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Feature Styling IPR

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i. Preface

This Interoperability Program Report (IPR) document was developed as part of the OGC Web Service, Phase 4 initiative (OWS-4) in the GeoDSS thread. This version of the IPR reflects the status of the specification as of the change history.

ii. Submitting organizations

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iv. Revision history

Date	Release	Editor	Primary clauses modified	Description
26th July 2006	pre	Markus Müller	All	First draft as OWS-4 GeoDSS IPR

1st September 2006	0.1.0	Markus Müller		Update on section 5.
7th September 2006	0.2.0	Markus Müller	5	Added section on motivation, reworked figure 4, added sequence diagram for integrated WMS (section 5.3.3). Renamed document. Deleted section 5.6
27th Novemer 2006	0.3.0	Markus Müller	5	Corrected minor flaws in the described sequences.
5th December 2006	0.4.0	Raj Singh, Markus Müller	All	Grammar fixes, added section 6 (Outlook)
7th December 2006	0.4.1	Markus Müller	All	Small re-work to make document better understandable for a wider audience.

v. Changes to the OpenGIS® Abstract Specification

None necessary.

vi. Future work

Improvements in this document are desirable in regard to Portrayal Catalogues and their relationship to Feature Styling.

Foreword

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Introduction

This document describes Feature Styling, that is mechanisms of software components that are capable to query, store and display symbology descriptions. It is based on the work described in 05-112 Symbology Management System that was created in the OWS-3 initiative.

The portrayal of feature and coverage data using XML-based encodings and OGC Web Services is an old subject in OGC. The first specification that addressed this issue in its entirety was the Styled Layer Descriptor Implementation Specification (SLD) (OGC 02-070) that can be seen as an add-on to WMS 1.1.1. Those two specifications were linked in the sense that WMS 1.1.1 had defined some connection points to SLD. SLD 1.0.0 is very comprehensive, it encompasses:

1. an XML based grammar for styling information
2. an XML based language for map composition
3. extensions for WMS operations to allow them to use SLD
4. additional operations for legend creation and storage/retrieval of styling information.

SLD was successful in its own right as there are a number of implementations of the specification now in the marketplace. There were a number of change requests for SLD 1.0.0 that were the starting point of the development of a 1.1.0 version of SLD. Because of organisational issues the development of SLD 1.1.0 took longer than originally expected.

During the OWS initiatives following the publication of SLD 1.0.0 a number of developments took place that were and are important for the development of SLD. One of these important developments was the specification of Catalogue Services to store portrayal rules and symbols. Another was the definition of the Feature Portrayal Service (FPS), an interface specialised on portraying feature data from WFS servers, using the mentioned Catalogue Services for retrieval of symbology and symbols. FPS though has so many characteristics in common with a component SLD-WMS as defined in SLD 1.0.0 that it can be seen as a specialised component WMS.

The use of portrayal registries based on OGC catalogue services motivated that the SLD specification was divided into two parts, one of them defining only the pure styling information (Symbology Encoding, OGC 05-077r4, see 1. above) and another part that allows WMS services to use Symbology Encoding in its service interface (SLD profile of WMS, OGC 05-078r2).

This document brings these developments together in a common conceptual model, taking into account the new ideas from the OWS initiatives while trying to retain as much backwards compatibility with SLD 1.0.0 as possible.

The specific operations of FPS and integrated SLD-WMS are described in more detail in 05-078r2 and its successor documents. The SLD profile of WMS again brings the ability to style features using extended GetMap requests and to create legends to the current WMS specification of version 1.3.

Feature Styling

1 Scope

Feature Styling is based on a distributed computational platform that employs a number of standard interfaces and encodings to allow for flexible, scalable and interoperable management of symbology (styles and symbols) in the process of producing maps from different kinds of data, most important being source GML data.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

OGC 05-008c1, OWS Common Implementation Specification, May 2005

OGC 05-077r4, Symbology Encoding, August 2006

OGC 05-078r2, SLD profile of WMS, September 2006

3 Terms and definitions

For the purposes of this specification, the definitions specified in Clause 4 of the OWS Common Implementation Specification [OGC 05-008] shall apply. In addition, the following terms and definitions apply.

4.1 application schema
Conceptual schema for data required by one or more applications [ISO/DIS 19109]

4.2 classification scheme
A taxonomy used to classify phenomena… used to characterize catalogue content [ebRIM 9.1]

4.3 client
Software component that can invoke an operation from a server

4.4 feature
Abstraction of real world phenomena; objects or phenomena on the Earth that are

normally represented as graphical entities on a map (e.g., a house, political boundary, lake).
NOTE: A feature may occur as a type or an instance. Feature type or feature instance should be used when only one is meant. [ISO/DIS 19109]

4.5 feature attribute
feature property
A characteristic of a feature.
NOTE 1: A feature attribute may occur as a type or an instance. Feature attribute type or feature attribute instance is used when only one is meant.
NOTE 2: A feature attribute type has a name, a data type and a domain associated to it. A feature attribute instance has an attribute value taken from the domain of the feature attribute type. [ISO/DIS 19109]

4.6 feature type
Class of real world phenomena with common properties; identifies the semantic, structure (properties and property types) and behavior of Feature instances and can be defined with an Application Schema.
EXAMPLE: The phenomenon 'Eiffel Tower' may be classified with other similar phenomena into a feature type 'tower'. [ISO/DIS 19110]

4.7 interface
Named set of operations that characterize the behavior of an entity

4.8 operation
Specification of a transformation or query that an object may be called to execute

4.9 service
Distinct part of the functionality that is provided by an entity through interfaces

4.10 service instance
server
Actual implementation of a service

4.11 style
Styles provide the mapping from feature types and feature properties and constraints to (parameterized) symbols used in drawing maps; the properties and rules describing how features are drawn during a graphical rendering process.

4.12 symbol
Symbols are bundles of predefined graphical parameters and predefined fixed graphic icons ("images" or strokes); the instructions for how vector graphics are to be represented (e.g., geometry/graphic, fill, color, stroke, font, orientation, size, opacity, etc.); the instructions for how raster graphics are to be represented (e.g., opacity, R/G/B channel selection, color map, shaded relief, contrast enhancements, etc.).

4.13 portrayal
Presentation of information to humans [ISO 19117].

4.14 map
Portrayal of geographic information as a digital image file suitable for display on a computer screen.

4 Conventions

4.1 Abbreviated terms

Most of the abbreviated terms listed in Subclause 5.1 of the OWS Common Implementation Specification [OGC 05-008] apply to this document, plus the following abbreviated terms.

FPS Feature Portrayal Service

SMS Style Management Service

SE Symbology Encoding

SLD Styled Layer Descriptor

WMS Web Map Service

WFS Web Feature Service

WCS Web Coverage Service

GML Geography Markup Language

OGC Open Geospatial Consortium

OWS OGC Web Service

DCP Distributed Computing Platform

EPSG European Petroleum Survey Group

GIS Geographic Information System

XML Extensible Markup Language

SVG Scalable Vector Graphics

URL Uniform Resource Locator Web

HTTP Hypertext Transfer Protocol

IETF Internet Engineering Task Force

MIME Multipurpose Internet Mail Extensions

4.2 UML notation

Most diagrams that appear in this specification are presented using the Unified Modeling Language (UML) diagrams, as described in Subclause 5.2 of the OGC Web Services Common Implementation Specification [OGC 04-016r2].

4.3 Document terms and definitions

This document uses the specification terms defined in Subclause 5.3 of [OGC 04-016r2].

5 Feature Styling

5.1 System context and the structure

The structure of the a system for portrayal feature data is shown in the following figure:

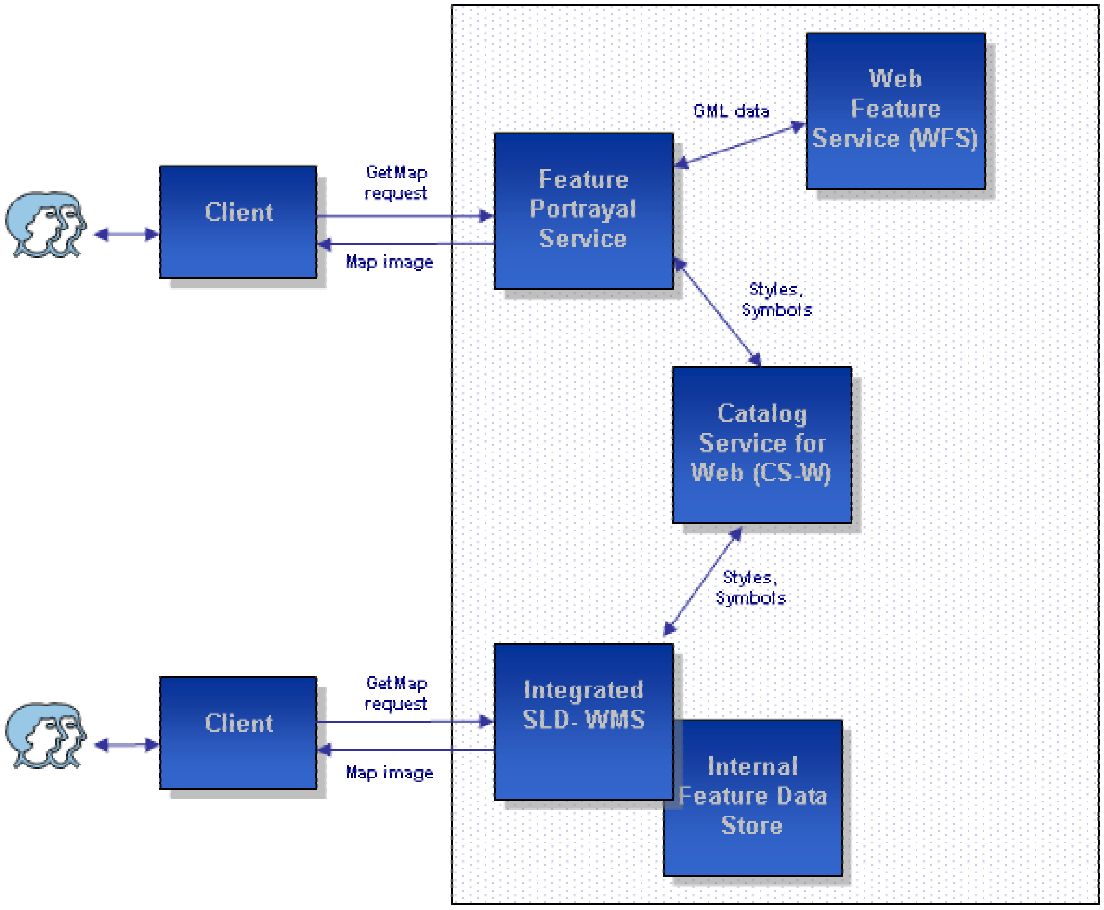

Figure 1 -- Relationship of FPS and Integrated SLD-WMS

Two related services are able to portray feature data, these being the Feature Portrayal service and integrated SLD-WMS (for a more detailed explanation of these terms refer to OGC document 05-078r2). The following components are part of the overall system:

Component SLD-WMS – a service for producing map images from feature and coverage data that is provided by WFS or WCS. Feature Portrayal Services and Coverage Portrayal Services are subclasses of component WMS, specialized on Feature or Coverage data.

Feature Portrayal Service (FPS): a specialised component SLD-WMS able to portray GML data from WFS services.

Integrated SLD-WMS- An integrated SLD-WMS is a basic WMS that allows clients to apply Symbology Encoding to all or a subset of its layers. In addition to the WMS operations of GetCapabilities, GetMap and GetFeatureInfo, an integrated WMS has to support the DescribeLayer and DescribeFeatureType operations. It basically is a specialised WMS Service allowing Symbology Encoding to be applied to its internal data store. An integrated WMS only supports named layers (the layers it supplies in its GetCapabilities document).

Web Feature Service (WFS) – a service for storing and retrieving GML feature data.. The role of the Web Feature Service is to serve as the data source in the context of a system for Feature Styling. Thus, its role in this context does not differ from a general purpose of WFS in Web-based scenario. Clients send the feature requests to WFS service instance and receive data (features) in GML form.

However, it should be noted that the focus on portraying features (as opposed to other abstract data forms) is stronger in this initiative than in some previous ones, and subsequently the role of WFS is that much more significant.

Catalog Service for Web (CS-W) – a cataloguing web service used in this context primarily for cataloguing symbol and style entities. It uses a specific ebRIM package for description of its information resources. Alternatively, the role of the CS-W can be fulfilled by a simple web server that supplies symbols and styles using URLs.

The role of the Catalog Service for Web is to support registering, management, discovery and access Symbology Encoding style specifications. In addition, CS-W can store symbol libraries. The service is required to provide the following functionality in the context of Style Management:

- Support for construction and publication of style type taxonomies
- Ability to publish and find metadata about styles.
- Ability to associate style instances to classification nodes in a style taxonomies
- Ability to bind styles to feature types

Additionally, the following elements are managed and processed:

Style – a generic term for a description of styling attributes applied to a particular feature data in the portrayal process. This system (specifically, the WMS and FPS component) uses ***Symbology Encoding (SE)*** to encode the styles.

Symbol – a generic graphical entity referenced in the styles and used by WMS/FPS in the styling process.

Feature – objects/phenomena on the Earth that are normally represented as graphical entities on a map (e.g., a house, political boundary, lake). The term GML Feature in addition implies that the feature and its properties are encoded using GML

Styled Layer Descriptor - an XML grammar for map composition using ***Symbology Encoding (SE)*** to encode the styles.

5.2 Operations

The following use case diagram describes the different types of interaction between components in the system.

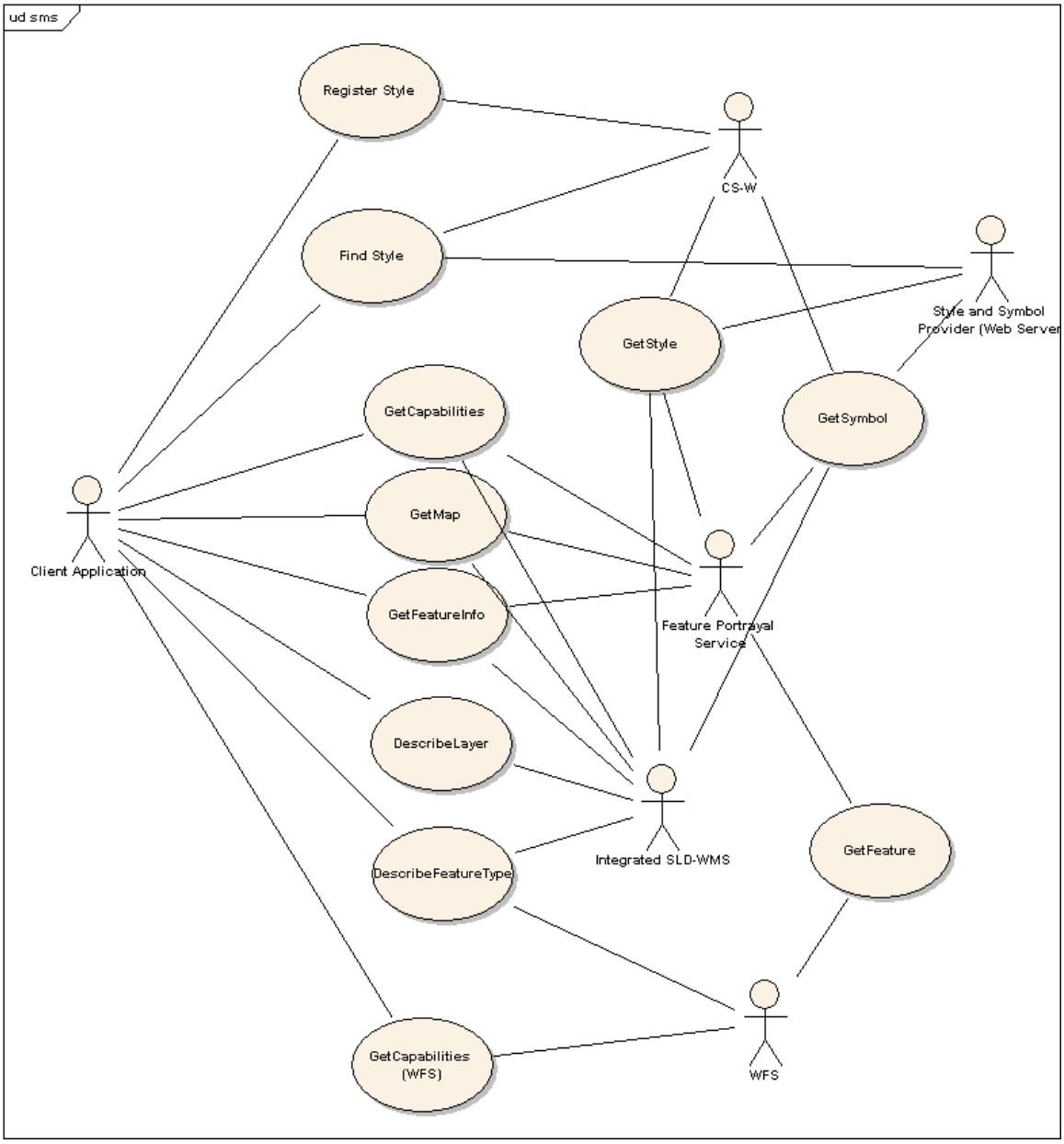

Figure 2 -- Operations within Feature Styling displayed in form of a use case diagram

Register Style

User uses a client application to create a Symbology Encoding (SE) style for a particular feature type. The SE Editor client can be a visual style editor client or a simple text or XML editor.

The feature information required by the style, comes from capabilities and data schema obtained from WFS(s) or integrated WMS services.

User uses a client application to send the SE document(s) to the CS-W that classifies them in its repository and makes them available for querying and retrieval.

Find Style

A user uses a client application to find a style (SE) in a CS-W instance or a simple web repository. Types of queries that can be submitted to the CS-W include queries by feature type, CS-W classification, assigned symbology standard (such as EMS or Geosym), and others.

If only a simple web repository is used (a web server that supplies Symbology Encoding documents in a web-accessible directory) a suitable style can only be identified by browsing the XML documents and analyzing the description and FeatureTypeName elements.

GetCapabilities

User uses the client application to retrieve the capabilities information from the WMS in order to decide whether and how to use the service in the map creation process. The user can this way select a number of appropriate WMS services.

The client application can, in the process of performing the GetMap (or some other) action, send the GetCapabilities request to the FPS service in order to obtain necessary information for the task.

GetMap

User uses the client application to construct a GetMap request and to send it to the WMS (FPS) service. The request includes information about the data source, styling reference and map properties (bounding box, size, etc). The service responds with the styled image of the data.

The client can issue multiple requests, potentially to multiple WMS/FPS services, thus retrieving multiple map images which it composes into a single map.

GetFeatureInfo

User uses the client application to retrieve object information about portrayed features.

DescribeLayer

An integrated SLD-WMSs only serves named layers and is not able to support arbitrary feauture types. A client application can therefore only apply styling information to available (“named”) layers. To do this, the client has to be able to find out about the feature types that compose the layer. The DescribeLayer-Operation supplies the names of the feature types pertaining to a layer that then can be used to issue a DescribeFeatureType request against the server.

Get Capabilities

A user uses a client application to query a WFS of his choice for the capabilities. This information is used to issue DescribeFeatureType requests.

DescribeFeatureType

A user uses a client application to query a WFS or integrated WMS of his choice for the data schema. These two information elements are used by the client for subsequent preparation of queries to CS-W and WMS/FPS.

GetStyle

WMS/FPS service interacts with the CS-W service to retrieve the style referenced in the GetMap request issued by the client. The style can be retrieved using the style id. It is assumed that the client performs the discovery and selection activities and supplies the FPS service with the direct reference (ID) of the style.

Alternatively an SE can be stored flatly under a URL on the web and then be referenced by the GetMap request. Style and Symbol Provider is, in this context, an abstract term denoting any kind of agent against which a simple query can be made to retrieve a symbol. This can include File System, HTTP Web Server, other kinds of web services, etc.

GetSymbol

The symbol is referenced in the SE document using URI scheme and the CS-W or Symbol Provider must be able to accept such references and return appropriate result.

GetFeature

Component WMS/FPS service interacts with the WFS service to retrieve the data referenced in the GetPortrayal request issued by the client.

5.3 Sequence diagrams

In the following the typical sequences for feature styling are described using UML notation. The sequences describe the registering of styles and the styling process itself using a FPS and an integrated SLD-WMS.

5.3.1 Register Style

The sequence diagram in the Figure 3 shows the RegisterStyle action activity.

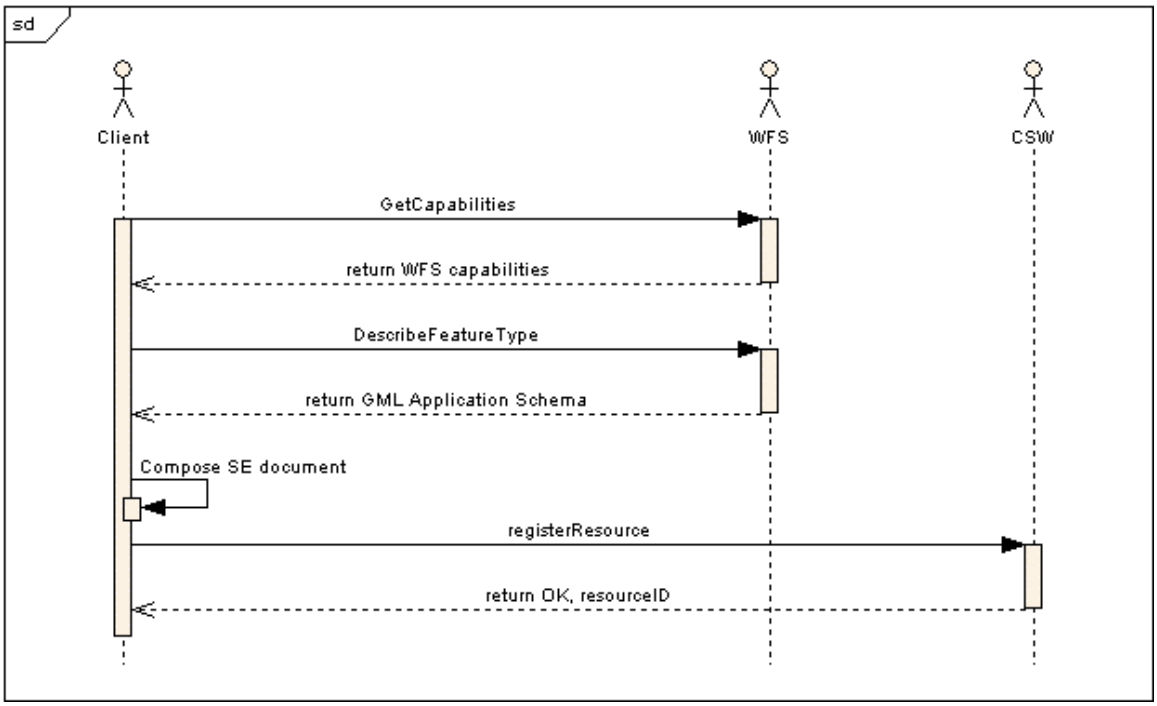

Figure 3 – Register Style sequence diagram

1. The client queries a WFS for capabilities using GetCapabilities.
2. return GetCapabilities. The WFS returns the capabilities. The client can repeat step 1 multiple times against different WFSs.
3. The client queries a WFS for data schema using DescribeFeatureType.
4. WFS returns the schema. The client can repeat step 3 multiple times against different WFSs.
5. Compose SE document. User uses the client to assemble an SE document.
6. Register resource. Client submits the SE document to CS-W for registration.

7. Response OK (ID). CS-W responds with affirmative response that includes the ID of the newly registered resource.

5.3.2 GetMap using FPS

The sequence diagram in the Figure 4 shows the GetMap action activity of a component WMS.

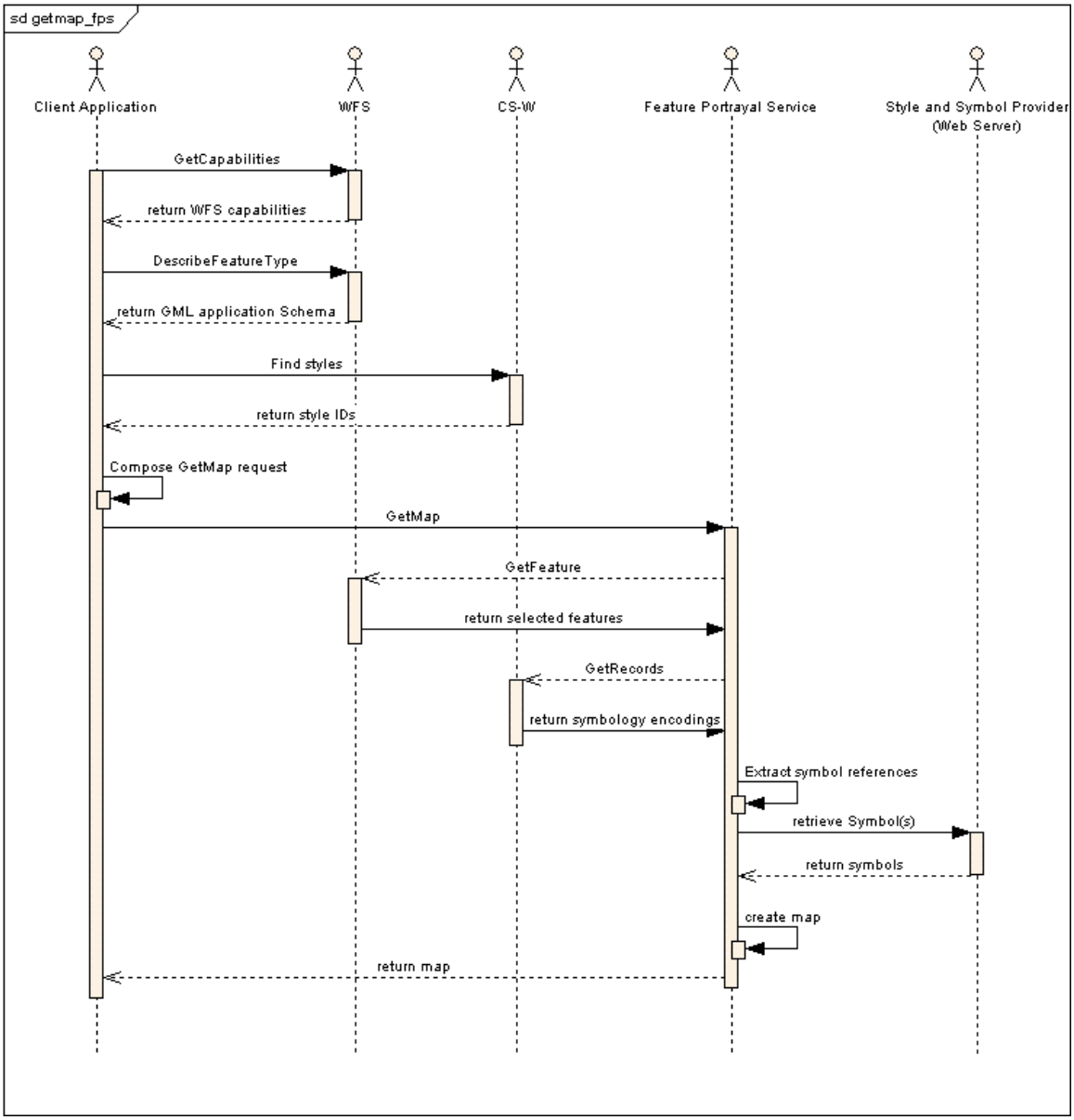

Figure 4 – GetMap sequence diagram using an FPS

1. The client queries a WFS for capabilities using GetCapabilities.

2. return GetCapabilities. The WFS returns the capabilities.
3. The client queries a WFS for data schema by using DescribeFeatureType.
4. WFS returns the schema.
5. Client queries CS-W for suitable styles
6. CS-W returns style IDs
7. Compose GetMap request.
8. GetMap. Client submits the request to FPS service.
9. Retrieve data. component FPS extracts the data source (WFS) reference from the request and submits the GetFeature request to it.
10. WFS returns the data (GML features)
11. Retrieve style. FPS extracts the style reference from the request and submits the appropriate request to the CS-W.
12. CS-W responds with the SE document
13. FPS extracts the symbol references from the SE style.
14. FPS makes the request to retrieve the referenced symbol
15. FPS receives the symbol
16. FPS portrays the features using the retrieved style and symbol
17. FPS returns the image to the client.

5.4 GetMap using integrated SLD-WMS

The sequence for a GetMap operation using an integrated SLD-WMS is slightly different, as the SLD-WMS itself acts partly as a WFS.

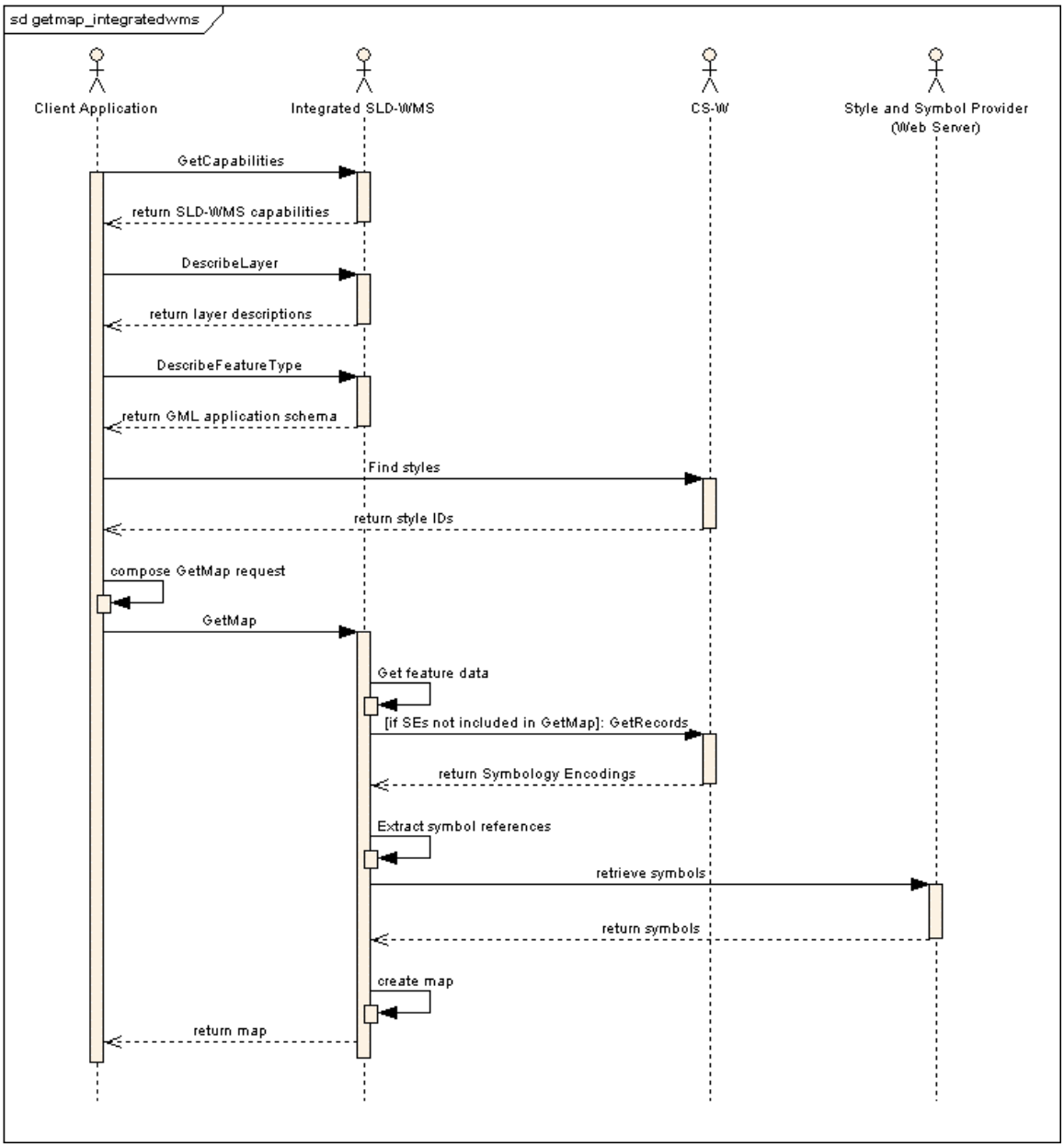

Figure 5 – GetMap sequence diagram using an integrated SLD-WMS

1. The client queries an integrated SLD-WMS for capabilities by using GetCapabilities.
2. return GetCapabilities. The WMS returns the capabilities.
3. The client queries the WMS for layer descriptions by using DescribeLayer
4. The WMS return descriptions of its layers including the relevant feature types

5. The client queries a SLD-WMS for (its internal) data schema by usind DescribeFeatureType.
6. SLD-WMS returns the schema.
7. Client queries CS-W for suitable styles
8. CS-W returns style IDs
9. Compose GetMap request. User uses the client to assemble an SE document.
10. GetMap. Client submits the request to WMS service.
11. Retrieve data. Integrated WMS extracts necessary data from its internal data store
12. Retrieve style. Integrated WMS extracts the style reference from the request and - if necessary - submits the appropriate request to the CS-W.
13. CS-W responds with the SE document
14. Integrated WMS extracts the symbol references from the SE style.
15. Integrated WMS makes the request to retrieve the referenced symbol
16. Integrated WMS receives the symbol
17. Integrated WMS portrays the features using the retrieved style and symbol
18. Integrated WMS returns the image to the client.

5.5 Symbology Encoding documents and Symbols

Symbology Encoding (SE) is an XML language for describing styling information that can be applied to digital Feature and Coverage data.

The goal in designing Symbology Encoding was to isolate the feature style description from other information relevant to map creation. The scope of the SE encoding can be visually depicted as in the following diagram:

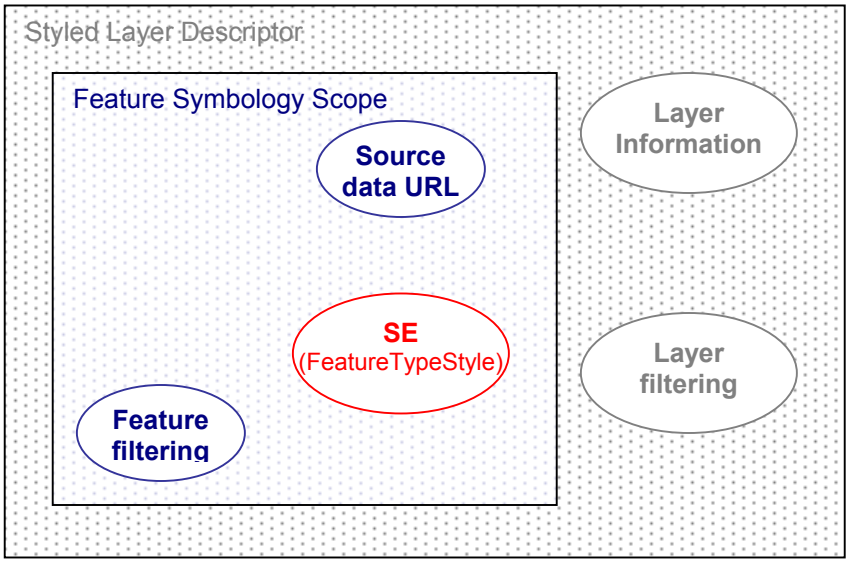

Figure 6 – Feature Symbology scope

The definition of the Symbology Encoding, based on the previous portrayal work in OGC, is very simple: It is the sld:FeatureTypeStyle and sld:CoverageStyle part of the SLD encoding. Symbology Encoding is defined in OGC document 05-077r4.

6 Outlook and future directions

With Symbology Encoding and SLD-profile of WMS the missing link between SLD and WMS is again established. Publications of both documents as public standards is expected in the near future. As SLD-profile of WMS also defines the interfaces of Feature Portrayal Service and Coverage Portrayal Service, the need for a separate specification does not exist any more.

Additional work for the future lies in a definition of a well-defined registry model for portrayal information and harmonization between SE/SLD and other OGC standards defining portrayal-related information e.g. Web Map Context or the default styling mechanism of GML. Another issue worth considering is the definition of conformance classes for Symbology Encoding, because its complexity (e.g. use of functions) results in the fact that almost no implementations of it will support all constructs defined and therefore interoperability is hard to achieve. Definition of a set of "basic" SE constructs (similar to GeoRSS or the Simple Feature profile of GML) might therefore be helpful.

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