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OWS1 Coverage Portrayal Service

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i. Preface

ii. Submitting organizations

This Interoperability Program Report – Engineering Specification is being submitted to the OGC Interoperability Program by the following organizations:

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iv. Revision history

Date	Release	Author	Paragraph modified	Description
2001-12-14	0.0.1	JL		Initial version.

2002-03-29	0.0.2	JL		Minor cleanup of entire document.

v.   Changes to the OpenGIS® Abstract Specification

The OpenGIS© Abstract Specification does not require changes to accommodate the technical contents of this document.

Foreword

OGC 01-xxx consists of the following parts, under the general title *OGC Web Services —
Coverage Portrayal Service*:

– *Part 1: Main body*

Introduction

This document describes a service -- called a Coverage Portrayal Service -- composed of standard interfaces that makes it possible to portray coverage data. The service is intended to operate within the context of existing OGC services and their clients. It operates as a client of an existing service that supplies coverage data. And it operates as a service for an existing type of geospatial client.

By bundling together the client sides of some interfaces, and the server sides of other interfaces, the Coverage Portrayal Service becomes an intermediary service. As an intermediary service, this service raises interesting questions about how services can and/or should be connected together. How much should a client of an intermediary service have to know about the remote service which it connects to? And how can it find out what it needs to know?

OWS1 Coverage Portrayal Service (CPS)

1   Scope

The Coverage Portrayal Service is intended to operate within the context of OGC Web
Services.

2   Conformance

Conformance and Interoperability Testing for this OGC Interoperability Program Report
may be checked using all the relevant tests specified in Annex A (normative). The
framework, concepts, and methodology for testing, and the criteria to be achieved to
claim conformance are specified in ISO 19105: Geographic information — Conformance
and Testing.

3   Normative references

The following normative documents contain provisions which, through reference in this
text, constitute provisions of this part of OGC 01-xxx. For dated references, subsequent
amendments to, or revisions of, any of these publications do not apply. However, parties
to agreements based on this part of OGC 01-xxx are encouraged to investigate the
possibility of applying the most recent editions of the normative documents indicated
below. For undated references, the latest edition of the normative document referred to
applies.

Abstract Specification Topic 0: Overview, OGC document 99-100r1

Guidelines for Successful OGC Interface Specifications, OGC document 00-014r1

4   Terms and definitions

For the purposes of this document, the following terms and definitions apply.

4.1
coverage
object that associates one or more attribute values to any direct position within its
spatiotemporal domain

4.2

coverage component
synonyms: band, dimension

a notional sub-part of a coverage, associated either with its attribute values, or with the positions within its spatiotemporal domain

4.3

coverage data
data which is represented as a coverage

4.4

coverage transfer format
an encoding for coverages, used to transfer the coverages from one computer or another (examples are HDF-EOS, NITF, and netCDF)

4.5

data
reinterpretable representation of information in a formalized manner suitable for communication, interpretation, or processing

4.6

portrayal
presentation of information to humans

5   Conventions

5.1   Symbols (and abbreviated terms)

The following symbols and abbreviated terms are used in this document.

OGC   Open GIS Consortium

XML   eXtended Markup Language

CPS   Coverage Portrayal Service

WMS   Web Map Service

SLD   Styled Layer Descriptor

WCS   Web Coverage Service

WFS   Web Feature Service

SRS   Spatial Reference System

BBOX   Bounding Box

6   Coverage Portrayal Service

6.1   Abstract

The CPS is an OGC Processing Service that adds value to the products of a Web Coverage Service. The CPS links together WMS clients and WCS services, using SLD as a service language. The CPS interfaces are slight extensions or restrictions of the corresponding WMS interfaces.

6.2   Purpose

The purpose of the CPS is to provide a standard interface for producing visual pictures from coverage data.

6.3   The CPS Operational Concept

The CPS integrates into the OGC architecture by implementing two standard OGC interfaces, the WMS interface and the WCS interface. Figure 6.3.1 shows this integration. The Engineering View format that this figure uses is taken from the OGC Services Abstract Specification[1] and the OGC Web Services Initiative - Reference Architecture for Phase 1 Testbed DIPR. The dashed lines in the figure represent networks.

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[1] Topic 12 - The OpenGIS Service Architecture, Versions 4.3, http://www.opengis.org/techno/abstract/02-112.pdf
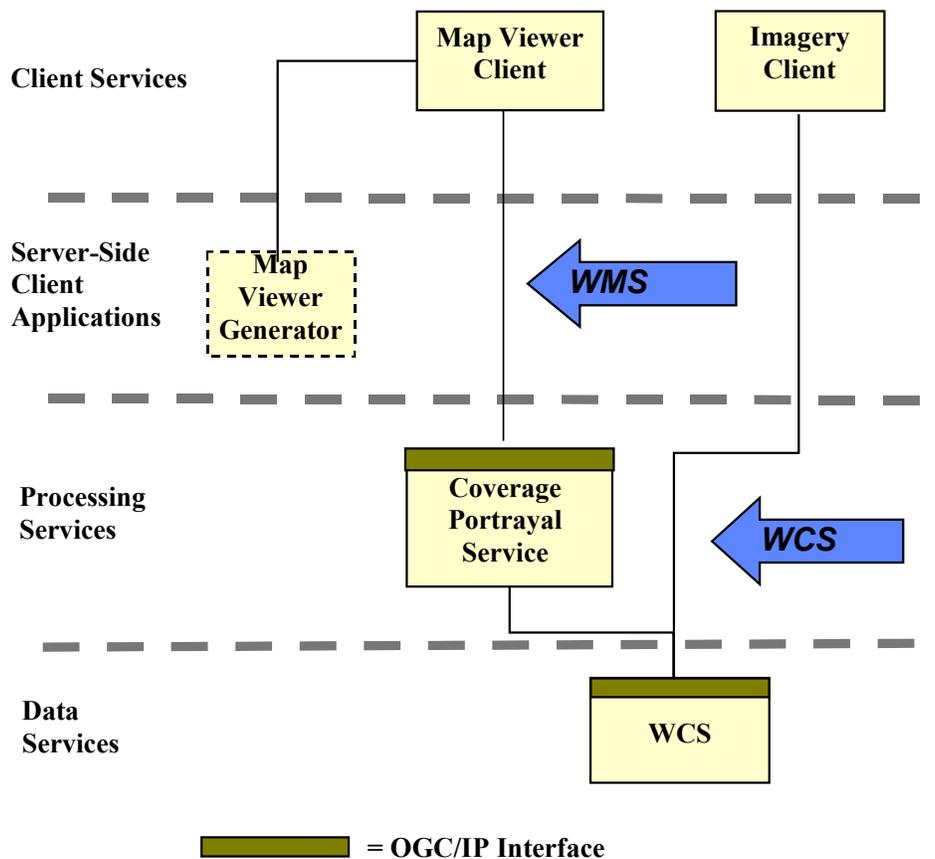
Figure 6.3.1.

Figure 6.3.1 shows how a thin WMS map viewer client, which has been generated on the fly by a server-side client generator, can use the services of a WCS by connecting through a CPS.

6.4 Use Case

6.4.1 Description

This use case presents the steps that might take place during a typical CPS session.

6.4.2 Pre-conditions

In this use case there are three components:

- A WCS that provides a swath coverage

- A CPS that styles a swath coverage

- A client that knows how to define an SLD for a coverage, can make WMS-SLD GetMap requests, and can display the GetMap request to a human.

6.4.3 Post-conditions

The result is a visual representation of the swath coverage in a form that can be overlaid with additional WMS map layers. Figure 6.4.1 shows an example of a georectified swath coverage that has been overlaid with an additional map layer showing watercourses. This map layer has been requested from a separate WMS.
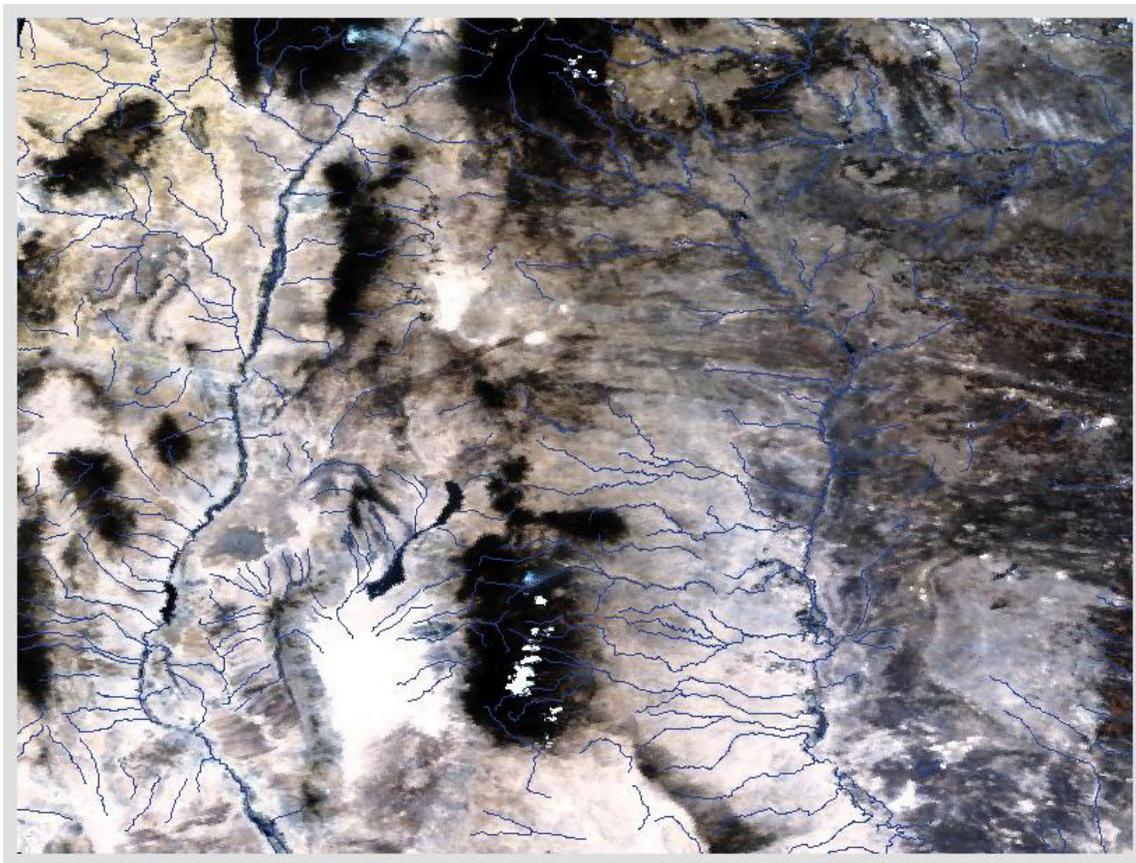
Figure 6.4.1. Layering of watercourses over a portrayed coverage

6.4.4 Flow of events

1) A Web Coverage Service (WCS) publishes a layer containing a multi-band swath of data located in some region.

2) A client finds that the published layer overlaps with its current region of interest and wishes to view the data in that layer graphically in order to determine if it bears further analysis, or further processing.

3) The client finds a CPS and decides to ask it to provide a view of the data that can be overlaid with familiar map features.

4) The client builds a Styled Layer Descriptor (SLD) raster descriptor that assigns red to band 3 of the swath data from the WCS in question, green to band 2, and blue to band 1.

5) The client formulates a Web Map Service (WMS) request which includes (alternately, refers to) the raster descriptor, together with a WIDTH, HEIGHT, BBOX, SRS, and so on.

6) The client issues the WMS request to the CPS.

7) The CPS receives the WMS request from the client, fetches the SLD if need be, and formulates a WCS request for the data from the bands which were mentioned in the SLD that covers the BBOX which was mentioned in the WMS request, and submits the WCS request.

8) The WCS returns the requested coverage data to the CPS. If necessary the CPS geolocates the data in the requested BBOX and SRS, applies the SLD to produce an image of the requested sort, with the requested WIDTH and HEIGHT, and returns the image to the client.

6.5   CPS and SLD

The CPS uses SLD as a language to request a specific portrayal. In addition to request parameters, which serve to qualify the request action, additional information has to be provided to the CPS for it to be able to do its work. This additional information can tell the CPS

1. where to get the coverage that the client is interested in,

2. what part or parts of the coverage data to work with, and

3. how the client wants the CPS to portray that data.

SLD is used to express this additional information. The rationale for this is that (3) above is a sort of user-defined "styling" of (part of) the coverage data.

There is a parallel between the way that a client can direct a CPS to use data from a WCS, and the way that a client can direct a WMS to use data from a WFS. Using SLD for both CPS requests and WMS requests exploits this parallel.

The parts of the SLD that affect (3) above are contained in the SLD RasterSymbolizer element. The following subsections discuss some relevant aspects of this element.

6.5.1   Histograms and mapping bands to colors

Regarding the question of how selecting the histogram option affects the mapping of bands to RGB, the current SLD has this documentation:

ContrastEnhancement: Defines contrast enhancement for a channel of a false-color image or for a color image. In the case of a color image, the relative greyscale brightness of a pixel color is used. "Normalize" means to stretch the contrast so that the dimmest color is stretched to black and the brightest color is stretched to white, with all colors in between stretched out uniformly. "Histogram" means to stretch the contrast based on a histogram of how many colors are at each brightness level on input, with the goal of producing equal number of pixels in the image at each brightness level on output. This has the effect of revealing many subtle ground features.

This document adopts the position that histogram equalization should be applied independently to each channel. In this way, assigning colors and doing histogram equalization are independent ("orthogonal") operations.

The RasterSymbolizer allows independent contrast enhancement per channel and contrast enhancement for the final image as a whole. The per-channel contrast enhancement is selected using the "RasterSymbolizer/ChannelSelection/*/ContrastEnhancement" and the overall contrast enhancement is selected with RasterSymbolizer/ContrastEnhancement".

The exact method of histogramming the overall image is up to the implementation, but a suggested interpretation is to assign intensities to pixels based on the usual formula

$$0.299 * red + 0.587 * green + 0.114 * blue$$

and to change the result intensity by multiplying all components of an RGB pixel by the same amount.

6.5.2 Mapping of categories via a color lookup table

The SLD 0.7.2 documentation says this:

ColorMap: Defines either the colors of a pallet-type raster source or the mapping of numeric pixel values to colors. For example, a DEM raster giving elevations in meters above sea level can be translated to a colored image with a ColorMap. ColorMap entries should be in order of increasing numeric quantity so that intermediate numeric values can be matched to a color (or be interpolated between two colors). Labels may be used for legends or may be used in the future to match character values. Not all systems can support opacity in colormaps. The default "opacity" is 1.0 (fully opaque). Defaults for "quantity" and "label" are system-dependent.

So if the categories are indexed numerically, then they can be handled by SLD.

7

6.5.3 Thematic map rendering

The CPS needs to get the category classification from WCS for a thematic map in order to be used for thematic map rendering. Distinction needs to be done between nominal classification and ordinal classification.

This information may be available to the CPS if the WCS supports a GetCoverageLayerDescription interface. That interface would return a coverage layer description encoded in XML that would include RangeDimension information (sample dimension) associated with a reference system (nominal, ordinal, interval or ratio).

6.5.4 Other portrayal options

There are other portrayal options, such as hillshading and contouring of coverage data, that are not included here.

6.6 CPS and WCS

If a CPS is to portray coverages using a user-defined styling, it is necessary to understand what is to be the source of the coverage data. Different relations between this data source and the CPS should be permitted. For example a CPS might portray coverage data stored in a remote Web Coverage Server (WCS) or it might only be able to style data from a specific default coverage store.

SLD allows a user to direct the CPS to use a remote WCS; this represents the simplest relationship between a CPS and a WCS. However there is a wide range of other possible relationships. To clarify the discussion, this document introduces the concept of 'component' and 'integrated' services:

- Component services: these are services designed to be loosely coupled and work in any combination. For example, a component CPS can portray coverage data from any WCS to which it is directed. A component service is synonymous with a loosely-coupled service as defined in the OGC Service Architecture[2]

- Integrated services: these are services that are closely coupled and can only work in particular configurations. For example, an integrated CPS might only be able to portray coverage data from the WCS with which it is integrated. A component service is synonymous with a tightly-coupled service as defined in the OGC Service Architecture[3]

A loosely-coupled CPS may have an association with specific coverage type as identified in the service type definition. In the tightly-coupled case, the CPS service metadata

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[2] Clause 7.4.1, Topic 12 - The OpenGIS Service Architecture, Versions 4.3

[3] Clause 7.4.1, Topic 12 - The OpenGIS Service Architecture, Versions 4.3

describes both the service and the coverage. Also for the tightly-coupled case, the permitted values in the operations shall be constrained by the values defined by the coverage associated with the CPS. For the loosely-coupled case, dataset metadata need not be provided in the service metadata.

Whether a particular service is a 'component' or 'integrated' service says something about how it is implemented. For example a CPS is a 'valid' OGC CPS provided it correctly supports the CPS interfaces. This makes no assumptions about how the CPS is implemented. However, a 'component' CPS that can portray coverage data from any WCS only interacts with the data through the WCS interfaces, and this does say something about the implementation. Of course, it is not important what type of WCS (component or integrated) that a component CPS is directed to. There will be a spectrum of CPS implementations with the ability to support user-defined styling. This is best illustrated by describing in more detail what might be considered the 'two ends' of the spectrum, represented by a 'component' CPS at one end and 'integrated' CPS at the other.

- Component CPS

  Essentially a portrayal engine that can portray coverage data obtained from one or more remote WCS services. Typically it has these characteristics:

  - A component CPS probably has no pre-defined 'named' layers or styles.

  - A component CPS only supports the CPS interfaces.

  - A component CPS can portray coverage data from any compliant WCS or from any compliant WCS serving a specific type of coverage data type.

  - A component CPS supports both user-defined styles and user-defined layers.

- Integrated CPS

  This is a service representing a closely coupled coverage store and a portrayal engine. Typically it has these characteristics:

  - An integrated CPS probably has pre-defined 'named' layers and styles.

  - An integrated CPS supports the CPS interface and the **DescribeCoverageType** request of the WCS interface.

  - An integrated CPS can only portray coverage data from its own internal coverage store.

  - An integrated CPS might only support user-defined styles being applied to pre-defined 'named' layers.

Whether one is using a component or integrated CPS, it must be possible to interrogate (albeit at a relatively superficial level) the underlying coverage store. This is because user-defined styling makes use of concepts not previously required by WCS. User-defined styling needs to be able to define new layers and styles using coverage types and coverage-type properties. For example, a new layer might be defined as all the coverages of a particular coverage type.

The underlying coverage store is interrogated using the WCS interface. For a component CPS this is not a problem, since the coverage store is indeed a remote WCS. For an integrated CPS, the server must support both the CPS interface and a minimal set of WCS operations. It must support the **DescribeCoverageType** request. This describes the properties of a coverage type specified by name in the request. And, if the CPS supports user-defined layers, then it must support the WCS **GetCapabilities** request. For a WCS this returns, among other things, the names of all the coverage types supported by the WCS. Together these two WCS requests allow clients to retrieve all of the information that they will require in order to construct user-defined styling.

It is also necessary to indicate where a CPS should find the coverage data that is to be portrayed. This is done using the following rules:

1. if the SLD specifies a WCS in the **WCS** attribute of the **UserLayer** element then it should be used; otherwise

2. the CPS should use a default WCS.

This approach does not permit coverages from different WCS services to be included in the same styled layer; however, it does allow different styled layers to be based on coverage data from different WCS instances. The first two options should only be used for a CPS that can be 'directed' to a remote WCS. The CPS will advertise this ability in response to a **GetCapabilities** request. For an integrated CPS, the default WCS is just the one with which it is integrated. However, there is no reason why a component CPS should not have a default WCS defined.

6.7 CPS and coverage transfer formats

The WCS takes the position that a number of coverage transfer formats are currently in use in the geospatial community, and that it should not legislate which of these to use[4]. Of course for these transfer formats to be used by a CPS, they must be well defined. But from the point of view of the CPS (or of any automated client of a WCS, for that matter) there is an even more important requirement. Most of these formats are quite flexible, in that they allow the same data to be encoded in more than one way. So not only does there need to be a well-known definition of the transfer format, but also it is critical to have a mapping from each of the formats which a WCS supports to some kind of common

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[4] Note that Coverages are defined in OGC Abstract Specification Topic 6 - The Coverage Type.

definition, which tells how the format is being used. Otherwise it is difficult or (more likely) impossible for the CPS to determine where the WCS has put the data that the client needs.

The common definition would allow a CPS client to make definite references to parts of the coverage which are encoded in the coverage transfer format, without having to know in advance (perhaps by some out of bandagreement) how the transfer format was being used. In other words, the coverage can have a number of different domain and range components, the transfer format can define a number of different structural parts, and the common definition needs to say which coverage components are encoded in which structural parts of the transfer format.

For an abstract illustration of this, assume we have two transfer formats, format H and format N, which transfer coverage data in structures Struct H and Struct N. (The parts of the structures are labelled using sequences of alternating horizontal and vertical 1-based indices.)

Struct H

Struct N

Also assume that there is a common definition. This means that there is a common structure Struct C, and a known semantics for the parts of the structure. So Struct C might look like this:

1,1,1	1,1,2
1,2	

Struct C

and the known semantics might be this:

1,1,1 = domain dimension 1

1,1,2 = domain dimension 2

1,2 = range dimension 1

Now what is required is a know mapping from the common structure, Struct C, to each of the transfer format structures. For example, the mapping to Struct H might be this:

Struct C to Struct H

1,1,1 = 2,2,1

1,1,2 = 2,2,2

1,2 = 2,3

This would allow a user to talk about, say, domain dimension 1, and the automated client would know that, if it was dealing with a coverage encoded in Struct H, that what was meant was the data in part 2,2,1 of the structure.

Of course Struct H might have its own semantics, for example:

1,1 = some metadata

1,2 = some more metadata

2,1 = some dimension

2,2,1 = some other dimension, and so on.

While this semantics may be useful in its own right to some users of the coverage data, and should be compatible with the semantics that is implied by the mapping above, it

does not in itself solve the problem of allowing a user to refer to interesting parts of the coverage data in an open and unambiguous way.

7 CPS Service Interfaces

The CPS interfaces modify the corresponding WMS interfaces in the following way. The CPS GetCapabilities interface extends the WMS GetCapabilities interface because the CPS needs to say something about its ability to interact with a WCS. The CPS GetMap interface restricts the WMS GetMap interface because the CPS requires SLD in order to function in a meaningful way.

7.1 GetCapabilities

The CPS capabilities response needs to say

1. what parts of SLD are supported,

2. what coverage transport formats are supported, and

3. whether the CPS can do georectification.

It would be useless for a client to direct a CPS to request data from a WCS when that WCS only supported coverage transport formats that the CPS could not handle. Therefore it should be possible for the client to discover in advance if the CPS and the desired WCS are incompatible in this way. A similar argument applies in the case of georectification. If a WCS only supplies ungeorectified data, and the CPS does not support georectification, then the client should be able to discover that fact.

NOTE: The schema for the CPS GetCapabilities request has not yet been defined.

7.2 GetMap

The parameters to the CPS GetMap request are identical to the parameters of the WMS GetMap request. However, because the purpose of the CPS is to portray coverages, additional user-styling information needs to be encoded into SLD, and supplied with a CPS GetMap request.

The following diagram illustrates the interaction between the CPS client, the CPS, and the WCS with respect to the GetMap request parameters.
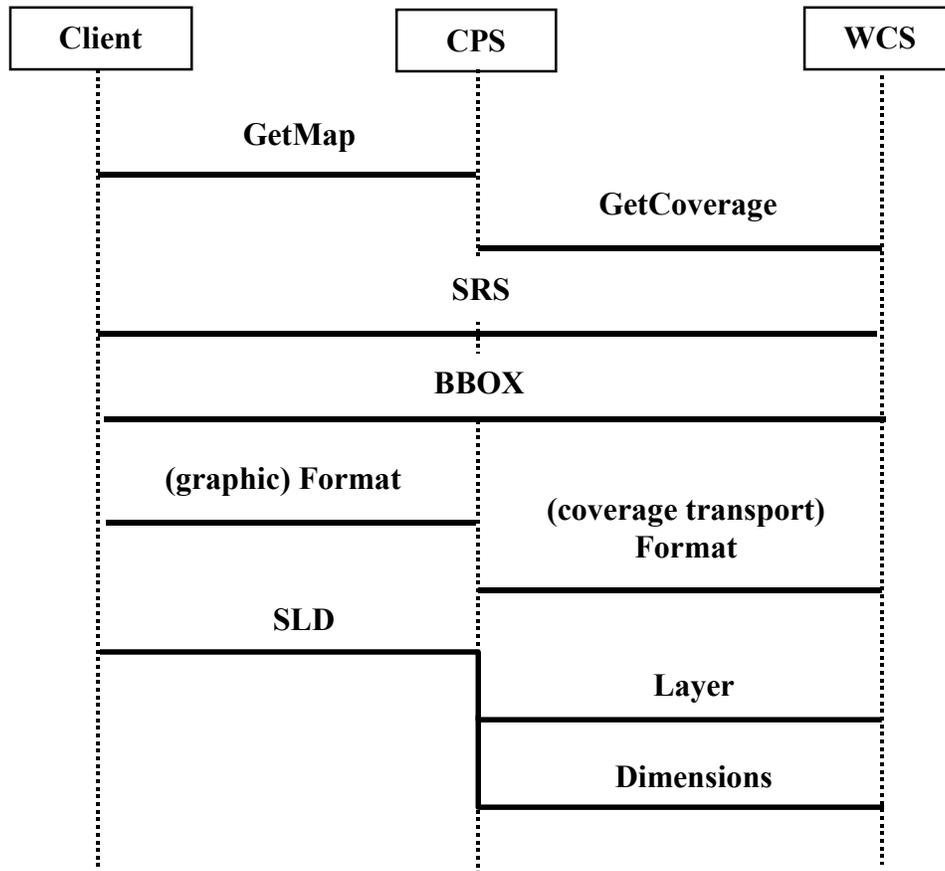
Figure 7.2.1.

As shown in Figure 7.2.1, some of the parameters that the CPS sends to the WCS are identical to the parameters that it gets from its client, some of the parameters it sends are derived from the parameters that it gets, and some of the parameters that it sends have to be extracted from the SLD Of the parameters that are extracted from the SLD, some are used for portrayal, while some are used to derive other parameters for the WCS.

The following example shows how the interaction shown in Figure 7.2.1 would happen in a particular case.

7.2.1 GetMap example

In this example the CPS receives the GetMap request that is listed below, and generates the following WCS coverage request based on it:

```
VERSION=1.0.3&
REQUEST=coverage&
LAYERS=mod2.hdf:SWATH:MODIS_SWATH_Type_L1B:EV_1KM_RefSB&
SRS=EPSG:4326&
BBOX=-106.38,38.78,-103.36,40.55&
Band_1KM_RefSB=1/3/1&
```

FORMAT=HDFEOS

and sends that coverage request to this URL:

http://heineken.gsfc.nasa.gov:8080/cgi-bin/dib/wcshdfeos?

by performing the following steps.

1. It finds the GetMap/StyledLayerDescriptor/UserLayer/RemoteOWS/OnlineResource from the (SLD portion of the) request and fetches a capabilities document from there.

2. It gets the OnlineResource for HTTP GET from the capabilities document, which it will use as the URL from which to request a coverage.

3. It finds the GetMap/StyledLayerDescriptor/UserLayer/LayerFeatureConstraints/FeatureType Constraint/FeatureTypeName, and tries to find the corresponding layer in the WCS capabilities document.

4. It finds all the contents of RasterSymbolizer/*/SourceChannelName elements and, using the convention that if such a content looks like

    bandname.bandnumber

    then it looks for a Dimension in the layer named "bandname" that has an extent that includes "bandnumber". (Note that this convention is totally ad hoc. Perhaps SLD 0.7.2 should provide separate elements for the dimension name and the channel name.)

To make this more specific, assume the layer in question looks like this:

```
<Layer queryable="1">
 <Name>mod2.hdf:SWATH:MODIS_SWATH_Type_L1B:EV_1KM_RefSB</Name>
 <Title>EV_1KM_RefSB</Title>
 <Abstract/>
 <Keywords/>
 <SRS>EPSG:4326</SRS>
 <LatLonBoundingBox minx="-120.093803" miny="21.792076" maxx="-90.692970"
maxy="42.964756"/>
 <Dimension name="Band_1KM_RefSB" units="None"/>
 <Extent name="Band_1KM_RefSB" default="1/15/1">1/15/1</Extent>
 <DataURL>http://heineken.gsfc.nasa.gov:8080/cgi-
bin/dib/dib_view/hdf?mod2.hdf&amp;HDFEOS&amp;SWATH|MODIS_SWATH_Type_L1B&amp;
FIELD|EV_1KM_RefSB  </DataURL>
</Layer>
```

and the request has this:

```
<sld:RedChannel>
  <sld:SourceChannelName>Band_1KM_RefSB.3</sld:SourceChannelName>
</sld:RedChannel>
```

and the layer has a Dimension with name = Band_1KM_RefSB

and the corresponding Extent goes from 1 to 15, which includes 3.

The complete WMS GetMap request is listed here:

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- User-defined layer from SLD WMS accessing a WCS -->
<GetMap xmlns="http://www.opengis.net/ows" xmlns:gml="http://www.opengis.net/gml"
xmlns:sld="http://www.opengis.net/sld" xmlns:wfs="http://www.opengis.net/namespaces/wfs"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/ows
../ows1/webmapping/wms/GetMap.xsd" version="1.2.0" service="WMS">
  <sld:StyledLayerDescriptor version="0.7.2">
   <sld:UserLayer>
    <sld:RemoteOWS>
     <sld:Service>WCS</sld:Service>
     <sld:OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink" xlink:type="simple"
xlink:href="http://heineken.gsfc.nasa.gov:8080/cgi-bin/dib/wcshdfeos?"/>
    </sld:RemoteOWS>
    <sld:LayerFeatureConstraints>
     <sld:FeatureTypeConstraint>

<sld:FeatureTypeName>mod2.hdf:SWATH:MODIS_SWATH_Type_L1B:EV_1KM_RefSB</sld:FeatureTypeName>
     </sld:FeatureTypeConstraint>
    </sld:LayerFeatureConstraints>
    <sld:UserStyle>
     <sld:FeatureTypeStyle>
      <sld:Rule>
       <sld:RasterSymbolizer>
        <sld:ChannelSelection>
         <sld:RedChannel>
          <sld:SourceChannelName>Band_1KM_RefSB.3</sld:SourceChannelName>
         </sld:RedChannel>
         <sld:GreenChannel>
          <sld:SourceChannelName>Band_1KM_RefSB.2</sld:SourceChannelName>
         </sld:GreenChannel>
         <sld:BlueChannel>
          <sld:SourceChannelName>Band_1KM_RefSB.1</sld:SourceChannelName>
         </sld:BlueChannel>
        </sld:ChannelSelection>
       </sld:RasterSymbolizer>
      </sld:Rule>
     </sld:FeatureTypeStyle>
    </sld:UserStyle>
```

```
    </sld:UserLayer>
  </sld:StyledLayerDescriptor>
  <BoundingBox srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
   <gml:coord>
     <gml:X>-106.38</gml:X>
     <gml:Y>38.78</gml:Y>
   </gml:coord>
   <gml:coord>
     <gml:X>-103.36</gml:X>
     <gml:Y>40.55</gml:Y>
   </gml:coord>
  </BoundingBox>
  <Output>
   <Format>image/gif</Format>
   <Transparent>true</Transparent>
   <Size>
     <Width>640</Width>
     <Height>480</Height>
   </Size>
  </Output>
  <Exceptions>application/vnd.ogc.se+inimage</Exceptions>
</GetMap>
```

8 Future Work

Future work on CPS falls into three areas.

8.1 Separation of Concerns.

The information contained in a request to the CPS can be separated into information related to service coordination, information related to control of the functionality provided by a remote service, and information related to the control of the portrayal functions which the CPS provides. Currently these three kinds of information are conflated together in two different ways.

8.2 Capabilities Definition

The CPS needs to be able to make it clear what its capabilities are. The current assumption behind the use of SLD in general is that an SLD-enabled service should make a "best effort" attempt to comply with requests that use SLD. But it could be useful if there was a way to guide a client's expectations as to what a "best effort" might entail. Currently there is now way to say what part of SLD a service supports, and what part not. There is not yet a language for doing this, but the notion of binding templates would seem to be applicable here.

8.3 WCS Interaction

The interaction of the CPS with the WCS needs to be refined, with respect to the following issues.

- What kind or kinds of coverages are available? Are they gridded or not? Are they georectified or not? This future work should draw on the development of coordinate reference system identifiers for sensor CRS's and geographic CRS. This work is to better define the domain of the coverage. Options for providing a sensor CRS or a grid of geographic lat/long points should be accommodated.

- What kinds of attributes does the coverage offer? This is the range question. Distinction needs to be done between nominal classification and ordinal classification.

- What choices does the WCS make when it encodes coverage data into a coverage transfer format?