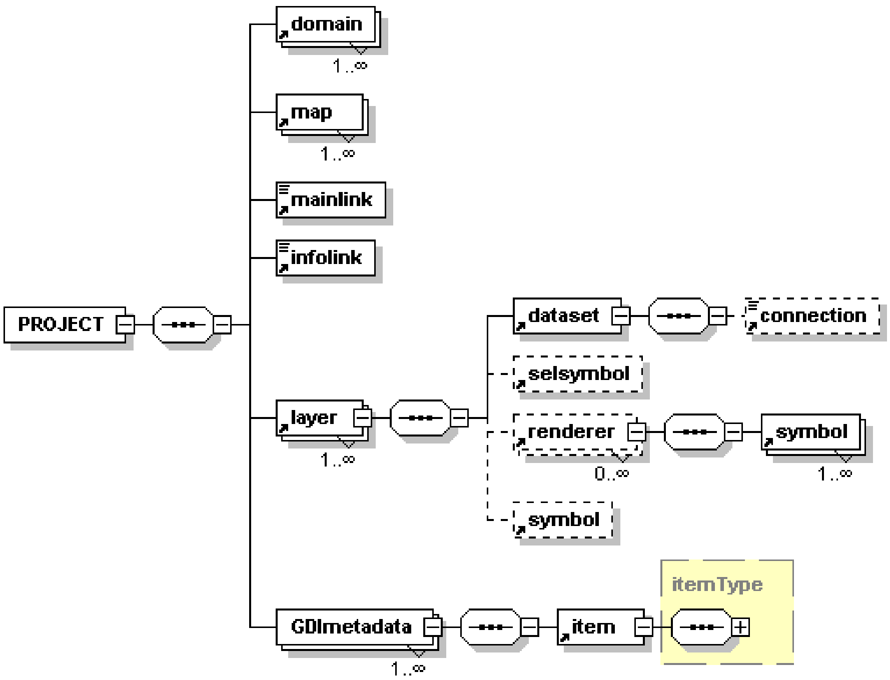

Figure 9. Dataset definition and the metadata inclusion in the map descriptor based on ALOV Map server (http://www.alov.org). The new element GDI metadata is used to hold relevant metadata elements coming from the providers.

5. CONCLUSIONS

This paper presents a new strategy to access the geospatial data in the GDI using the atlas concept. This is motivated by the need to supply the user a usable interface to locate the data and make comparison, selection from the search results. Such gateway interface with maps and subjects hints on the frontline is required. Atlas as a visualization medium can be adjusted to achieve this objective. The atlas tools and the atlas coverage can be linked to the distributed metadata. To permit this, it requires capability to organise metadata and represent them on top of the maps within the subjects. The developed prototype of atlas as a geospatial data organiser has been presented in this paper. It uses the content syndication notion. With this way, the providers have enough control to publish the data and simultaneously it requires straightforward task to maintain and to participate in the GDI. The mechanism, arguably, require simple effort to link the metadata to the map in the atlas. Next, automatic updating can be done remotely by the atlas metaphor.

Future work

This work is far from complete. Several research questions still need solutions. For example: how can synthesis maps be realized to bring the summary of spatial data, which in turn will ease the user's understanding of the context of framework and thematic data on the GDI? In addition, can the national atlas metaphor be built with the support of ontology to cover the problem domain concepts of the user when experimenting with the GDI clearinghouse? Towards the solution in developing the atlas metaphor, a full understanding of the GDI setting is required. Furthermore, the essential achievement to be made is providing the GDI resources container that is easy and maintainable to be implemented in the NGDI organisations. This container can be generated on the request to deliver different flavours of locating geospatial data based on the users domains and experiences.

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