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OGC[®] OWS-5 Sub-setting Engineering Report

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Preface

Suggested additions, changes, and comments on this draft report are welcome and encouraged. Such suggestions may be submitted by email message or by making suggested changes in an edited copy of this document.

The changes made in this document version, relative to the previous version, are tracked by Microsoft Word, and can be viewed if desired. If you choose to submit suggested changes by editing this document, please first accept all the current changes, and then make your suggested changes with change tracking on.

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OGC[®] OWS-5 Sub-setting Engineering Report

1 Introduction

1.1 Scope

This OGC[®] document represents an OWS-5 SWE thread Engineering Report on subsetting georeferencable imagery. It discusses how to handle georeferencable imagery in the JPEG2000 format as well as using JPIP within the WCS-T and the SWE set of services.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The OGC shall not be held responsible for identifying any or all such patent rights.

1.2 Document contributor contact points

All questions regarding this document should be directed to the editor or the contributors:

Name	Organization
Steven Keens	PCI Geomatics

1.3 Revision history

Date	Release	Editor	Primary clauses modified	Description
2007-11-28	0.0.1	S. Keens	All	Initial revision
2007-12-10	0.0.1	S. Keens	Most	Added subclauses related to JPIP and WCS Transactions – pretty much everything.
2008-03-06				

1.4 Future work

Improvements in this document are desirable to [\[text\]](#).

2 References

The following documents are referenced in 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 03-013, *Web Object Service Implementation Specification (0.0.3)*

OGC 03-105r1, *OpenGIS® Geography Markup Language (GML) Encoding Specification 3.1.1*

OGC 05-047r3, *OpenGIS® GML in JPEG 2000 for Geographic Imagery Encoding Specification 1.0.0*

OGC 06-111, *GML 3.1.1 Grid CRSs Profile Corrigendum (1.0.1)*

OGC 06-121r3, *OpenGIS® Web Services Common Specification*

OGC 07-036, *OpenGIS® Geography Markup Language (GML) Encoding Specification 3.2.1*

OGC 07-067r2, *OpenGIS® Web Coverage Service (WCS) Implementation Specification Corrigendum 1 (1.1.1 c1)*

In addition to this document, this report includes several XML Schema Document files as specified in Annex B.

3 Terms and definitions

For the purposes of this report, the definitions specified in Clause 4 of the OGC referenced documents listed in clause 2 shall apply. In addition, the following terms and definitions apply.

4.1

georeferencable imagery

Imagery that is itself not rectified but may be rectified because of the metadata associated to the imagery.

4.2

term name

synonym

text of the definition

NOTE Note text.

4 Conventions

4.1 Abbreviated terms

JP2	JPEG 2000
JPIP	JPEG 2000 Interactive Protocol – JPEG2000 Part 9
MTOM	SOAP Message Transmission Optimization Mechanism
SensorML	Sensor Model Language
SwA	SOAP with Attachments
SWE	Sensor Web Enablement
WCPS	Web Coverage Processing Service
WCS	Web Coverage Service
WCS-T	Web Coverage Service Transactional
WCTS	Web Coordinate Transformation Service
WOS	Web Object Service
WPS	Web Processing Service

5 Georeferencable Coverages & JPIP in a WCS-T

The goal of the OWS-5 georeferencable workflow is to learn about the issues when using unrectified JPIP based coverages directly within workflows involving the WCS-T and the SWE set of services. The workflows are described in [7].

5.1 WCS-T Transactions

The OWS-5 SWE workflows require a WCS-T for disseminating JPIP imagery. The JPIP images are added to the WCS-T via the workflow. The JPIP images are then available to a WCS client able to read JPIP.

The WCS-T extension to the WCS 1.1.1 described in [2] is a good first attempt at adding transactions to the WCS. However, it has several flaws that could make it simpler to implement and easier to understand. The main flaw is that the WCS-T schemas are tightly bound to the WCS 1.1.1 schemas.

5.1.1 WCS-T XML Schema Modifications

The WCS-T XML Schemas from [2] are tightly coupled with the WCS 1.1.1 XML Schemas [OGC 07-067r2]. The current WCS-T schemas use constructs from the WCS 1.1.1 schemas, as well as the WCS-T schemas are in the same namespace.

The current WCS-T schemas are functional but should be modified to get better reuse from other versions of the WCS. To achieve that the WCS-T schemas should be

completely independent of the WCS schemas: by changing the namespace, and by using tags that are more meaningful.

The WCS-T XML Schemas went through two modifications. The first was a simple namespace change. The second was a complete overhaul. Note that due to time constraints the original WCS-T schemas from [2] were used in OWS-5.

Table 2 lists the XML Schema documents develop during OWS-5 for the WCS-T transactions. Those documents are contained in the ZIP package in which this file is contained.

Table 1 – WCS-T XML Schema Documents

WCS-T XML Schema Document	Changes
wcsTransaction07068r1.xsd <i>(Used in OWS-5 workflow)</i>	None Original from WCS-T extension specification [2].
wcsTransactionNewXmlNS.xsd	Only changed the target namespace: From: http://www.opengis.net/wcs/1.1.1 To: http://www.opengis.net/wcs-t/1.0.0
wcsTransactionDecoupled.xsd	Major changes to be more like transactions from Web Object Service (WOS). Completely eliminated the tight coupling between the WCS-T and the WCS 1.1.1. This new WCS-T schema should be usable by any WCS. Uses MTOM instead of SwA. See 5.1.2. Changed the target namespace: From: http://www.opengis.net/wcs/1.1.1 To: http://www.opengis.net/wcs-t/1.0.0
wcsAllTrans.xsd	New schema document to load all WCS-T schema documents.

5.1.2 MTOM and SwA

The OW-5 SWE thread participants discussed using MTOM and SwA in the WCS-T. They agreed to use MTOM where new XML Schemas were required and to continue to use SwA where it is already used.

The difference between MTOM and SwA are discussed in [6].

5.2 Adding a single JPIP based coverage to a WCS-T

Note: the information here (the text and examples) are based upon the draft WCS-T extension [2].

To add a Virtual JPIP Coverage to the WCS-T via a Transaction request the items listed in Table 2 are needed.

Table 2 – Items required to add a JPIP Coverage to a WCS-T

Item/Sub-Item	Why and How
CoverageDescription	<p>A coverage description is used to avoid requiring that the WCS-T access the JPIP image to extract metadata (which may be in a non-recognized format). Ideally that metadata should be given to the WCS in a standard format. That is best by using constructs the WCS already knows – in this case a coverage description.</p> <p>That is done via a <Reference> element pointing to an XML instance document valid against the <code>wcsCoverageDescription.xml</code> containing a single <CoverageDescription> element.</p> <p>The <Reference> can point to a remote location or to an attachment in a SwA request.</p>
CoverageDescription/ ImageCRS	<p>An <ImageCRS> is required because the workflow is for georeferencable imagery. The WCS uses an ImageCRS to indicate that the offered coverage is unrectified. The ImageCRS contains the image's size.</p>
CoverageDescription/ Transformation	<p>A Transformation is required because the workflow is for georeferencable imagery (unrectified). The transformation indicates how to transform the unrectified coverage to a rectified coverage.</p> <p>For OWS-5 the <code>wcsCoverageDescription.xml</code> schema has been modified because the <Transformation> element lacked the ability to reference a SensorML XML fragment containing a different encoding of the transformation. The modifications are in the file <code>wcsDescribeCoverageOws5.xsd</code>.</p> <p>The difference between <code>wcsCoverageDescription.xml</code> and <code>wcsDescribeCoverageOws5.xsd</code> is the addition of the choice between the original <Transformation> element and the <OtherTransformation> element.</p> <p>See subclause 5.3 for more details.</p>
JPIP Image/URL	<p>The WCS server needs to identify the actual JPIP image the coverage is based upon.</p> <p>That's done via the following XML fragment in the transaction:</p> <pre data-bbox="553 1331 1365 1528"><Reference xlink:role="urn:ogc:def:role:WCS:1.1:Pixels" xlink:href="JPIP URL GOES HERE"> <Format>image/jp2; type=urn:ogc:def:wcs:jp2:1.0.0:jpip</Format> </Reference></pre> <p>The JPIP URL is identified by the <code>xlink:role</code> value <code>urn:ogc:def:role:WCS:1.1:Pixels</code></p> <p>Example URL: <code>http://www.jpipserver.com/image.jp2?fsiz=5000,4000&roff=100,50</code></p>
JPIP Image/Subset	<p>Indicate the subset of the JPIP image that is represented by the coverage. That's done within the coverage description using the bounding box in the Image CRS.</p> <p>Set the bounding box in the ImageCRS to (0, 0, sx, sy).</p> <p><code>fsize=fx,fy</code> parameter is the source image's full frame size at resolution level 0. That's needed to convert the GetCoverage request spatial</p>

	<p>domain subset to the corresponding window in the image on the JPIP server. The fsize parameter corresponds to the frame sizes, fx and fy, in the diagram below. It goes in the JPIP URL.</p> <p>roff=ox,oy parameter is the offset of the virtual coverage within the JPIP frame. This value is needed so that we can use relative coordinates (starting at 0, 0) within the coverage description. It goes in the JPIP URL</p>

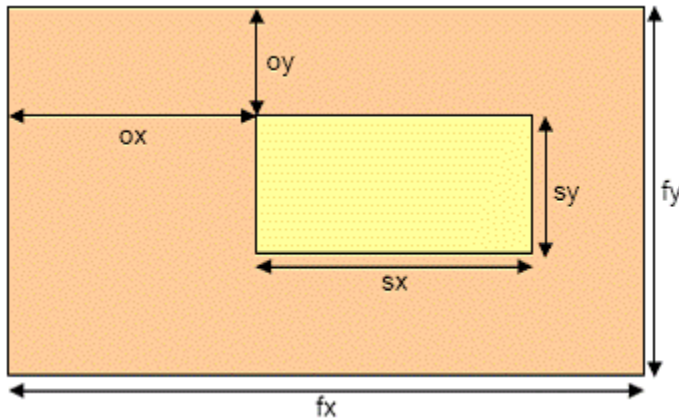


Figure 1: JPIP image offsets and dimensions.

5.2.1 WCS-T JPIP Transaction Request

Example 1 shows an XML encoded WCS-T Transaction request for adding a JPIP based Coverage where the coverage description is on a remote server.

EXAMPLE 1 Add JPIP based coverage where Coverage Description is remote

```
<?xml version="1.0" encoding="UTF-8"?>
<soap:Envelope
xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
<soap:Body>

<Transaction service="WCS" version="1.1.1"
  xmlns="http://www.opengis.net/wcs-t/1.0.0"
  xmlns:wcst="http://www.opengis.net/wcs-t/1.0.0"
  xmlns:wcs="http://www.opengis.net/wcs/1.1.1"
  xmlns:ows="http://www.opengis.net/ows/1.1"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wcs/1.1.1
    ../wcsTransaction.xsd">
  <InputCoverages>
    <wcs:Coverage>
      <ows:Title>Add</ows:Title>
      <ows:Reference
```

```

xlink:href="http://www.jpipserver.com/image.jp2?fsiz=5000,4000&ro
ff=100,50"
    xlink:role="urn:ogc:def:role:WCS:1.1:Pixels">
    <ows:Format>image/jp2;
type=urn:ogc:def:wcs:jp2:1.0.0:jpip</ows:Format>
    </ows:Reference>
    <ows:Reference
        xlink:href="http://someserver/coveragedescription.xml"
xlink:role="urn:ogc:def:role:WCS:1.1:CoverageDescription"/>
    </wcs:Coverage>
    </InputCoverages>
</Transaction>

</soap:Body>
</soap:Envelope>

```

Note the `<ows:Format>image/jp2;`
`type=urn:ogc:def:wcs:jp2:1.0.0:jpip</ows:Format>` element. It exists to
tell the server that the image being added is a JPIP based image and that the server
shouldn't retrieve the image. It just needs to keep the reference.

5.2.2 WCS-T JPIP Transaction Acknowledgement

Example 1 shows an acknowledgement that does not contain a copy of the transaction
request. The acknowledgement is used when an asynchronous response is requested.

EXAMPLE 1 Acknowledgement response when for asynchronous transaction.

```

<?xml version="1.0" encoding="UTF-8"?>
<soap:Envelope
xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
<soap:Body>

<wcst:Acknowledgement
    xmlns:wcst="http://www.opengis.net/wcs-t/1.0.0"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://www.opengis.net/wcs-t/1.0.0
        ../wcsTransaction.xsd">
    <wcst:TimeStamp>21-12-17T09:30:47-05:00</wcst:TimeStamp>
    <wcst:TransactionId>T-ABCD-1</wcst:TransactionId>
</wcst:Acknowledgement>

</soap:Body>
</soap:Envelope>

```

5.2.2.1 Acknowledgement TransactionId

The acknowledgement requires some form of session or transaction identifier. The
reason is that when the WCS-T sends a final response (see 5.2.3) the client may need to

be able to associate the final response with the request. The WCS-T draft does not contain such a mechanism.

The draft XML Schema document, `wcsTransactionDecoupled.xsd`, adds a mandatory `<TransactionId>` element in the acknowledgement. The `TransactionId` is used to associate the request to this acknowledgment and to the final response for asynchronous transactions.

5.2.3 WCS-T JPIP Transaction Final Transaction Response

This example shows the XML for a WCS-T Transaction response after adding a Virtual JPIP Coverage. This is the final response from a WCS-T to a transaction request and is sent to the client either synchronously or asynchronously.

```
<?xml version="1.0" encoding="UTF-8"?>
<soap:Envelope xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
<soap:Body>

<Coverages transactionId="T-ABCD-1"
  xmlns="http://www.opengis.net/wcs/1.1.1"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:ows="http://www.opengis.net/ows/1.1"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wcs/1.1.1
    ../wcsCoverages.xsd
    http://www.opengis.net/ows/1.1
    ../../../../ows/1.1.0/owsAll.xsd">
  <Coverage>
    <ows:Title>Add</ows:Title>
    <ows:Reference xlink:href="null"
      xlink:role="urn:ogc:def:role:WCS:1.1:CoverageDescription">
      <ows:Identifier>new_cov_desc_identifier</ows:Identifier>
    </ows:Reference>
  </Coverage>
</Coverages>

</soap:Body>
</soap:Envelope>
```

5.2.3.1 New Coverage's Identifier

Notice that the new coverage identifier is in the `<ows:Identifier>new_cov_desc_identifier</ows:Identifier>` element. That is a change from what the WCS-T extension specification [2] dictates. The reason for the change is that it:

- a) Eliminates the need to transmit the coverage description in the transaction response.
- b) Allows the client to retrieve the coverage description from the server using a preferred request encoding.

5.2.3.2 Final Response TransactionId

For asynchronous transactions the final response needs to contain a reference to the TransactionId. The transaction identifier associates the final response, the request, and the acknowledgement.

To that end the new element `<TransactionId>` has been added to another new element `<Coverages>` in the `wcsTransactionNewXmlNs.xsd` XML Schema document.

The fully decoupled version has a `<TransactionResponse>` element containing the Transaction identifier.

5.3 ImageCRS & Transformations

The OWS-5 SWE scenario requires the use of georeferencable imagery; and the WCS 1.1.1 specification mandates that a coverage description for unrectified imagery use an ImageCRS and Transformation. To also support other SWE services the OWS-5 SWE thread participants agreed to use a SensorML based Transformation instead of the GML based Transformation element in a coverage descriptions domain. This caused a problem because the WCS 1.1.1 coverage description's domain `<Transformation>` element was not substitutable nor could it reference an external XML document without abusing the semantics of an existing child element.

A discussion between the OWS-5 SWE participants and the WCS 1.2 SWG occurred that clarified many issues related to ImageCRS. In fact Arliss Whiteside created a change request for WCS 1.1.1 that has been incorporated into the WCS 1.1.2 corrigendum [8]. It clarifies many issues but it does not incorporate the `<OtherTransformation>` element discussed in this document. The `<OtherTransformation>` element was a solution devised early in the project before the WCS SWG was involved and the design was too far advanced to change to something else. This brings up the issue of SWE and WCS harmonization which is discussed in subclause 5.5.

5.3.1 Grid and Image CRSes

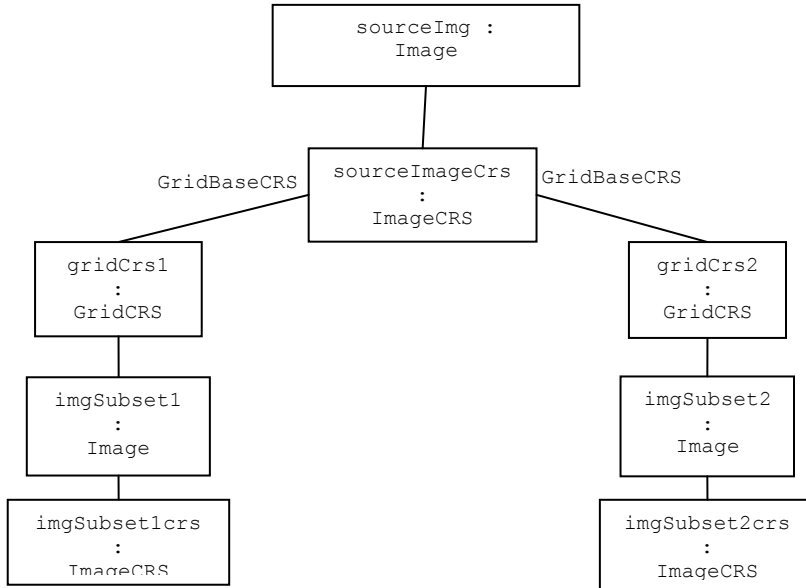


Figure 2 – Object diagram: sub-sampled images based upon same source image

Figure 2 depicts is an object diagram use case where two new images are created from a single image. The new images are the result of two different requested GridCRSes.

An application should be able to overlap the two new images correctly since they are derived from the same source. Currently, it is impossible to know that the images `imgSubset1` and `imgSubset2` originated by subsetting the same source image namely, `sourceImg` because the original GridCRS information is lost.

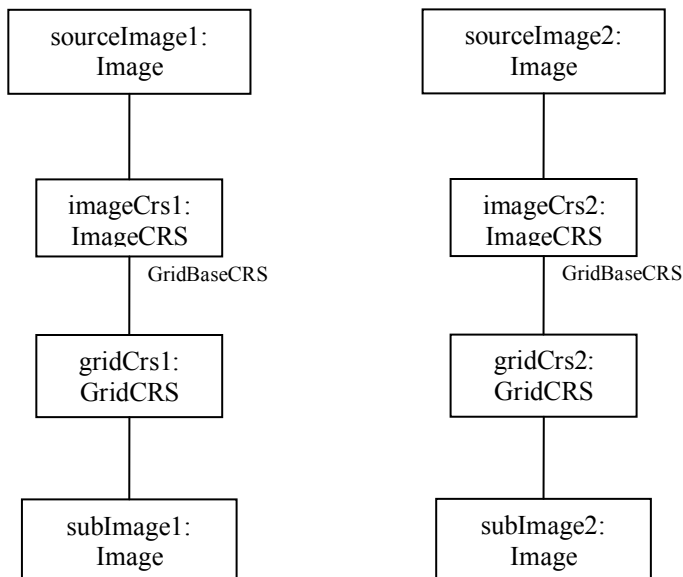
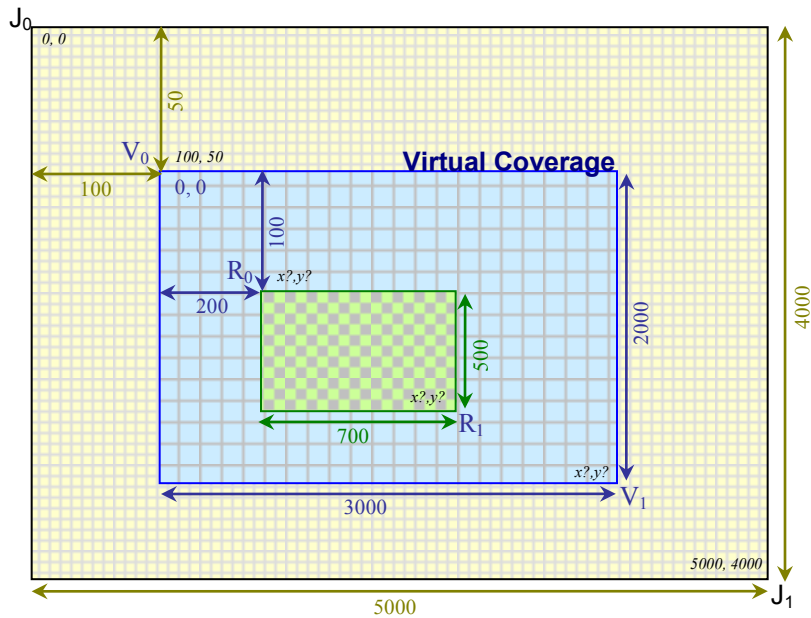


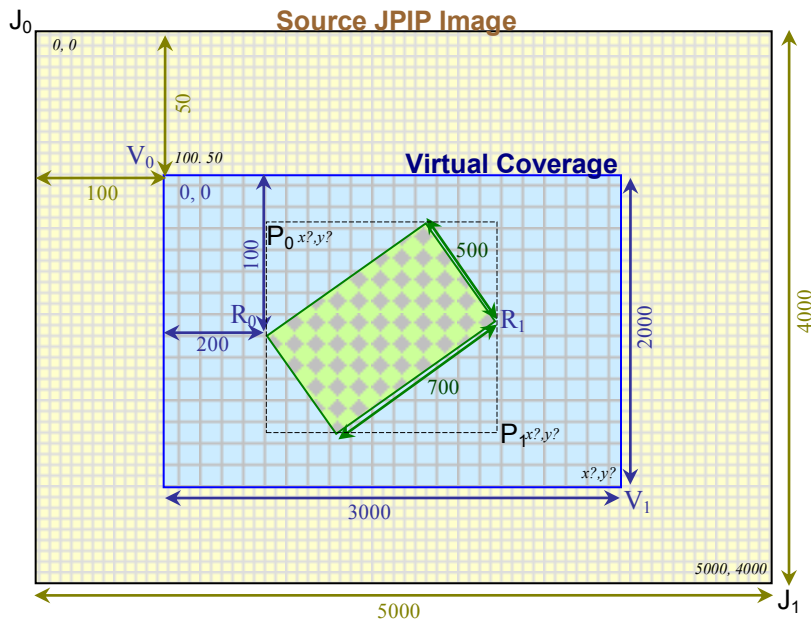
Figure 3 – Object diagram: sub-sampled images based upon different source images

Figure 3 depicts a use case where two image subsets are created from different source images. In this use case it is impossible to overlay the two image subsets unless metadata external to the images is used.



NOTE 1 Small, black, and italicized coordinates are absolute coordinates from J_0 .

Figure 4 – Sub-sampled images: no rotation



NOTE 1 Small, black, and italicized coordinates are absolute coordinates from J_0 .

Figure 5 – Sub-sampled images – having a rotation

Requests for sub-sampled and rotated images were not discussed in great detail in the OWS-5 initiative. It is a subject that could be considered in future OWS initiatives.

5.4 Subsetting a JPIP based coverage

5.4.1 WCS Interpolations Methods and JPIP Resolutions

JPEG2000 and JPIP images can carry different resolution levels. Resolution levels are required to always be in powers of 2. Resolution level 0 contains the best resolution.

Note that resolution levels are synonymous to pyramids within geospatial circles.

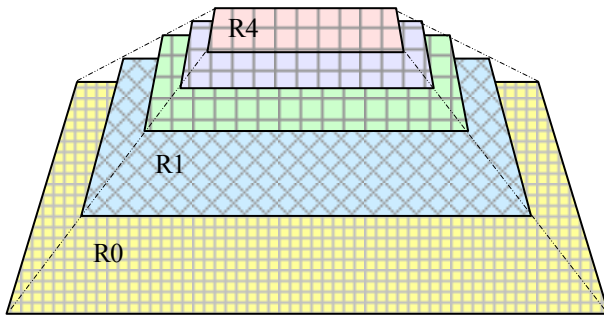


Figure 6 – JPIP Resolution Levels

Table 3 – Example JPIP resolution levels for Figure 6

Resolution Level	X	Y
R0	12000	8000
R1	6000	4000
R2	3000	2000
R3	1500	1000
R4	750	500

5.4.2 JPIP GetCoverage Use Case – Fractional resolution levels

The requirement that JPEG2000 and JPIP images contain resolution levels in powers of 2 renders use cases that produce fractional resolution levels impossible to implement without modifications to the WCS. The reason is that the WCS offers functionality that can produce fractional resolution levels.

For example: A WCS offers a coverage based upon an image available on a JPIP server matching Figure 6 and Table 3. A WCS client determines that the offered coverage contains the region of interest but determines that R1 is too detailed and R2 is too obscure and thus decides to build a request such that the resulting coverage would be between R1 and R2.

It is impossible for a WCS client to make a GetCoverage request such that the resulting image's size and resolution be somewhere between R1 and R2 – something like R1.3 approximately 4873x3249. The reason is that JPIP resolution levels are discrete. A standard JPIP server can not return resolution levels that are between advertised resolution levels.

Possible solutions are:

- 1) WCS server responds with closest and lowest resolution level, in this case R1. It means that the response doesn't exactly match the request. That's a new paradigm to the OGC. The repercussion is that the response must contain enough metadata so that clients can correctly interpret the result.
- 2) WCS server performs the interpolation itself. To do so it must first retrieve the JPIP image data at the best matching resolution level and interpolate from that. It then responds with the image created. The repercussion to this is that the response is no longer a JPIP based image and thus the client can't use the wonderful capabilities of JPIP. A solution is that the WCS server uploads the generated coverage to the JPIP server and references that new image in the response.
- 3) Client requests R1 and down-samples to the level equivalent to R1.3. This is similar to #1 but puts the onus on the client to choose the most appropriate resolution level.
- 4) An extension to the WCS coverage description indicates that the coverage is JPIP based. The client then knows that it can not make requests that result in fractional resolution levels. The problem with this is that a generic WCS client not aware of the restriction would still be able to make bad requests. In such a case the server should respond with an exception.

5.5 SWE, WCS, GML, and GMLJP2 harmonization

The work in the OWS-5 SWE thread has exposed the need to harmonize SensorML, WCS, GML, and GMLJP2. The lack of harmonization was a big source of problems and should be dealt with quickly. The problem will worsen if the SWE, WCS, and GML don't start harmonization efforts.

It is suggested that the next OWS focus some activity on SWE, WCS, GML, and GMLJP2 harmonization.

Annex A

XML Schema Documents

In addition to this document, this report includes several XML Schema Documents. These XML Schema Documents are bundled in a zip file with the present document.

The WCS and WCS-T abilities specified in this document use OWS-5 specific XML Schema Documents included in the zip file with this document. The XML Schema Documents are also available via the OGC's Subversion repository at <https://svn.openegeospatial.org/ogc-projects/ows/>.

These XML Schema Documents combine the XML schema fragments listed in various subclauses of this document, eliminating duplications. These XML Schema Documents roughly match the WCS and WCS-T UML packages described in Annex B, and are named:

- wcsAll.xsd – *used in OWS-5*
- wcsAllTrans.xsd
- wcsCommon.xsd
- wcsContents.xsd
- wcsCoverages.xsd
- wcsDescribeCoverage.xsd
- wcsDescribeCoverageOws5.xsd
- wcsGetCapabilities.xsd
- wcsGetCoverage.xsd
- wcsGridCRS.xsd
- wcsGridCRSold.xsd
- wcsInterpolationMethod.xsd
- wcsTransaction.xsd – *used in OWS-5: original from draft extension document*
- wcsTransactionDecoupled.xsd – *not use: proposed change to WCS-T*
- wcsTransactionNewXmlNS.xsd - *not used: first attempt at decoupling*

Annex B

Example files

Table 4 lists files containing examples of WCS-T requests and responses. All example files are contained are bundled in a zip file with the present document.

Table 4 – Example files used in OWS-5 SWE and descriptions

Filename	Description
./WCS-T SOAP Transaction Example.txt	Full SOAP example containing the full HTTP request (including headers and body) for adding a JPIP based coverage description to a WCS-T.
./Schemas/wcs/1.1.1/Examples/Ows5JpipCoverageDescriptionExampleInlineSensorML_RPCs.xml	A coverage description containing inline SensorML for the domains transformation. The transformation is RPC based and is in an <OtherTransformation> element.
./Schemas/wcs/1.1.1/Examples/Ows5JpipCoverageDescriptionExampleRemoteSensorML_RPCs.xml	A coverage description pointing to remote a SensorML document for the domains transformation. The transformation is RPC based and is in an <OtherTransformation> element.

Bibliography

- [1] OGC 05-047r3, *OpenGIS® GML in JPEG 2000 for Geographic Imagery Encoding Specification 1.0.0*
- [2] OGC 07-068r1, *WCS - Transaction operation extension (1.1.1)*
- [3] OGC 07-145, *WCS Application Profile for JPEG 2000 Coverage*
- [4] OGC 07-146, *WCS Application Profile for JPIP Coverage Encoding*
- [5] OGC 03-013, *Web Object Service Implementation Specification (0.0.3)*
- [6] OGC 08-009, *OWS 5 SOAP/WSDL Common Engineering Report*
- [7] OGC xx-yyy, *OWS-5 Workflow Engineering Report*
- [8] OGC 07-067r3, *Web Coverage Service (WCS) version 1.1 Corrigendum 2*
- [9] OGC 07-066r3, *WCS 1.1.1 to 1.1.2 Revision Notes*
- [10] OGC 07-173r2, *WCS change request - Summarize CRS uses*
- [11] OGC 07-149r2, *WCS change request - Allow non-georeferenced images*