OGC® Web Coverage Service Interface Standard -
Scaling Extension

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### Bibliography

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i. Abstract

This document specifies parameters to the OGC Web Coverage Service (WCS) GetCoverage request which allow scaling of a coverage during its server-side processing in a GetCoverage request.

ii. Keywords

ogcdoc, wcs, scaling

iii. Terms and definitions

This document uses the standard terms defined in Subclause 5.3 of [OGC 06-121r9], which is based on the ISO/IEC Directives, Part 2, Rules for the structure and drafting of International Standards. In particular, the word “shall” (not “must”) is the verb form used to indicate a requirement to be strictly followed to conform to this standard.

iv. Submitting organizations

The following organizations have submitted this Interface Specification to the Open Geospatial Consortium, Inc.:

☐ Jacobs University Bremen ☐ Fuzhou University

v. Document Contributor Contact Points

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</tr>
<tr>
<td>Jinsongdi Yu</td>
<td>Fuzhou University</td>
</tr>
</tbody>
</table>

vi. Changes to the OGC® Abstract Specification

The OGC® Abstract Specification does not require any changes to accommodate the technical contents of this (part of this) document.

vii. Future Work

Among the topics for future development are the following items:

☐ None defined right now
Foreword

This WCS Scaling extension is an OGC Interface Standard which relies on WCS Core [OGC 09-110] and the GML Application Schema for Coverages [OGC 09-146].

This document includes one normative Annex.

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OGC® Web Coverage Service Interface Standard - Scaling Extension

1 Scope

This OGC Web Coverage Service (WCS) – Scaling Extension (in short: Scaling Extension) defines an extension to the WCS Core [OGC 09-110] for the scaling of grid coverages along one or more of its axes during a GetCoverage retrieval.

To this end, the GetCoverage request is extended with a parameter allowing to control output resolution of the grid coverage returned. The scale parameter always is expressed relative to the grid coverage’s Grid CRS, that is: in array indices.

2 Conformance

This document establishes the following requirements and conformance classes:

- scaling, of URI http://www.opengis.net/spec/WCS_service-extension_scaling/1.0/req/scaling; the corresponding conformance class is scaling, with URI http://www.opengis.net/spec/WCS_service-extension_scaling/1.0/conf/scaling.

This is the mandatory core conformance class of this extension.

Standardisation target of all requirements and conformance classes are WCS implementations (currently: servers).

Requirements URIs defined in this document are relative to http://www.opengis.net/spec/WCS_service-extension_scaling/1.0/req, conformance test URIs are relative to http://www.opengis.net/spec/WCS_service-extension_scaling/1.0/conf.

Annex A lists the conformance tests which shall be exercised on any software artefact claiming to implement WCS.

3 Normative references

This OGC WCS Scaling Extension specification consists of the present document and an XML Schema. The complete specification is identified by OGC URI http://www.opengis.net/spec/WCS_service-extension_scaling/1.0, the document has OGC URI http://www.opengis.net/doc/IS/WCS_service-extension_scaling/1.0.

The complete specification is available for download from http://www.opengeospatial.org/standards/wcs; additionally, the XML Schema is posted online at http://schemas.opengis.net/wcs/scaling/1.0 as part of the OGC schema repository. In the event of a discrepancy between bundled and schema repository versions of the XML Schema files, the schema repository shall be considered authoritative.

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The normative documents listed in Table 1 contain provisions that, through reference in this text, constitute provisions of this specification. 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.

Table 1 — Conformance class dependencies

<table>
<thead>
<tr>
<th>Range subsetting conformance class</th>
<th>Dependency document</th>
<th>Dependency conformance class</th>
</tr>
</thead>
<tbody>
<tr>
<td>scaling</td>
<td>OGC 09-146, <em>GML 3.2.1 Application Schema for Coverages</em>, version 1.0</td>
<td>gml-coverage</td>
</tr>
<tr>
<td></td>
<td>OGC 09-110, <em>OGC® Web Coverage Service 2.0 Interface Standard - Core</em>, version 2.0</td>
<td>core</td>
</tr>
</tbody>
</table>

4 Terms and definitions

For the purposes of this document, the terms and definitions given in the above references apply. In addition, the following terms and definitions apply. An arrow “→” indicates that the following term is defined in this Clause.

4.1 Scaling (of a grid coverage)

linear transformation that changes resolution of a grid coverage by a scale factor that may or may not be the same in all directions

5 Conventions

5.1 UML notation

Unified Modeling Language (UML) static structure diagrams appearing in this specification are used as described in Subclause 5.2 of OGC Web Services Common [OGC 06-121r9].

5.2 Data dictionary tables

The UML model data dictionary is specified herein in a series of tables. The contents of the columns in these tables are described in Subclause 5.5 of [OGC 06-121r9]. The contents of these data dictionary tables are normative, including any table footnotes.

5.3 Namespace prefix conventions

The following namespaces are used in this document. The prefix abbreviations used constitute conventions used here, but are not normative. The namespaces to which the prefixes refer are normative, however.
### Table 2 — Namespace mappings

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Namespace URI</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>xsd</td>
<td><a href="http://www.w3.org/2001/XMLSchema">http://www.w3.org/2001/XMLSchema</a></td>
<td>XML Schema namespace</td>
</tr>
<tr>
<td>gml</td>
<td><a href="http://www.opengis.net/gml/3.2">http://www.opengis.net/gml/3.2</a></td>
<td>GML 3.2.1</td>
</tr>
<tr>
<td>gmlcov</td>
<td><a href="http://www.opengis.net/gmlcov/1.0">http://www.opengis.net/gmlcov/1.0</a></td>
<td>GML Application Schema for Coverages 1.0</td>
</tr>
<tr>
<td>wcs</td>
<td><a href="http://www.opengis.net/wcs/2.0">http://www.opengis.net/wcs/2.0</a></td>
<td>WCS 2.0 Core</td>
</tr>
<tr>
<td>scal</td>
<td><a href="http://www.opengis.net/wcs/scaling/1.0">http://www.opengis.net/wcs/scaling/1.0</a></td>
<td>WCS 2.0 Scaling Extension</td>
</tr>
</tbody>
</table>

#### 5.4 Multiple representations

When multiple representations of the same information are given in a specification document these are consistent. Should this not be the case then this is considered an error, and the XML schema shall take precedence.

#### 6 Scaling requirements class

##### 6.1 Overview

Clients and servers supporting this scaling requirements class shall support retrieval of scaled versions of grid coverages offered by a WCS server.

This Clause 6 establishes the Scaling Extension core requirements class, *scaling*.

##### 6.2 Modifications to GetCapabilities

A server announces support of the *scaling* requirements class to a client by adding the URL identifying this extension to the list of supported extensions delivered in the Capabilities document.

**Requirement 1 extension-identifier:**

A WCS service implementing requirements class *scaling* of this Scaling Extension shall include the following URI in the Profile element of the ServiceIdentification in a GetCapabilities response:

http://www.opengis.net/spec/WCS_service-extension_scaling/1.0/conf/scaling

##### 6.3 Modifications to DescribeCoverage

None.
6.4 Modifications to GetCoverage

6.4.1 Modifications to the GetCoverage request

An additional request parameter indicates the scale factor. A scale factor can be given as

- a single number indicating the scale factor to be applied to all axes of the coverage addressed, or
- a list of coverage axes and their individual scale factors, or
- a list of coverage axes and their individual target size, or
- a target domain to which the coverage addressed is to be scaled.

Note: It is recommended to use the target size in a scaling request, as scale factors sometimes can lead to numerical errors in the result domain extent, which can confuse clients.

No statement is made in this specification about the interpolation method applied by the server in the course of the scaling operation. A server is free to employ any interpolation method during scaling, and information about the interpolation applied may not be accessible to the client. While the interpolation method applied may change over requests, and different interpolation methods may be applied to different range components of a particular coverage, a server should not change interpolation across the domain of coverage during execution of a single coverage scaling operation.

Note: The WCS Interpolation Extension allows controlling interpolation behaviour.

Requirement 2 getCoverage-scaling:

A GetCoverage request shall adhere to Figure 1, Table 3 through Table 6, and the XML schema defined for this Scaling Extension, containing zero or one Scaling element.
Figure 1 — GetCoverage with scaling support UML diagram

Table 3 — Components of Scale::ScaleByFactor structure

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
<th>Data type</th>
<th>Multiplicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>scaleFactor</td>
<td>Scale factor to be applied to all coverage axes</td>
<td>float</td>
<td>zero or one  (optional)</td>
</tr>
</tbody>
</table>

Requirement 3  grid-coverage:
The coverage identifier in a GetCoverage request shall address a coverage which is a Grid-Coverage, RectifiedGridCoverage, ReferenceableGridCoverage, or a subtype of one of these.

Requirement 4  getCoverage-mutually-exclusive:
A GetCoverage request containing a scaling operation shall contain exactly one of
Scal::scaleByFactor, Scal::scaleAxesByFactor, Scal::scaleToSize, and Scal::scaleToExtent.

**Alternative 1:** Scaling can be expressed by indicating a scale factor to be applied uniformly along all axes.

**Requirement 5 getCoverage-scale-by-factor-positive:**
The Scal::scaleByFactor parameter in a GetCoverage request, if present, shall have a positive float value.

Note A value of 1.0 leaves the coverage unscaled, a value between 0 and 1 scales down (reduces target domain), a value greater than 1 scales up (enlarges target domain).

**Alternative 2:** Scaling can be expressed by indicating scale factors individually per axis; axes not mentioned will remain unaffected.

**Requirement 6 getCoverage-scale-axes-by-factor-present:**
The Scal::scaleAxesByFactor parameter in a GetCoverage request, if present, shall consist of a non-empty sequence of Scal::scaleAxis elements with a structure as defined in Table 4.

Note In literature, this is sometimes referred to as *anisotropic scaling*.

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
<th>Data type</th>
<th>Multiplicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>axis</td>
<td>Axis to which scaling is to be applied</td>
<td>anyURI</td>
<td>one (mandatory)</td>
</tr>
<tr>
<td>scaleFactor</td>
<td>Scale factor for this axis</td>
<td>Float</td>
<td>one (mandatory)</td>
</tr>
</tbody>
</table>

**Note** See Subclause 6.6 for examples.

**Alternative 3:** Scaling can be expressed by indicating, per domain axis given, the target domain extent to which the coverage should be rescaled; this leaves the lower bound of the grid unchanged while the upper bound is adjusted accordingly. Axes not mentioned remain unaffected.

**Requirement 7 getCoverage-scale-to-size-positive:**
The targetSize of every Scal::targetAxisSize parameter in a GetCoverage request shall have a positive value.

**Requirement 8 getCoverage-scale-to-size-existing-axis:**
Each Scal::targetAxisSize parameter in a GetCoverage request shall contain an axis element which is identical to the axisAbbrev element of some domain axis in the Grid CRS of the coverage addressed.
Requirement 9  getCoverage-scale-to-size-unique-axis:
The Scal::scaleToSize parameter in a GetCoverage request, if present, shall contain no two Scal::targetAxisSize elements with identical axis names.

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
<th>Data type</th>
<th>Multiplicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>axis</td>
<td>Axis to which scaling is to be applied</td>
<td>anyURI</td>
<td>one (mandatory)</td>
</tr>
<tr>
<td>targetSize</td>
<td>Target size of the coverage in the axis indicated</td>
<td>int</td>
<td>one (mandatory)</td>
</tr>
</tbody>
</table>

Note  See Subclause 6.6 for examples.

Alternative 4: Scaling can be expressed by indicating, per domain axis given, the target domain to which the coverage should be rescaled. Axes not mentioned remain unchanged.

Requirement 10 getCoverage-scale-to-extent:
The Scal::scaleToExtent parameter in a GetCoverage request, if present, shall have a structure as defined in Table 6.

Table 6 — Components of Scal::TargetAxisExtent structure

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
<th>Data type</th>
<th>Multiplicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>axis</td>
<td>Axis to which scaling is to be applied</td>
<td>anyURI</td>
<td>one (mandatory)</td>
</tr>
<tr>
<td>low</td>
<td>Target lower bound of domain extent in this axis</td>
<td>int</td>
<td>one (mandatory)</td>
</tr>
<tr>
<td>high</td>
<td>Target upper bound of domain extent in this axis</td>
<td>int</td>
<td>one (mandatory)</td>
</tr>
</tbody>
</table>

Requirement 11 getCoverage-scale-to-extent-existing-axis:
The Scal::TargetAxisExtent parameter in a GetCoverage request, if present, shall contain an axis element which is identical to the identifier of some domain axis in the Grid CRS of the coverage addressed.

6.4.2  Modifications to the GetCoverage response

The scaling parameter effectuates that a coverage is returned which has

- a domain obtained by scaling the original coverage’s domain according to the scaling parameters;
- a range type which is identical to the original coverage’s range type;
a range set where the elements are rescaled, possibly involving resampling and interpolation.

Note How the new range values are derived is left open, but it should resemble some interpolation of the original value and its neighborhood. The server is not required to disclose the interpolation method applied, but should normally use, per coverage, one and the same method upon subsequent scaling requests executed against this coverage. The WCS Interpolation Extension [1] defines how clients can influence interpolation behavior, provided the server supports this Interpolation Extension.

**Requirement 12 getCoverage-scale-by-factor-result:**
The response to a successful GetCoverage request scaling by scale factor $f$ shall be identical to that of a request with scale vector $s = (s_1, \ldots, s_d)$ where $s_i = f$ for all $1 \leq i \leq d$ and $d$ is the dimension of the original coverage.

**Requirement 13 getCoverage-scale-axes-by-factor-result:**
Let $c$ be a coverage with dimension $d$,
- grid domain $X = \{l_1, \ldots, h_1\} \times \ldots \times \{l_d, \ldots, h_d\}$, and
- range set $R = \{(v,p) | \text{ where } p = (x_1, \ldots, x_d) \text{ and } l_i \leq x_i \leq h_i \text{ for } 1 \leq i \leq d\}$;

Let further $s=(s_1, \ldots, s_d)$ be a valid GetCoverage request scale vector.

Then, the response coverage to a successful GetCoverage request scaling coverage $c$ by scale vector $s$ shall have
- dimension $d$,
- Grid domain $X' = \{\text{floor}(l_1 / s_1), \ldots, \text{floor}(h_1 / s_1)\} \times \ldots \times \{\text{floor}(l_d / s_d), \ldots, \text{floor}(h_d / s_d)\}$, and
- range set $R' = \{(v',p') | p' = (x_1', \ldots, x_d') \in X' \text{ and } v' \text{ is a function of the corresponding original location } p \text{ and possibly a neighborhood of } p\}$,

where any eventual subsetting of the coverage is done before this scale operation.

Note The above dimension implies that a scale operation cannot make reference to axis directions that are “sliced away” by a WCS Core subsetting operation. Note that “directions” in a coverage can be identified through different axes, such as “latitude” (using geo coordinates) and “j” (using integer grid coordinates), but still mean the same “direction” in the sense of this discussion: slicing away “latitude”, in this example, disqualifies “j” from getting scaled.

Example The following list shows sample 2-D coverage grid domains and the output coverage’s grid domain when scaled uniformly by a factor of 2.0:

<table>
<thead>
<tr>
<th>Original Domain</th>
<th>Scaled Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>[0:99,0:199]</td>
<td>[0:49,0:99]</td>
</tr>
<tr>
<td>[100:199,100:199]</td>
<td>[50:99,50:99]</td>
</tr>
<tr>
<td>[-10:10,-20:20]</td>
<td>[-5:5,-10:10]</td>
</tr>
</tbody>
</table>

**Requirement 14 getCoverage-scale-to-size-result:**
Let $c$ be a coverage with dimension $d$,
- grid domain $X = \{l_1, \ldots, h_1\} \times \ldots \times \{l_d, \ldots, h_d\}$,
- range set $R = \{(v,p) | \text{ where } p = (x_1, \ldots, x_d) \text{ and } l_i \leq x_i \leq h_i \text{ for } 1 \leq i \leq d\}$;

Let further $s=(s_1, \ldots, s_d)$ be a valid GetCoverage request scale vector.

Then, the response coverage to a successful GetCoverage request scaling coverage $c$ by scale vector $s$ shall have
dimension $d$, 
Grid domain $X' = \{ l_1, \ldots, l_I + s_I - 1 \} \times \ldots \times \{ l_d, \ldots, l_d + s_d - 1 \}$, 
range set $R' = \{ (v', p') \mid p' = (x'_1, \ldots, x'_d) \cap X'$ and $v'$ is a function of the corresponding original location $p$ and possibly a neighborhood of $p$ \},
where any eventual subsetting of the coverage is done before this scale operation.

Note This implies that axes not addressed by the scale factor will not be scaled at all (in other words, their scale factor is 1).

Example The following list shows sample 2-D coverage grid domains and the output coverage’s grid domain when scaled uniformly to size 500:

```
[0:99,0:199]   
[0:499,0:499]  
[100:199,100:199] 
[100:599,100:599]  
[-10:10,-20:20]  
[-10:489,-20:479]  
```

**Requirement 15 getCoverage-scale-to-extent-result:**

Let $c$ be a coverage with

- dimension $d$, 
- grid domain $X = \{ l_1, \ldots, h_I \} \times \ldots \times \{ l_d, \ldots, h_d \}$, 
- range set $R = \{ (v, p) \mid p = (x_1, \ldots, x_d) \text{ and } l_i \leq x_i \leq h_i \text{ for } 1 \leq i \leq d \}$;

let further $s = \{ (a, s_l, s_h) \}$ be a valid GetCoverage request scale interval set with each $a_i$ being the identifier of a Grid axis in $c$, and $s_l \leq s_h$ being target domain intervals.

Then, the response coverage to a successful GetCoverage request scaling coverage $c$ by scale vector $s$ shall have

- dimension $d$, 
- Grid domain $X'$ of dimension $d$ where the domain extent is the same as in $c$ for all those axes not mentioned in $s$, and set to $[s_l, \ldots, s_h]$ for all axes $a_i$ occurring in $s$, 
- range set $R' = \{ (v', p') \mid p' = (x'_1, \ldots, x'_d) \cap X'$ and $v'$ is a function of the corresponding original location $p$ and possibly a neighborhood of $p$ \},

where any eventual subsetting of the coverage is done before this scale operation.

If no Scal::Scaling parameter is present in the GetCoverage request then the coverage will be delivered unscaled, as per WCS Core [OGC 09-110].

**Requirement 16 getCoverage-unscaled:**

The response to a successful GetCoverage request containing no Scal::Scaling parameter shall consist of a coverage with no scaling applied to the original coverage.

The type of the coverage is preserved by the scaling operation.

**Requirement 17 getCoverage-keep-type:**

The response to a successful GetCoverage request containing a Scal::Scaling parameter shall consist of a coverage whose type is not changed by the scaling operation.

Note Other GetCoverage parameters might change the output coverage type indeed.
6.5 Exceptions

**Requirement 18 getCoverage-exception:**
When a WCS server encounters an error while evaluating a `scaleFactor` or `scaleExtent` parameter in a *GetCoverage* operation it *shall* return an exception report message chosen as indicated in Table 7 with a `locator` parameter value as specified in the right column of Table 7 for each `exceptionCode` listed.

<table>
<thead>
<tr>
<th><code>exceptionCode</code> value</th>
<th>HTTP code</th>
<th>Meaning of exception code</th>
<th><code>locator</code> value</th>
</tr>
</thead>
<tbody>
<tr>
<td>InvalidCoverageType</td>
<td>404</td>
<td>Coverage addressed is not a grid coverage</td>
<td>Coverage identifier</td>
</tr>
<tr>
<td>InvalidScaleFactor</td>
<td>404</td>
<td>Scale factor passed is not valid (no number or less than or equal to zero)</td>
<td><code>scaleFactor</code> request parameter value</td>
</tr>
<tr>
<td>InvalidExtent</td>
<td>404</td>
<td>Extent interval passed has upper bound smaller than lower bound</td>
<td><code>high</code> request parameter value</td>
</tr>
<tr>
<td>ScaleAxisUndefined</td>
<td>404</td>
<td>CRS axis indicated is not an axis occurring in this coverage</td>
<td><code>scaleFactor</code> or <code>scaleExtent</code> request parameter value</td>
</tr>
</tbody>
</table>

6.6 Encodings

6.5.1 GET/KVP Encoding

**Requirement 19 getCoverage-getkvp-scale-by-factor:**
In a *GetCoverage* request using the GET/KVP protocol, a `Scale::ScaleByFactor` parameter *shall* be represented as

```
SCALEFACTOR=s
```

where `s` is a `scaleFactor` represented as the ASCII representation of a positive floating-point number.

**Requirement 20 getCoverage-getkvp-scale-axes-by-factor:**
In a *GetCoverage* request using the GET/KVP protocol, a `Scale::ScaleAxesByFactor` parameter containing \( n > 0 \) axis scaling specifications *shall* be represented as

```
SCALEAXES=a_1(s_1), ..., a_n(s_n)
```

where, for \( 1 \leq i \leq n \),
- \( a_i \) is an axis abbreviation;
- \( s_i \) is a `scaleFactor` expressed as the ASCII representation of a positive floating-point number.

**Requirement 21 getCoverage-getkvp-scale-to-size:**
In a *GetCoverage* request using the GET/KVP protocol, a `Scale::ScaleToSize` parameter...
containing \( n > 0 \) axis extent specifications shall be represented as

\[
\text{SCALESIZE} = a_1(s_1), \ldots, a_n(s_n)
\]

where, for \( 1 \leq i \leq n \),
- \( a_i \) is an axis abbreviation;
- \( s_i \) are sizes.

**Requirement 22 getCoverage-getkvp-scale-to-extent:**

In a GetCoverage request using the GET/KVP protocol, a `Scalar:ScaleToExtent` parameter containing \( n > 0 \) axis extent specifications shall be represented as

\[
\text{SCALEEXTENT} = a_1(lo_i:hi_i), \ldots, a_n(lo_n:hi_n)
\]

where, for \( 1 \leq i \leq n \),
- \( a_i \) is an axis abbreviation;
- \( lo_i \) and \( hi_i \) are low and high, respectively, each of them represented as either a string, enclosed in double quotes, or a number.

**Example** Below are three individually (not in combination) valid KVP fragments, assuming that the Grid CRS of the (gridded) coverage addressed contains the axes mentioned:

\[
\begin{align*}
\ldots & \text{SCALEFACTOR}=2.0 \ & \\
\ldots & \text{SCALEAXES}=i(3.5), j(3.5), k(2.0) \ & \\
\ldots & \text{SCALESIZE}=i(1000), j(1000), k(10) \ & \\
\ldots & \text{SCALEEXTENT}=i(10:20), j(20:30) \ &
\end{align*}
\]

**6.5.2 XML/POST Encoding**

**Requirement 23 getCoverage-xmlpost:**

In a GetCoverage request using the XML/POST protocol, the following mapping shall be used:

- Alternative 1 shall be encoded by a `scal:ScaleByFactor` element;
- Alternative 2 shall be encoded by a `scal:ScaleAxesByFactor` element;
- Alternative 3 shall be encoded by a `scal:ScaleToSize` element;
- Alternative 4 shall be encoded by a `scal:ScaleToExtent` element.

**Note** The alternatives refer to Clause 6.4.

**Example** The XML fragments below resemble the same example cases as the GET/KVP fragments above.

```xml
<scal:ScaleByFactor>
  <scal:scaleFactor>2.0</scal:scaleFactor>
</scal:ScaleByFactor>

<scal:ScaleAxesByFactor>
  <scal:ScaleAxis>
    <scal:axis>i</scal:axis>
    <scal:scaleFactor>3.5</scal:scaleFactor>
  </scal:ScaleAxis>
  <scal:ScaleAxis>
    <scal:axis>j</scal:axis>
    <scal:scaleFactor>3.5</scal:scaleFactor>
  </scal:ScaleAxis>
</scal:ScaleAxesByFactor>
```
<scal:scaleFactor>3.5</scal:scaleFactor>
</scal:ScaleAxis>
<scal:ScaleAxis>
  <scal:axis>k</scal:axis>
  <scal:scaleFactor>2.0</scal:scaleFactor>
</scal:ScaleAxis>
</scal:ScaleAxesByFactor>

<scal:ScaleToSize>
  <scal:TargetAxisSize>
    <scal:axis>i</scal:axis>
    <scal:targetSize>1000</scal:targetSize>
  </scal:TargetAxisSize>
  <scal:TargetAxisSize>
    <scal:axis>j</scal:axis>
    <scal:targetSize>1000</scal:targetSize>
  </scal:TargetAxisSize>
  <scal:TargetAxisSize>
    <scal:axis>k</scal:axis>
    <scal:targetSize>10</scal:targetSize>
  </scal:TargetAxisSize>
</scal:ScaleToSize>

<scal:ScaleToExtent>
  <scal:TargetAxisExtent>
    <scal:axis>i</scal:axis>
    <scal:low>10</scal:low>
    <scal:high>20</scal:high>
  </scal:TargetAxisExtent>
  <scal:TargetAxisExtent>
    <scal:axis>j</scal:axis>
    <scal:low>20</scal:low>
    <scal:high>30</scal:high>
  </scal:TargetAxisExtent>
</scal:ScaleToExtent>

### 6.5.3 SOAP Encoding

**Requirement 24 getCoverage-soap:**
In a GetCoverage request using the SOAP protocol, scaling parameters **shall** be mapped as in Requirement 23 above.

**Dependency:** [09-149r1] ([http://www.opengis.net/spec/WCS_protocol-bindingSoap/1.0/soap](http://www.opengis.net/spec/WCS_protocol-bindingSoap/1.0/soap))

**Example** See previous subclause.
Bibliography

Annex A
(normative)

Abstract test suite

A Scaling Extension implementation must satisfy the following system characteristics to be conformant with this specification.

Test identifiers below are relative to http://www.opengis.net/spec/WCS/2.0/WCS_service-extension_scaling/1.0/conf.

A.1 Conformance Test Class: scaling

The OGC URI identifier of this conformance class is:
http://www.opengis.net/spec/WCS/2.0/conf/WCS_service-extension_scaling/1.0/conf/scaling.

A.1.1 Scaling/extension identifier

Test id: extension-identifier:
Test Purpose: A WCS service implementing requirements class scaling of this Scaling Extension shall include the following URI in the Profile element of the ServiceIdentification in a GetCapabilities response:
http://www.opengis.net/spec/WCS_service-extension_scaling/1.0/conf/scaling

Test method: Send a GetCapabilities request to server under test, verify that the response contains a Profile element with said URI.

Test passes if result is as expected.

A.1.2 scaling/getCoverage scaling

Test id: getCoverage-scaling:
Test Purpose: A GetCoverage request shall adhere to Figure 1, Table 3 through Table 6, and the XML schema defined for this Scaling Extension, containing zero or one Scaling element.

Test method: Send GetCoverage requests testing server response on the cases distinguished in said reference. Check proper response.

Test passes if expected result is delivered.

A.1.3 grid coverage

Test id: grid-coverage:
Test Purpose: The coverage identifier in a GetCoverage request shall address a coverage which is a GridCoverage, RectifiedGridCoverage, ReferenceableGridCov-
verage, or a subtype of one of these.

**Test method:** Send *GetCoverage* requests to the service under test, check whether responses are adequate. Exercise tests for each of the following situations:

- with the coverage identifier of a GridCoverage. Verify that request succeeds;
- with the coverage identifier of a RectifiedCoverage. Verify that request succeeds;
- with the coverage identifier of a ReferenceableCoverage. Verify that request succeeds.

Test passes if expected result is delivered.

**A.1.4 getCoverage mutually exclusive**

**Test id:** getCoverage-mutually-exclusive:

**Test Purpose:** A *GetCoverage* request containing a scaling operation **shall** contain exactly one of Scal::scaleByFactor, Scal::scaleAxesByFactor, Scal::scaleToSize, and Scal::scaleToExtent.

**Test method:** Send *GetCoverage* requests to the service under test containing:

- No scaling parameter. Verify that request succeeds.
- a Scal::scaleByFactor. Verify that request succeeds.
- a Scal::scaleAxesByFactor. Verify that request succeeds.
- a Scal::scaleToSize. Verify that request succeeds.
- a Scal::scaleToExtent. Verify that request succeeds.
- more than one scaling element. Verify that request fails.

Test passes if expected result is delivered.

**A.1.5 getCoverage scale by factor positive**

**Test id:** getCoverage-scale-by-factor-positive:

**Test Purpose:** The Scal::scaleByFactor parameter in a *GetCoverage* request, if present, **shall** have a positive float value.

**Test method:** Send *GetCoverage* requests to the service under test with the Scal::scaleByFactor parameter containing:

- a positive float value. Verify that request succeeds.
- 0. Verify that request fails.
- a random negative value. Verify that request fails.
Test passes if result is as expected.

A.1.6 getCoverage scale axes by factor present

Test id: getCoverage-scale-axes-by-factor-present:
Test Purpose: The Scal::scaleAxesByFactor parameter in a GetCoverage request, if present, shall consist of a non-empty sequence of Scal::scaleAxis elements with a structure as defined in Table 4.

Test method: Send GetCoverage requests testing server response on the cases distinguished in said reference. Check proper response.

Test passes if expected result is delivered.

A.1.7 getCoverage scale to size positive

Test id: getCoverage-scale-to-size-positive:
Test Purpose: The targetSize of every Scal::targetAxisSize parameter in a GetCoverage request shall have a positive value.

Test method: Send GetCoverage requests to the service under test with a Scal::targetAxisSize parameter containing:

- a positive float value. Verify that request succeeds.
- 0. Verify that request fails.
- a random negative value. Verify that request fails.

Test passes if expected result is delivered.

A.1.8 getCoverage scale to size existing axis

Test id: getCoverage-scale-to-size-existing-axis:
Test Purpose: Each Scal::targetAxisSize parameter in a GetCoverage request shall contain an axis element which is identical to the axisAbbrev element of some domain axis in the Grid CRS of the coverage addressed.

Test method: Send GetCoverage requests to the service under test with a Scal::targetAxisSize parameter containing an axis element which is:

- a domain axis in the Grid CRS of the coverage addressed. Verify that request succeeds.
- a domain axis not in the Grid CRS of the coverage addressed. Verify that request fails.
Test passes if expected result is delivered.

A.1.9  getCoverage scale to size unique axis

Test id:  getCoverage-scale-to-size-unique-axis:
Test Purpose:  The Scal::scaleToSize parameter in a GetCoverage request, if present, shall contain no two Scal::targetAxisSize elements with identical axis names.

Test method:  Send GetCoverage requests to the service under test, with a Scal::scaleToSize parameter contains:

- two Scal::targetAxisSize elements with different axis names. Verify that request succeeds.
- two Scal::targetAxisSize elements with identical axis names. Verify that request fails.

Test passes if expected result is delivered.

A.1.10  getCoverage scale to extent

Test id:  getCoverage-scale-to-extent:
Test Purpose:  The Scal::scaleToExtent parameter in a GetCoverage request, if present, shall have a structure as defined in Table 6.

Test method:  Send GetCoverage requests testing server response on the cases distinguished in said reference. Check proper response.

Test passes if expected result is delivered.

A.1.11  getCoverage scale to extent existing axis

Test id:  getCoverage-scale-to-extent-existing-axis:
Test Purpose:  The Scal::TargetAxisExtent parameter in a GetCoverage request, if present, shall contain an axis element which is identical to the identifier of some domain axis in the Grid CRS of the coverage addressed.

Test method:  Send GetCoverage requests to the service under test, with a Scal::TargetAxisExtent parameter contains an axis element which is:

- a domain axis in the Grid CRS of the coverage addressed. Verify that request succeeds.
- a domain axis not in the Grid CRS of the coverage addressed. Verify that request fails.
Test passes if expected result is delivered.

A.1.12 getCoverage scale by factor result

Test id: getCoverage-scale-by-factor-result:
Test Purpose: The response to a successful GetCoverage request scaling by scale factor $f$ shall be identical to that of a request with scale vector $s = (s_1, \ldots, s_d)$ where $s_i = f$ for all $1 \leq i \leq d$ and $d$ is the dimension of the original coverage.

Test method: Send separate GetCoverage requests to the service under test with:

- a scale factor $f$, resulting in response $d_1$;
- scale vector $s = (s_1, \ldots, s_d)$ where $s_i = f$ for all $1 \leq i \leq d$ and $d$ is the dimension of the original coverage, resulting in response $d_2$;
- check if $d_1$ and $d_2$ are equal.

Test passes if expected result is delivered.

A.1.13 getCoverage scale axes by factor result

Test id: getCoverage-scale-axes-by-factor-result:
Test Purpose: Let $c$ be a coverage with dimension $d$, grid domain $X = \{l_1, \ldots, h_1\} \times \ldots \times \{l_d, \ldots, h_d\}$, and range set $R = \{(v, p) \mid \text{where } p = (x_1, \ldots, x_d) \text{ and } l_i \leq x_i \leq h_i \text{ for } 1 \leq i \leq d\}$; let further $s=(s_1, \ldots, s_d)$ be a valid GetCoverage request scale vector. Then, the response coverage to a successful GetCoverage request scaling coverage $c$ by scale vector $s$ shall have dimension $d$, grid domain $X' = \{\text{floor}(l_1 / s_1), \ldots, \text{floor}(h_1 / s_1)\} \times \ldots \times \{\text{floor}(l_d / s_d), \ldots, \text{floor}(h_d / s_d)\}$, and range set $R' = \{(v', p') \mid p' = (x_1', \ldots, x_d') \subset X' \text{ and } v' \text{ is a function of the corresponding original location } p \}$, where any eventual subsetting of the coverage is done before this scale operation.

Test method: Send a GetCoverage request to the service under test using a scale vector, check that response is correct.

Test passes if result is as expected.
A.1.14 getCoverage scale to size result

Test id: getCoverage-scale-to-size-result:
Test Purpose: Let $c$ be a coverage with
dimension $d$,
grid domain $X = \{l_1, \ldots, l_1\} \times \cdots \times \{l_d, \ldots, h_d\}$,
range set $R = \{(v, p) | \text{where } p = (x_1, \ldots, x_d) \text{ and } l_i \leq x_i \leq h_i \text{ for } 1 \leq i \leq d\}$;
let further $s = (s_1, \ldots, s_d)$ be a valid GetCoverage request scale vector.
Then,
the response coverage to a successful GetCoverage request scaling coverage $c$ by scale vector $s$ shall have
dimension $d$,
Grid domain $X' = \{l_1, \ldots, l_1 + s_1 - 1\} \times \cdots \times \{l_d, \ldots, l_d + s_d - 1\}$,
range set $R' = \{(v', p') | p' = (x_1', \ldots, x_d') \cap X' \text{ and } v' \text{ is a function of the corresponding original location } p \}$,
and possibly a neighborhood of $p$,
where any eventual subsetting of the coverage is done before this scale operation.

Test method: Send a GetCoverage request to the service under test using scale to size,
check that response is correct.
Test passes if result is as expected.

A.1.15 getCoverage scale to extent result

Test id: getCoverage-scale-to-extent-result:
Test Purpose: Let $c$ be a coverage with
dimension $d$,
grid domain $X = \{l_1, \ldots, h_1\} \times \cdots \times \{l_d, \ldots, h_d\}$,
range set $R = \{(v, p) | \text{where } p = (x_1, \ldots, x_d) \text{ and } l_i \leq x_i \leq h_i \text{ for } 1 \leq i \leq d\}$;
let further $s = \{(a, s_l, s_h)\}$ be a valid GetCoverage request scale interval set
with each $a_i$ being the identifier of a Grid axis in $c$, and $s_l \leq s_h$ being target domain intervals.
Then,
the response coverage to a successful GetCoverage request scaling coverage $c$ by scale vector $s$ shall have
dimension $d$,
Grid domain $X'$ of dimension $d$ where the domain extent is the same as in $c$ for all
those axes not mentioned in $s$, and set to $[s_l, \ldots, s_h]$ for all axes $a_i$ occurring in $s$,
range set $R' = \{(v', p') | p' = (x_1', \ldots, x_d') \cap X' \text{ and } v' \text{ is a function of the corresponding original location } p \}$,
and possibly a neighborhood of $p$,
where any eventual subsetting of the coverage is done before this scale operation.

Test method: Send a GetCoverage request to the service under test using scale to extent, check that response is correct.

Test passes if result is as expected.

A.1.16 getCoverage unscaled

Test id: getCoverage-unscaled:
Test Purpose: The response to a successful GetCoverage request containing no Scal::Scaling parameter shall consist of a coverage with no scaling applied to the original coverage.

Test method: Send a GetCoverage request to the service under test without a Scal::Scaling parameter, send a further GetCoverage request with a uniform scaling of 1.0; check that both responses are identical.

Test passes if result is as expected.

A.1.17 getCoverage keep type

Test id: getCoverage-keep-type:
Test Purpose: The response to a successful GetCoverage request containing a Scal::Scaling parameter shall consist of a coverage whose type is not changed by the scaling operation.

Test method: Send a GetCoverage request to the service under test, containing a Scal::Scaling parameter, check that the coverage type is the same as reported by DescribeCoverage.

Test passes if result is as expected.

A.1.18 getCoverage exception

Test id: getCoverage-exception:
Test Purpose: When a WCS server encounters an error while evaluating a scaleFactor or scaleExtent parameter in a GetCoverage operation it shall return an exception report message chosen as indicated in Table 7 with a locator parameter value as specified in the right column of Table 7 for each exceptionCode listed.

Test method: For each exception referenced in the requirement: Send an erroneous GetCoverage request to the server under test provoking this exception, as per its definition. Check for proper exception reporting.
Test passes if result is as expected.

A.1.19  getCoverage getkvp scale by factor

Test id:  getCoverage-getkvp-scale-by-factor:
Test Purpose:  In a GetCoverage request using the GET/KVP protocol, a 
Scal::ScaleByFactor parameter shall be represented as 
SCALEFACTOR=s 
where s is a scaleFactor represented as the ASCII representation of a 
positive floating-point number.

Test method:  Send a GET/KVP GetCoverage request containing a 
Scal::ScaleByFactor parameter represented as SCALEFACTOR=s, 
where s is a scaleFactor represented as the ASCII representation of a 
positive floating-point number. Check proper response.

Test passes if result is as expected.

A.1.20  getCoverage getkvp scale axes by factor

Test id:  getCoverage-getkvp-scale-axes-by-factor:
Test Purpose:  In a GetCoverage request using the GET/KVP protocol, a 
Scal::ScaleAxesByFactor parameter containing \( n \geq 0 \) axis scaling 
specifications shall be represented as 
SCALEAXES=\( a_1(s_1), \ldots, a_n(s_n) \) 
where, for \( 1 \leq i \leq n \), 
- \( a_i \) is an axis abbreviation; 
- \( s_i \) is a scaleFactor expressed as the ASCII representation of a positive 
floating-point number.

Test method:  Send a GET/KVP GetCoverage containing a 
Scal::ScaleAxesByFactor parameter represented as 
SCALEAXES=\( a_1(s_1), \ldots, a_n(s_n) \), where, for \( 1 \leq i \leq n \), \( a_i \) is an axis identifier (i.e., URL); \( s_i \) is a scaleFactor expressed as the ASCII representation of a positive floating-point number scale axes by factor. Check proper response.

Test passes if result is as expected.

A.1.21  getCoverage getkvp scale to size

Test id:  getCoverage-getkvp-scale-to-size

Test Purpose:  In a GetCoverage request using the GET/KVP protocol, a 
Scal::ScaleToSize parameter containing \( n \geq 0 \) axis extent specifications shall be represented as
SCALESIZE = a_1(s_1), ..., a_n(s_n)
where, for 1 ≤ i ≤ n,
- a_i is an axis abbreviation;
- s_i are sizes.

**Test method:** Send a GET/KVP `GetCoverage` containing a `Scal::ScaleToSize` parameter represented as `SCALESIZE = a_1(s_1), ..., a_n(s_n)` where, for 1 ≤ i ≤ n, a_i is an axis name; s_i are sizes. Check proper response.

Test passes if result is as expected.

### A.1.22 getCoverage getkvp scale to extent

- **Test id:** getCoverage-getkvp-scale-to-extent
- **Test Purpose:** In a `GetCoverage` request using the GET/KVP protocol, a `Scal::ScaleToExtent` parameter containing n>0 axis extent specifications shall be represented as
  SCALEEXTENT = a_1(lo_1:hi_1), ..., a_n(lo_n:hi_n)
  where, for 1 ≤ i ≤ n,
- a_i is an axis abbreviation;
- lo_i and hi_i are low and high, respectively, each of them represented as either a string, enclosed in double quotes, or a number.

**Test method:** Send a GET/KVP `GetCoverage` containing a `Scal::ScaleToExtent` parameter represented as
  SCALEEXTENT = a_1(lo_1:hi_1), ..., a_n(lo_n:hi_n), where, for 1 ≤ i ≤ n, a_i is an axis name; lo_i and hi_i are an admissible lower and upper bound value, resp., for this coverage. Check proper response.

Test passes if result is as expected.

### A.1.23 getCoverage xmlpost

- **Test id:** getCoverage-xmlpost
- **Test Purpose:** In a `GetCoverage` request using the XML/POST protocol, the following mapping shall be used:
  - Alternative 1 shall be encoded by a `scal:ScaleByFactor` element;
  - Alternative 2 shall be encoded by a `scal:ScaleAxesByFactor` element;
  - Alternative 3 shall be encoded by a `scal:ScaleToSize` element;
  - Alternative 4 shall be encoded by a `scal:ScaleToExtent` element.

**Test method:** Send XML/POST `GetCoverage` requests to the service under test containing:

- a `scal:ScaleByFactor` element. Verify that request succeeds;
- a `scal:ScaleAxesByFactor` element. Verify that request suc-
ceeds;
- a `scal:ScaleToSize` element. Verify that request succeeds;
- a `scal:ScaleToExtent` element. Verify that request succeeds.

Test passes if expected result is delivered.

**A.1.24 getCoverage soap**

**Test id:** getCoverage-soap:  
**Test Purpose:** In a `GetCoverage` request using the SOAP protocol, scaling parameters shall be mapped as in Requirement 23 above.  
**Dependency:** [09-149r1] (http://www.opengis.net/spec/WCS_protocol-binding_soap/1.0/soap)

**Test method:** Send SOAP `GetCoverage` requests to the service under test containing:

- a `scal:ScaleByFactor` element. Verify that request succeeds;
- a `scal:ScaleAxesByFactor` element. Verify that request succeeds;
- a `scal:ScaleToSize` element. Verify that request succeeds;
- a `scal:ScaleToExtent` element. Verify that request succeeds.

Test passes if expected result is delivered.

-- end of ATS --
Annex B: Revision history

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<th>Author</th>
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<td>2012-04-20</td>
<td>0.0.1</td>
<td>Peter Baumann</td>
<td>All</td>
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<td>2012-12-03</td>
<td>0.1.0</td>
<td>Peter Baumann, JinsongdiYu</td>
<td>Several, in particular: Annex A</td>
<td>Finalized and added ATS</td>
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<td>2014-01-06</td>
<td>1.0</td>
<td>Peter Baumann, JinsongdiYu</td>
<td>Req7, Req9, Annex A</td>
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