A Web Service-Based and User Specific Portrayal for Geodata

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Abstract. The users of a geoportal come from various domains and have different tasks. For that reason the visualization of the geodata has to be customized to their individual needs. The paper focuses on how to present specific geodata to different users of a geoportal. Therefore a standard-based portrayal concept is extended to adapt the symbolization to user needs; a concept for a user-dependent framework is introduced and tested in a web-based environment. We present a workflow for fast and easy over-view of a 3D scene via a visualization web service. The workflow extends the portrayal rules and symbols of a 2D symbolization for a 3D scene.

1 INTRODUCTION

The nature of geographical applications requires seamless integration and sharing of spatial data from a variety of providers. To solve this interoperability problem, standardized geospatial web services like the Web Map Service have been introduced. The Web Map Service creates and displays map-like views of information and allows users to define symbolization for the geodata with symbology encoding. The users of geoportals have different tasks and thus individual geodata views are required. Therefore the portrayal rules have to be adapted for each user. The goal of our investigations is to portray user specific geodata views, which are generated by a web service-based geoportal within a specific domain and with respect to a given task without any conflict.

The structure of the paper is as follows: First portrayal and portrayal services are described. Then the paper focuses on the structure of portrayal rules. The concept of portrayal rules is extended with symbolization adapted to user needs. This concept will be based on standards that are independent of vender solutions and supporting interoperability. A proposed framework shows how to customize the portrayal rules according to individual needs of the users in a geoportal. To prove the web-based portrayal framework, we implemented a prototype of a 3D portrayal service for integration in a geoportal. Our approach extends the 2D portrayal specifications into 3D environment and adds symbol definitions. The paper is concluded by a summary of the results of the investigations and an outlook.

2   PORTRAYAL DEFINITION, SERVICES AND INDIVIDUAL VIEWS

The creation of digital maps requires two major components: geodata and a portrayal specification. The portrayal specification defines how the data should be presented e.g. on a digital screen. It contains the portrayal rules and their symbology. For the representation of a digital map an application ((web)-client) or a service (e.g. a web map service)) interprets the portrayal rules to get the symbology for a selection of geodata and creates the map according to these rules.

Portrayal is a term used in ISO 19117 (2004) for the "presentation of information to humans". The *Portrayal Model* of the Open Geospatial Consortium (OGC) defined in Reference Model (2003) is shown in Figure 1. It illustrates a simple features-based access and a portrayal service pipeline. This portrayal model is divided into four representation components (grey boxes: data source, features, display elements, image) and four units of processing (white boxes: filter, display element generator, render, display). The processing is done via services or clients. Features are selected from the data source through query constraints. With the help of styles encoded in rules the display element generator produces display elements. The graphical representation will be rendered with image constraints and displayed on the screen afterwards.
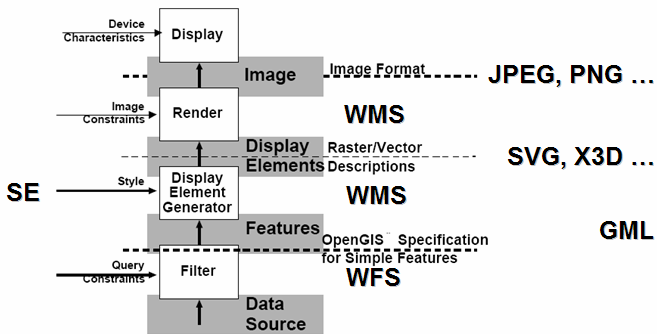

Figure 1: OGC Portrayal Model with its different services (WMS, WFS), representation components (GML, SVG, and JPEG) and style definition (SE) (Reference Model (2003))

2.1   Portrayal Services and Supported Formats

In the following the portrayal services and their supported formats are described. The Web Map Service (WMS) is a 2D portrayal service. There are different kinds of WMS:

- Basic WMS,

- Integrated Styled Layer Descriptor (SLD)-WMS

- Component Styled Layer Descriptor (SLD)-WMS.

The *basic version of a WMS* (ISO 19128 (2005)) creates and displays map-like views of information. These maps are generally rendered in pictorial formats like PNG, GIF or JPEG. Furthermore the specification gives the possibility to display vector-based graphical elements in Scalable Vector Graphics (SVG) or Web Computer Graphics Metafile (WebCGM) formats (see Figure 1 WMS). In Wiebrock and Reinhardt (2004) a comparison of these vector formats is given. Since the end of 2005 the Web Map Server Interface has attained the status ISO Standard (ISO 19128). It classifies *layers* and offers a number of predefined *styles* in which to display those layers. It is based on the OGC WMS version 1.3 and does not include a mechanism for user-defined symbolization of features.

An *integrated Styled Layer Descriptor (SLD)-WMS* is a specialized WMS that allows clients to apply Symbology Encoding (SE (2006)) to all or a subset of its layers. SE is the encoding of the styling description for digital features or coverage data. The styling orders for feature types are defined with *symbolizers* (point, line, polygon, text and raster) embedded in rules. They are used to display the results of a WMS, WFS (Web Feature Service) and WCS (Web Coverage Service). Styled Layer Descriptor (SLD (2007)) is the link between SE and WMS layers. An integrated SLD-WMS accesses its database via an internal, proprietary interface.

In contrast, a *component Styled Layer Descriptor (SLD)-WMS* like the OGC Feature Portrayal Service (FPS (2005)) requests feature data from a WFS server in GML (Geography Markup Language) and uses a portrayal specification encoded in SE for generating a map (see Figure 1). This service is the portrayal engine for GML data and does not advertise any layers of its own (*named layers*).

SLD allows user-defined symbolization of features. Zipf (2005) uses SLD for the dynamic generation of user- and context-adaptive mobile maps. He describes a general way to use SLD in such an application, but it is still open how to adapt the SLD for specific parameters like color, opacity etc.. Brinkhoff (2005) extends the SLD basic specification by characteristics of the Cascading Style Sheets (CSS) specification and by observing

the demands of Location Based Services (LBS). He defines external parameters for LBS that influence the portrayal properties for the current location.

Besides the 2D portrayal services there are two 3D portrayal service specifications of OGC: the *Web Terrain Service* (WTS (2003)) and the *Web3DService* (W3DS (2005)). The WTS produces a perspective view of georeferenced data. These views are generally rendered in a pictorial format, thus there is no navigation possible in the scene. The W3DS generates a 3D scene with graphical elements describing a geographic area. There is a possibility to navigate in the scene, because the 3D scene graph is rendered on the client. Today, there is no SLD support for 3D portrayal services and thus no possibility to support user-defined symbolization.

There are two groups of portrayal formats for displaying the results of a portrayal service: *vector-based description formats* (e.g. SVG) and *raster formats* (e.g. images like JPEG) (see Figure 1 WMS). Using XML-based vector description languages for graphics in 2D (e.g. SVG) and in 3D (e.g. Extensible 3D (X3D (2004)) as a means of interacting with a WFS data service requires parsing of the GML content. This parsing can be done on the server (e.g. through XSL) or client. Extensible Stylesheet Language (XSL (2001)) is a XML language for transforming XML documents. The styling rules can also be defined in a XSL document instead of a SE document. This second possibility of encoding styling rules is used for the prototype described in 4.4.

2.2   Individual Geodata Views in a Geoportal

Since the users come from different domains (military, metrology, etc) and have different tasks (e.g. GIS analyst) and thus one or more different roles (view, analyst) in a geoportal, there is a need for individualized geodata views. A geoportal supports the personalization with the help of user profiles (preferred subjects, language, and functionality, etc.). The techniques to support different user profiles in a geoportal help to satisfy different needs within a specific user group. In Tatnall (2005) a web portal "is seen as a special Internet (or intranet) site designed to act as a *gateway* to give access to other sites." In Tait (2005) a *geoportal* is defined as "a web site that presents an entry point to geographic content on the web or, more simply, a web site where geographic content can be discovered". That means a geoportal acts as a broker between the users and different services providing the geodata, thus a geoportal can be seen as an open distributed system. For every user of such geoportals the geodata is presented in the same way, but the users have different domains and roles. Thus every user needs individual geodata views and personalized symbolizations. For that reason the

portrayal rules are described in the next section, followed by a description of a method to adapt the symbolization to user needs.

3   PORTRAYAL RULES

In this section the concept of portrayal rules to get the symbology for a selection of geodata is described.

In ISO 19117 (2004) portrayal catalogues include portrayal instructions for all objects of a feature catalogue. These features are symbolized according to its portrayal rules. A change of context, like scale, leads to another portrayal catalogue. The *portrayal catalogue* consists of the feature portrayal, portrayal rule and external function (see Figure 2). Each feature type has a set of portrayal rules called *feature portrayal*. The *priority* in feature portrayal defines the order of the display. The *portrayal rule* has a query statement and a portrayal action. The *query statement* includes the feature instance defined by feature type, its attributes and the geometry (e.g. line). If the query statement is true, the portrayal action will execute the drawing command with a given symbol (see example in Figure 2). The symbol is defined in a portrayal specification. The *external function* (e.g. scale) is a function that influences the selection of a portrayal catalogue or feature portrayal.
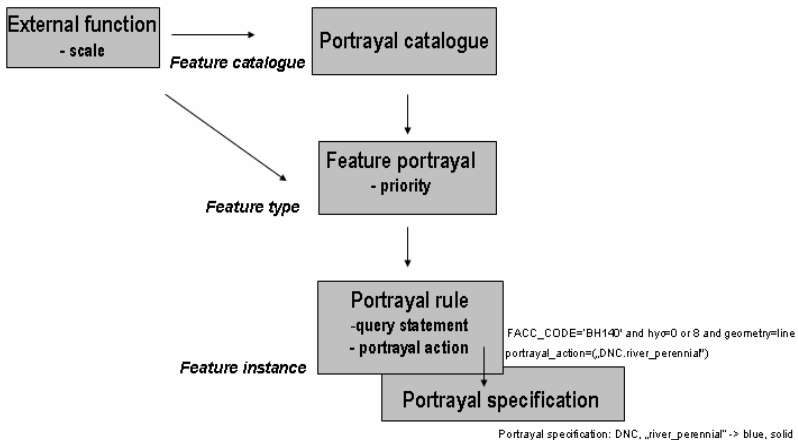

Figure 2: Portrayal concept of ISO 19117 (2004)

However this standard has limitations e.g.:

- No clear conceptual model for portrayal rules; the standard gives an example but no definition of the elements (Figure 2). It fails to describe the composition of portrayal rules.

- No symbol model; there are no elements defined.

The DGIWG (Digital Geospatial Information Working Group), a multinational body responsible for geospatial standardization for defense organizations, proposed modifications in a NWIP (New Work Item Proposal) of ISO 19117 (Draft NWIP ISO 19117rev (2006)). The first author of this paper participates in DGIWG and represents the BGIO (Bundeswehr Geo Information Office). The Draft NWIP ISO 19117rev (2006) revises the conceptual model of portrayal rules. Further it adds a conceptual model for symbols to the standard.

In the NWIP a *mapping* is a set of feature portrayal defined e.g. in a portrayal catalogue. The feature portrayal has a number of portrayal rule which consist of a rule expression and a reference to a symbol (symbol reference). Figure 3 illustrates this structure.
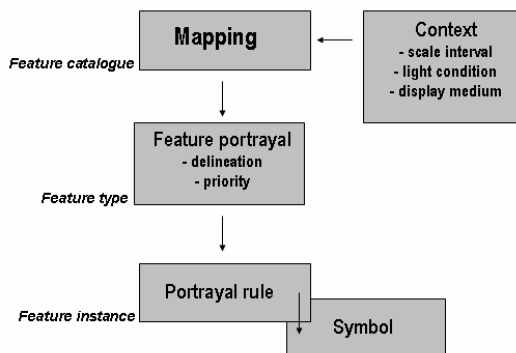

Figure 3: Portrayal concept of Draft NWIP ISO 19117rev (2006)

Portrayal mappings associate features with symbols for the portrayal of the features on maps and other display media. The mapping is not specific to a particular dataset but to a feature catalogue, which defines feature types and their associated attributes. There are no more external functions in this standard; instead the context concept has been introduced. The portrayal of a feature catalogue is influenced by the context, like scale interval, light conditions or display medium. The values of the context elements have an impact on the selection of a mapping from a mapping collection. The mapping corresponds to the OGC terminology style.

The feature portrayal contains the definition of the delineation and priority for a feature type. The *delineation* specifies the displayed geometry e.g. point, line or area to which the feature portrayal applies and corresponds to *geometry* in ISO 19117 (2004). The priority defines the order of the display. The feature portrayal links to a set of portrayal rules for each feature instance. For feature instances the portrayal rules are evaluated and mapped to their referenced symbols.

A new conceptual model of portrayal rules are defined in the NWIP. A portrayal rule consists of a rule expression and a reference to a symbol. A symbol is a graphic element of a portrayal that represents an instance of all features.

An example of a portrayal rule definition, its attribute expression and its symbol reference is shown below:

> <portrayal rule> = <rule expression> : <symbol reference>
>
> <rule expression> = <attribute expression> { AND <attribute expression> }

Example code for feature river:

> <portrayal rule> = <hyc="0" or hyc="8"> : symbol1_river_perennial

Each object class and single feature instance has its own attribute expressions with attribute values encoded in a portrayal rule. If these portrayal rules are evaluated true, the referenced symbol is displayed.

Single attribute expressions are joined by Boolean "AND" to a rule expression. The attribute expression with the Boolean "or" and "and" consists of an attribute condition and an attribute value. The attribute condition can take a comparison operator like "<", ">", and "=". Possible attribute value are character, integer, real or enumerated value.

Furthermore a new conceptual model for symbols is introduced in the NWIP. According to the NWIP a symbol has a symbol base describing the appearance and a transformation parameter for displacement. In Figure 4 the arrow is placed according to the displacement parameters.

Figure 4 (left) shows an example with the portrayal specification *MIL-PRF GeoSym* (Geospatial symbols for digital displays) based on the NWIP. This is a portrayal specification of the NGA (National Geospatial-Intelligence Agency) to display digital 2D VPF-products.

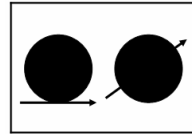| Definitions	GeoSym Example
Mapping (portrayal catalogue)	GeoSym part VMap1 (Vector Map level 1)
Feature portrayal Delineation, priority	Feature Type: BH 140 (river) line, 6
portrayal rule	1) hyc=0 or 8 (perennial) -> symbol1 ——— 2) hyc=3 or 6 (dry) -> symbol2 - - -

Figure 4: Portrayal example is based on Draft NWIP ISO 19117rev (2006)

After the portrayal standard element definitions (like portrayal rules) are described, the possibilities of the user to influence these elements are introduced in the next section.

4   USER DEPENDENT PORTRAYAL RULES

For a personalization of geodata views it is important to model and consider both the current situation (context) and the user. Such a general context-aware user adaptive system is described in Jameson (2001). Zipf and Jöst (2005) propose an integrated situation model including several types of context for "Adaptive Mobile GI Services". This includes context and user aware personalized tour planning and adaptive maps based on an ontology approach. The main focus in Reichenbacher (2004) is on the elaboration of adaptive methods for visualization of geographic information for mobile usage. But especially the modeling of the different context domains requires extensive investigations.

The users demands for geodata selection, representation style and user interface are different as stated in Yu et al (2003). In Moisuc et al (2006) personalization is performed through a model-driven approach (adaption of geodata selection and representation style). An adaptive GIS is described in Petit et al (2006) with a framework separated into a user, geographic and device context.

The goal of our investigations is to portray user specific geodata views, which are generated by a web service-based geoportal within a specific domain and with respect to a given task without any conflict. In addition, the managing process of portrayal data and user has to be defined. To get a user specific geodata view we have to investigate the different indicators influencing the portrayal. For that reason we have to define a user model and a symbol component model with its different attributes and discover their relationship and possible conflicts.

Based on the explanations in the previous section we introduce a user-dependent portrayal model. With this extension it is possible to include user specific views into the portrayal model.

The following tasks have to be accomplished to develop the envisioned framework:

- Definition of portrayal requirements for different user domains and roles for a data set from one feature catalogue based on scenarios

- Definition of a user model and extension of the portrayal model

- Refinement of a symbol component model

- Derivation of (high level) general portrayal customized elements

- Discovering the relationship of these elements to different users, their impact on the portrayal rules and symbols and possible conflicts

- Definition of the whole method and framework

In the following we introduce and explain the extended portrayal model. The proposed model includes the definition of the general user model, general symbol component model and general portrayal elements separately, followed by a description of the whole framework and its dependencies.

Our system is designed for personalizing the interface and the view of the geodata. The user models provide information about user preferences for representation style and interface.

4.1 User Model

First of all we have to define a user model (profile). The user profile has different elements like ID, name, account, domain (e.g. military, meteorology), task/role (e.g. view, analysis), presentation and content (ranking), system (device), environment (light conditions) and probably more. Moreover, the user model has to contain elements like window size, bounding box, layer list and elements describing the user interface, e.g. screen size, orientation or number of different map windows. The users come from different domains, but can share the same task. For example a GIS coordinator (military) has the task view and lead, while a meteorologist has view and analysis.

Information to generate the user model can be extracted from the user in one of three ways: implicitly, explicitly, and observing the user while solving different tasks as stated in Domik and Gutkauf (1994). For implicit modeling the user is being monitored in his use of the system, e.g. mouse click or eye movement, while for an explicit modeling the user answers di-

rect questions, like filling out forms. The third method requires a supervisor who observes the user when completing a task.

We create our user profile in two steps. To assign the user to a user group, we asked the user to define his domain and task (explicit). The user gets a geodata view according to this group. Afterwards the user has the possibility to make changes, like switching layers on/off (implicit). Every time the user logs into the geoportal and modifies his view, his user profile will be updated.

The user system and environment affects the context, while the user properties (domain, task/role and content (ranking)) influence the feature portrayal and thus the portrayal of a feature type or a single feature instance (Figure 5).
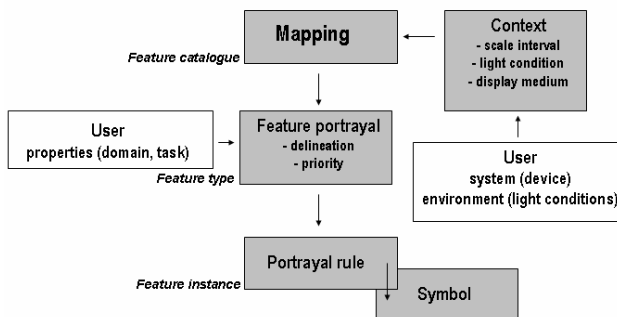

Figure 5: Extended portrayal model

4.2 Symbol Component Model and General Portrayal Elements

In the previous section, we have described one feature catalogue for all users. But every user gets his own adapted symbology and thus the portrayal specification changes. This means the priority of the symbols (feature portrayal) and the referenced symbols themselves have to be modified, while the portrayal rules with associated attribute expressions do not change. For that reason we refine the symbol model described above to a symbol component model. A component model describes the components of a symbol together with their delineation. There is a set of variables for web-based visualization, e.g. *visual* and *screen variables* for describing a symbol (Li and Kraak (2002)). The variables include the geographic position of a mark on a surface, which can vary in two dimensions (x and y location). A particular mark can further vary graphically (visual variables) in size, value,

texture, color, orientation and shape (Bertin (1973)). The screen variables are blur, focus and transparency. For dynamic geodata we extend the model with the element motion with its attributes direction, speed and acceleration (Wilkinson (1999)).

There are different kinds of delineations: point, line, and area. A point and a line symbol can be described with all variables described above. The size of a line symbol is its stroke width. An area symbol is defined by the dynamic and screen variables and the value, texture and color for its fill and the attributes for a line symbol for its stroke. The element texture has two attributes: type and offset. The type is predefined like dashed etc. or has a reference to a marker. The marker defines a shape which has coloring applied to it. The offset specifies the distance in the texture. Besides according to the NWIP a symbol has a symbol base and a transformation parameter for displacement. The transformation parameter is defined relative to the geographic position.

The whole portrayal specification with its priority and symbol elements should be organized in a catalogue in order to facilitate easy modification of the single elements according to the user's individual needs (see black boxes in Figure 6). Figure 6 describes an example for a feature class tree.

Feature portrayal rule			Portrayal rule		Symbol				
Feature Type	priority	delineation	attributes (VEG)	Symbol	Symbol	shape	color	opacity	...
tree	5	point	D (deciduous tree)	p123.svg	p123.svg	point	green	1	
			C (conifer)	p124.svg	p124.svg	point	green	1	
	5	area	D (deciduous tree)	a123.svg	...				
			C (conifer)	a124.svg					

Figure 6: Portrayal specification (example for the feature class tree)

General portrayal elements are high-level elements, which can influence several different elements of the symbol component model. We explain the identification of the general portrayal elements by means of an example. One user scenario is a major flooding, where the military is supporting disaster relief. The military sets up an emergency command centre with different users like GIS coordinator and (field) viewer. The viewer has specific requirements for his roles like displaying relevant and irrelevant objects on diverse levels (object category (vegetation) or object type (tree)) differently. On that account the portrayal priority and the symbolization itself, like the transparency (SVG parameter: opacity), will be influenced (as described in the symbol component model). Hence one possible general customized element is the *(portrayal) relevance*.

4.3   Framework

A possible framework with its components described above for a user-dependent portrayal is shown in Figure 7.
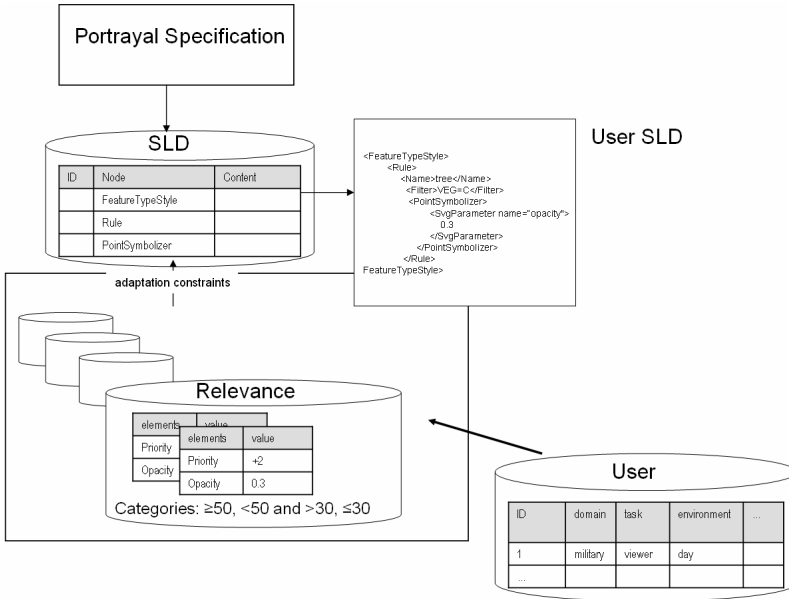

Figure 7: User-dependent framework

Each user has a link to his domain and task. These definitions are associated with different general portrayal element registers like relevance of object categories. The general portrayal elements are categorized in ranges, e.g. relevance ≥ 50, ≤ 30 or between. For our scenario the display of the vegetation (relevance = 30, default = 50) objects are less relevant than the hydrography (relevance = 100) for example. Relevance of object groups affects the symbol description (SVG code) and the feature portrayal rule like priority defined in the portrayal specification. In our case (Figure 7) the vegetation priority value will be higher (+2 points, 1: highest priority, display on top) than default, and the opacity value for the symbol elements description in SVG will increase (+0.3 points) too. The layers and the rules in SLD are Z-ordered, which means that the first item in a list is plotted first and hence at the bottom. Therewith the element priority in the portrayal model controls the order of the *FeatureTypeStyle* in SLD.

An empty SLD template is filled on the fly with the user customized portrayal specification content. A portrayal service like SLD-WMS uses the

generated SLD file to display an individual geodata view. In Figure 8 the result for the user military/viewer is shown. The "wood" is displayed with less intensity than the "river".
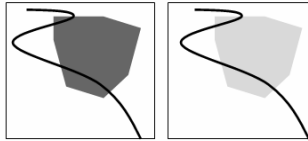

Figure 8: Example ("wood" and "river") for an original and individual view

Our framework takes the default values from the portrayal specification and customizes them with the user values. An approach is the definition of general portrayal elements. Relevance is just one example of possible customization with different scenarios. Another element is light condition. When the light condition (environment) changes, it influences the attributes color and value of a symbol. More customized classifications will be defined in future investigations. Besides, all the portrayal data (rules and symbols) and the SLD template can be managed and organized in catalogues.

4.4   Application of the User Dependent Portrayal Model

As described above, the user's profile has different attribute values that influence the geodata display. In this section we illustrate the user dependent portrayal model by a simple example in which the basic 2D portrayal specification is extended to be able to handle "3D" symbols. We add new symbols and modify the type of delineation in the feature portrayal for extrusion. We verify our proposed extended rules with a prototype implementation.

The rule expression for a feature instance references to:

- a 2D image (opacity…) for surface texture mapping or
- a 3D symbol (simple 3D object) for displaying point features and as texture mapping for areas or
- a symbol (fill, color…) for a simple 3D object generated from extrusion.

Figure 9 shows an example for a 3D visualization: a 2D image and a 3D symbol texture mapping. The polygon area is referenced to a 2D texture for displaying the surface. Besides, a function calculates a point spreading over this area. These points reference to a 3D symbol for representing the polygon object as a coniferous wood.
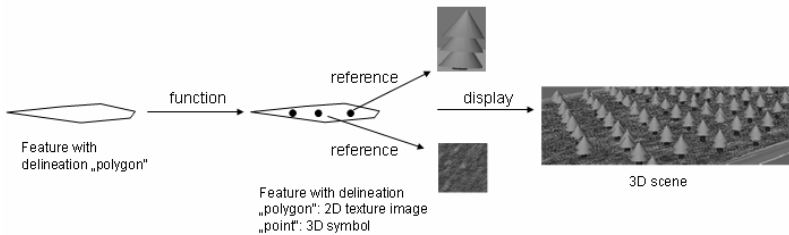
Figure 9: Example: 3D symbols and 2D image as texture mapping over an area

For a texture mapping of a polygon object the rule references to a 2D image. In many texturing applications it is necessary to be able to tile the texture over a larger region than the texture segment covers. In the ideal case the texture segment automatically tiles.

Example of a portrayal rule with reference to a texture mapping:

Delineation: polygon

<rule expression> : 2D texture image

A tile function over the area is a capability of 3D formats like X3D.

For a 3D symbolization of a point object the rule references to a 3D symbol. 3D symbols are simple 3D models like trees, for example.

Example of a portrayal rule with reference to a 3D symbol:

Delineation: point

<rule expression> : 3D.sym

For a 3D symbol texture mapping over an area a function calculates a point spreading over this area. These points reference to the 3D symbol (see Figure 9).

Function area to points:

Calculate points in area (area min (x,y) (down left) and area max (x,y) (top right) with point distance (10m) inside area) -> set of points

Portrayal rule:

Delineation point:

<rule expression> : 3D.sym

The extrusion adds another dimension (here z-axis) to the base geometry. With the help of object attributes like height, a 2D object can be displayed as a simple 3D model. Figure 10 shows the 2D geometry (polygon object) with its attribute height and the result as a simple 3D model.
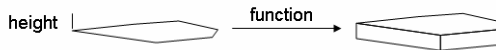
Figure 10: Extrusion function

With the extrusion function, a point will become a line, a line an area, and a polygon a solid. The portrayal rule shows how the delineation of a feature is changed.

Function extrusion:

Function: point (height) -> line, line (height) -> area, polygon (height) -> solid

Portrayal rule

Delineation line:

<rule expression> : symbol

Delineation polygon:

<rule expression> : symbol

Delineation solid:

<rule expression> : symbol

In the next section the prototype implementation for generating 3D scenes according to the portrayal rules explained above is described. Figure 11 illustrates this workflow.
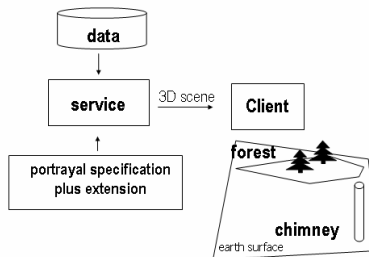

Figure 11: Workflow

The data is stored in a database. The service (see Figure 11) interprets the portrayal specification plus extension to get the symbology for a selection of data and creates the map according to these rules. For our implementation the basic portrayal specification MIL-PRF GeoSym was used. We extend this portrayal specification for displaying a 3D scene with our 3D visualization rules from above. At this particular point our user-dependent

rules have to be added (see Figure 11, portrayal specification plus extension). The 3D scene graph is rendered via a client, because there should be a possibility to navigate in the scene. For the described representation of 3D scenes we recommend the use of X3D, because it is XML-based ISO standard and thus it is suited for a service-based architecture of a geoportal.

Stoter (2004) describes a system architecture to support cadastral registration in 3D situations and how to access a Geo-DBMS with different front-ends like CAD, GIS and web technology. He proposes among others the "XSQL, X3D and Oracle" framework. We used this concept and encoded our portrayal rules with their extensions in a XSLT document.

With our prototype implementation we proved the concept of extended symbols and modified the delineation of feature portrayal in a web service-based environment with a geodatabase as data source. The investigations are performed within a BGIO (Bundeswehr Geo Information Office) project.

5   CONCLUSION AND OUTLOOK

In this paper the general portrayal rules were discussed and we have introduced a framework to customize the geodata view for different users.

At the current stage of our investigations we have defined different scenarios for dynamic and static geodata to identify the different user domains and roles. In the next step we have to find out more general portrayal components like the relevance and determine the user model in more detail and the influences on our symbol component model. After refining the models we have to adapt the implementation and based on this result the suggested workflow. The users, their adaptation rules and the portrayal data (like symbols and rules) could be managed in a register as defined in ISO 19135 (2005). This standard specifies elements of information that are necessary to provide identification and meaning to registered items. This requires further investigations.

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