Open Geospatial Consortium

Publication Date: 2014-02-26
Approval Date: 2014-01-17
Submission Date: 2013-08-20
Reference number of this Document: OGC 12-049
External reference for this document: http://www.opengis.net/doc/IS/WCS-scaling-extension/1.0
Version: 1.0
Category: OGC® Interface Standard
Editor: Peter Baumann, Jinsongdi Yu

OGC® Web Coverage Service Interface Standard - Interpolation Extension

Copyright © 2014 Open Geospatial Consortium.
To obtain additional rights of use, visit http://www.opengeospatial.org/legal/.

Warning

This document is an OGC Member approved international standard. This document is available on a royalty free, non-discriminatory basis. Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Document type: OGC Standard
Document subtype: Interface
Document stage: Approved
Document language: English
License Agreement

Permission is hereby granted by the Open Geospatial Consortium, ("Licensor"), free of charge and subject to the terms set forth below, to any person obtaining a copy of this Intellectual Property and any associated documentation, to deal in the Intellectual Property without restriction (except as set forth below), including without limitation the rights to implement, use, copy, modify, merge, publish, distribute, and/or sublicense copies of the Intellectual Property, and to permit persons to whom the Intellectual Property is furnished to do so, provided that all copyright notices on the intellectual property are retained intact and that each person to whom the Intellectual Property is furnished agrees to the terms of this Agreement.

If you modify the Intellectual Property, all copies of the modified Intellectual Property must include, in addition to the above copyright notice, a notice that the Intellectual Property includes modifications that have not been approved or adopted by LICENSOR.

THIS LICENSE IS A COPYRIGHT LICENSE ONLY, AND DOES NOT CONVEY ANY RIGHTS UNDER ANY PATENTS THAT MAY BE IN FORCE ANYWHERE IN THE WORLD.

THE INTELLECTUAL PROPERTY IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NONINFRINGEMENT OF THIRD PARTY RIGHTS. THE COPYRIGHT HOLDER OR HOLDERS INCLUDED IN THIS NOTICE DO NOT WARRANT THAT THE FUNCTIONS CONTAINED IN THE INTELLECTUAL PROPERTY WILL MEET YOUR REQUIREMENTS OR THAT THE OPERATION OF THE INTELLECTUAL PROPERTY WILL BE UNINTERRUPTED OR ERROR FREE. ANY USE OF THE INTELLECTUAL PROPERTY SHALL BE MADE ENTIRELY AT THE USER'S OWN RISK. IN NO EVENT SHALL THE COPYRIGHT HOLDER OR ANY CONTRIBUTOR OF INTELLECTUAL PROPERTY RIGHTS TO THE INTELLECTUAL PROPERTY BE LIABLE FOR ANY CLAIM, OR ANY DIRECT, SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES, OR ANY DAMAGES WHATSOEVER RESULTING FROM ANY ALLEGED INFRINGEMENT OR ANY LOSS OF USE, DATA OR PROFITS, WHETHER IN AN ACTION OF CONTRACT, NEGLIGENCE OR UNDER ANY OTHER LEGAL THEORY, ARISING OUT OF OR IN CONNECTION WITH THE IMPLEMENTATION, USE, COMMERCIALIZATION OR PERFORMANCE OF THIS INTELLECTUAL PROPERTY.

This license is effective until terminated. You may terminate it at any time by destroying the Intellectual Property together with all copies in any form. The license will also terminate if you fail to comply with any term or condition of this Agreement. Except as provided in the following sentence, no such termination of this license shall require the termination of any third party end-user sublicense to the Intellectual Property which is in force as of the date of notice of such termination. In addition, should the Intellectual Property, or the operation of the Intellectual Property, infringe, or in LICENSOR’s sole opinion be likely to infringe, any patent, copyright, trademark or other right of a third party, you agree that LICENSOR, in its sole discretion, may terminate this license without any compensation or liability to you, your licensees or any other party. You agree upon termination of any kind to destroy or cause to be destroyed the Intellectual Property together with all copies in any form, whether held by you or by any third party.

Except as contained in this notice, the name of LICENSOR or of any other holder of a copyright in all or part of the Intellectual Property shall not be used in advertising or otherwise to promote the sale, use or other dealings in this Intellectual Property without prior written authorization of LICENSOR or such copyright holder. LICENSOR is and shall at all times be the sole entity that may authorize you or any third party to use certification marks, trademarks or other special designations to indicate compliance with any LICENSOR standards or specifications.

This Agreement is governed by the laws of the Commonwealth of Massachusetts. The application to this Agreement of the United Nations Convention on Contracts for the International Sale of Goods is hereby expressly excluded. In the event any provision of this Agreement shall be deemed unenforceable, void or invalid, such provision shall be modified so as to make it valid and enforceable, and as so modified the entire Agreement shall remain in full force and effect. No decision, action or inaction by LICENSOR shall be construed to be a waiver of any rights or remedies available to it. None of the Intellectual Property or underlying information or technology may be downloaded or otherwise exported or reexported in violation of U.S. export laws and regulations. In addition, you are responsible for complying with any local laws in your jurisdiction which may impact your right to import, export or use the Intellectual Property, and you represent that you have complied with any regulations or registration procedures required by applicable law to make this license enforceable.
## Contents

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Scope ....................................................................................................................... 1</td>
</tr>
<tr>
<td>2</td>
<td>Conformance ........................................................................................................... 1</td>
</tr>
<tr>
<td>3</td>
<td>Normative references .............................................................................................. 1</td>
</tr>
<tr>
<td>4</td>
<td>Terms and definitions .............................................................................................. 2</td>
</tr>
<tr>
<td>4.1</td>
<td>Interpolation (of a coverage) ............................................................................. 2</td>
</tr>
<tr>
<td>5</td>
<td>Conventions ............................................................................................................ 2</td>
</tr>
<tr>
<td>5.1</td>
<td>UML notation .................................................................................................... 2</td>
</tr>
<tr>
<td>5.2</td>
<td>Data dictionary tables ........................................................................................ 2</td>
</tr>
<tr>
<td>5.3</td>
<td>Namespace prefix conventions ......................................................................... 2</td>
</tr>
<tr>
<td>5.4</td>
<td>Multiple representations .................................................................................... 3</td>
</tr>
<tr>
<td>6</td>
<td>Interpolation requirements class ........................................................................ 3</td>
</tr>
<tr>
<td>6.1</td>
<td>Overview ........................................................................................................... 3</td>
</tr>
<tr>
<td>6.2</td>
<td>Modifications to GetCapabilities ..................................................................... 3</td>
</tr>
<tr>
<td>6.3</td>
<td>Modifications to DescribeCoverage .................................................................. 5</td>
</tr>
<tr>
<td>6.4</td>
<td>Modifications to GetCoverage ........................................................................... 5</td>
</tr>
<tr>
<td>6.4.1</td>
<td>Modifications to the GetCoverage request ......................................................... 5</td>
</tr>
<tr>
<td>6.4.2</td>
<td>Modifications to the GetCoverage response ........................................................ 5</td>
</tr>
<tr>
<td>6.5</td>
<td>Exceptions ......................................................................................................... 6</td>
</tr>
<tr>
<td>6.6</td>
<td>Encodings ........................................................................................................ 6</td>
</tr>
<tr>
<td>6.6.1</td>
<td>GET/KVP Encoding ............................................................................................ 6</td>
</tr>
<tr>
<td>6.6.2</td>
<td>XML/POST Encoding .......................................................................................... 6</td>
</tr>
<tr>
<td>6.6.3</td>
<td>SOAP Encoding ................................................................................................. 7</td>
</tr>
<tr>
<td>7</td>
<td>Interpolation-per-axis requirements class .......................................................... 7</td>
</tr>
<tr>
<td>7.1</td>
<td>Overview ........................................................................................................... 7</td>
</tr>
<tr>
<td>7.2</td>
<td>Modifications to GetCapabilities ..................................................................... 7</td>
</tr>
<tr>
<td>7.3</td>
<td>Modifications to DescribeCoverage .................................................................. 7</td>
</tr>
<tr>
<td>7.4</td>
<td>Modifications to GetCoverage ........................................................................... 7</td>
</tr>
<tr>
<td>7.4.1</td>
<td>Modifications to the GetCoverage request ......................................................... 7</td>
</tr>
<tr>
<td>7.4.2</td>
<td>Modifications to the GetCoverage response ........................................................ 9</td>
</tr>
<tr>
<td>7.5</td>
<td>Exceptions ......................................................................................................... 9</td>
</tr>
<tr>
<td>7.6</td>
<td>Encodings ........................................................................................................ 10</td>
</tr>
<tr>
<td>7.6.1</td>
<td>GET/KVP Encoding ............................................................................................ 10</td>
</tr>
<tr>
<td>7.6.2</td>
<td>XML/POST Encoding .......................................................................................... 10</td>
</tr>
<tr>
<td>7.6.3</td>
<td>SOAP Encoding ................................................................................................. 11</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Bibliography ...................................................................................................................... 12</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Annex A (normative) Abstract test suite ........................................................................ 13</td>
<td></td>
</tr>
<tr>
<td>A.1</td>
<td>Conformance Test Class: interpolation ................................................................ 13</td>
</tr>
<tr>
<td>A.1.1</td>
<td>Interpolation/interpolation identifier ................................................................. 13</td>
</tr>
<tr>
<td>A.1.2</td>
<td>Interpolation/capabilities ................................................................................. 13</td>
</tr>
<tr>
<td>A.1.3</td>
<td>Interpolation/wcs ServiceMetadata .................................................................. 13</td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>A.1.4</td>
<td>Interpolation/wcs ServiceMetadata interpolation Methods</td>
</tr>
<tr>
<td>A.1.5</td>
<td>Interpolation/interpolation GetCoverage request</td>
</tr>
<tr>
<td>A.1.6</td>
<td>Interpolation/interpolation GetCoverage response</td>
</tr>
<tr>
<td>A.1.7</td>
<td>Interpolation/interpolation per axis GetCoverage getkvp</td>
</tr>
<tr>
<td>A.1.8</td>
<td>Interpolation/interpolation per axis GetCoverage xmlpost</td>
</tr>
<tr>
<td>A.1.9</td>
<td>Interpolation/interpolation per axis GetCoverage soap</td>
</tr>
<tr>
<td>A.1.10</td>
<td>Interpolation-per-axis/identifier</td>
</tr>
<tr>
<td>A.1.11</td>
<td>Interpolation-per-axis/getCoverage request</td>
</tr>
<tr>
<td>A.1.12</td>
<td>Interpolation-per-axis/getCoverage axes</td>
</tr>
<tr>
<td>A.1.13</td>
<td>Interpolation-per-axis/getCoverage-axes-pairwise-distinct</td>
</tr>
<tr>
<td>A.1.14</td>
<td>Interpolation-per-axis/getCoverage existing axis</td>
</tr>
<tr>
<td>A.1.15</td>
<td>Interpolation-per-axis/getCoverage response</td>
</tr>
<tr>
<td>A.1.16</td>
<td>Interpolation-per-axis/getCoverage getkvp</td>
</tr>
<tr>
<td>A.1.17</td>
<td>Interpolation-per-axis/getCoverage xmlpost</td>
</tr>
<tr>
<td>A.1.18</td>
<td>Interpolation-per-axis/getCoverage-soap</td>
</tr>
</tbody>
</table>
Tables

Table 1 — Conformance class dependencies .................................................................2
Table 2 — Namespace mappings ..................................................................................3
Table 3 — Components of Int::InterpolationMetadata structure ................................4
Table 4 — Components of Int::InterpolationMethod structure ....................................5
Table 5 — Exception codes for use of Interpolation .......................................................6
Table 6 — Components of Int::InterpolationAxis structure .........................................8
Table 7 — Exception codes for use of InterpolationPerAxis ........................................9
i. Abstract

This OGC standard specifies parameters to the OGC Web Coverage Service (WCS) GetCoverage request which give control over interpolation of a coverage during its server-side processing. This allows the client (user) to control and specify the interpolation mechanism to be applied to a coverage during server processing.

This WCS Interpolation extension relies on WCS Core [OGC 09-110r4] and the GML Application Schema for Coverages [OGC 09-146r2].

ii. Keywords

ogcdoc, wcs, interpolation

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peter Baumann</td>
<td>Jacobs University Bremen, rasdaman GmbH</td>
</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 foreseen currently
Foreword

This WCS Interpolation extension is an OGC Interface Standard which relies on WCS Core [OGC 09-110r4] and the GML Application Schema for Coverages [OGC 09-146r2].

This document includes one normative Annex.

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

Recipients of this document are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of the standard set forth in this document, and to provide supporting documentation.
Introduction

The OGC Web Coverage Service (WCS) –Interpolation Extension defines an extension to the WCS Core [OGC 09-110r4] to control interpolation during processing of a GetCoverage request. This affects all operations that require interpolation, such as scaling and CRS change.

Note As such, this Interpolation Extension has impact on the operational behaviour described in other WCS extensions, such as the ones mentioned above.

On principle, the set of interpolation types supported is a property of a coverage. Actually, interpolation can be even more localized and constitute a property of particular coverage axes and on particular bands. For example, a coverage may undergo linear interpolation along lat/long axes and nearest neighbour interpolation along time.

However, modelling interpolation this fine-grain would pose severe load on WCS implementations and concrete services. Server implementation is complicated substantially by a dynamic per-axis choice of interpolation methods applied. Reporting interpolation capabilities with individual coverages would lead to substantially larger metadata, and would substantially complicate client-side handling of this information.

Therefore, a mixed approach has been adopted. In the core conformance class of this standard, one interpolation method can be selected by the client which subsequently gets applied along all coverage axes simultaneously. In an optional further conformance class, interpolation-per-axis, for each axis an override can be indicated using a different interpolation method.

Interpolation methods available are reported by the service in its GetCapabilities response; a normative set of specific interpolation techniques is provided by OGC Abstract Topic 6 (which is identical to ISO 19123) [1]; OGC-NA might normatively establish URLs for such interpolation methods.

Support of the Interpolation Extension does not automatically mean that interpolation parameters provided with a request have an effect. Only on operations involving interpolation – such as scaling or reprojection – such parameters will affect the result.
OGC® Web Coverage Service Interface Standard - Interpolation Extension

1 Scope

This OGC WCS Interpolation Extension – in short: Interpolation Extension – defines how a client can control interpolation performed by a server during GetCoverage interpolation, should an interpolation occur in the course of request evaluation.

2 Conformance

This document establishes the following requirements and conformance classes:

- **interpolation**, of URI [http://www.opengis.net/spec/WCS_service-extension_interpolation/1.0/req/interpolation](http://www.opengis.net/spec/WCS_service-extension_interpolation/1.0/req/interpolation); the corresponding conformance class is **interpolation**, with URI [http://www.opengis.net/spec/WCS_service-extension_interpolation/1.0/conf/interpolation](http://www.opengis.net/spec/WCS_service-extension_interpolation/1.0/conf/interpolation).

  This is the mandatory core conformance class of this extension.

- **interpolation-per-axis**, of URI [http://www.opengis.net/spec/WCS_service-extension_interpolation/1.0/req/interpolation-per-axis](http://www.opengis.net/spec/WCS_service-extension_interpolation/1.0/req/interpolation-per-axis); the corresponding conformance class is **interpolation-per-axis**, with URI [http://www.opengis.net/spec/WCS_service-extension_interpolation/1.0/conf/interpolation-per-axis](http://www.opengis.net/spec/WCS_service-extension_interpolation/1.0/conf/interpolation-per-axis).

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_interpolation/1.0/req](http://www.opengis.net/spec/WCS_service-extension_interpolation/1.0/req), conformance test URIs defined in this document are relative to [http://www.opengis.net/spec/WCS_service-extension_interpolation/1.0/conf](http://www.opengis.net/spec/WCS_service-extension_interpolation/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 Interpolation 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_interpolation/1.0](http://www.opengis.net/spec/WCS_service-extension_interpolation/1.0), the document has OGC URI [http://www.opengis.net/doc/IS/WCS_service-extension_interpolation/1.0](http://www.opengis.net/doc/IS/WCS_service-extension_interpolation/1.0).

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

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>
<thead>
<tr>
<th>Range subsetting conformance class</th>
<th>Dependency document</th>
<th>Dependency conformance class</th>
</tr>
</thead>
<tbody>
<tr>
<td>interpolation</td>
<td>OGC 09-110, OGC® Web Coverage Service 2.0 Interface Standard - Core, version 2.0</td>
<td>core</td>
</tr>
<tr>
<td>interpolation-per-axis</td>
<td>This specification</td>
<td>interpolation</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 Interpolation (of a coverage)

Estimation of a – non-existing – range value of a coverage for a location in the coverage which is situated between positions containing range values

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>int</td>
<td><a href="http://www.opengis.net/wcs/interpolation/1.0">http://www.opengis.net/wcs/interpolation/1.0</a></td>
<td>WCS Interpolation 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 Interpolation requirements class

6.1 Overview

This Clause 6 establishes the Interpolation Extension core conformance class, interpolation. Clients and servers supporting this requirements class allow choosing an interpolation method to be applied whenever interpolation takes place during GetCoverage request evaluation. The interpolation method chosen is applied simultaneously along all axes.

6.2 Modifications to GetCapabilities

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

Requirement 1 interpolation/interpolation-identifier:
A WCS service implementing conformance class interpolation of this Interpolation 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_interpolation/1.0/conf/interpolation

Requirement 2 interpolation/capabilities:
The response to a successful GetCapabilities request shall adhere to Figure 1, Table 2, and the XML schema defined for this Interpolation Extension.

Figure 1 presents the UML diagram of the extended Capabilities document. Table 2 details the components added.
Table 3 — Components of \texttt{InterpolationMetadata} structure

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
<th>Data type</th>
<th>Multiplicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>interpolation-Supported</td>
<td>Identifier(s) of interpolation method(s) supported by the server</td>
<td>List of anyURI</td>
<td>zero or more (optional)</td>
</tr>
</tbody>
</table>

**Requirement 3 interpolation/wcsServiceMetadata:**
The response to a successful \texttt{GetCapabilities} request \textbf{shall} contain an \texttt{InterpolationMetadata} element.

Example  The following list is returned in the Capabilities document of a server supporting nearest-neighbor, linear, and quadratic interpolation (URLs are fictitious; see OGC-NA for actually standardized interpolation URIs):

```xml
<int:InterpolationMetadata>
  <int:InterpolationSupported>
    http://www.opengis.net/def/interpolation/OGC/1/nearest-neighbor
  </int:InterpolationSupported>
  <int:InterpolationSupported>
    http://www.opengis.net/def/interpolation/OGC/1/linear
  </int:InterpolationSupported>
  <int:InterpolationSupported>
    http://www.opengis.net/def/interpolation/OGC/1/quadratic
  </int:InterpolationSupported>
</int:InterpolationMetadata>
```

**Requirement 4 interpolation/wcsServiceMetadata-interpolationMethods:**
The \texttt{interpolationSupported} item(s) delivered in the \texttt{ServiceMetadata} element of the response to a successful \texttt{GetCapabilities} request \textbf{shall} consist of a pairwise distinct list of URLs.

Note  The above requirement tentatively does not constrain the admitted URLs to those defined in the \texttt{*-interpolation} requirements classes of this document. This allows vendors to support further types of interpolation. However, implementations should use the interpolation URLs for those interpolation types this standard provides definitions for.
6.3 Modifications to DescribeCoverage

None.

6.4 Modifications to GetCoverage

6.4.1 Modifications to the GetCoverage request

The GetCoverage request is extended with a parameter, globalInterpolation, determining what interpolation technique is to be applied by the server when preparing the GetCoverage response; this interpolation is applied uniformly on all axes of the resulting coverage.

Note: This will be extended in the requirements class defined in Clause 7; the representation in this UML diagram has been prepared for this, explaining why it could be simplified theoretically. Further, the pertaining XML Schema of this Interpolation Extension contains all variants.

Requirement 5 interpolation/GetCoverage-request:
A GetCoverage request shall adhere to Figure 2, Table 3, and the XML schema defined for this Interpolation Extension.

![UML diagram](image)

**Figure 2 — GetCoverage with interpolation support UML diagram**

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
<th>Data type</th>
<th>Multiplicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>globalInterpolation</td>
<td>Interpolation method to be applied on all axes during GetCoverage result preparation</td>
<td>anyURI</td>
<td>one (mandatory)</td>
</tr>
</tbody>
</table>

6.4.2 Modifications to the GetCoverage response

Requirement 6 interpolation/GetCoverage-response:
The contents of the response to a successful GetCoverage request containing an Int::globalInterpolation parameter with value \( m \) shall be obtained by applying in-
interpolation method $m$ any time interpolation takes place during preparation of the response, and along every axis of the coverage being processed.

Note This interpolation is applied uniformly along all axes of the coverages.

### 6.5 Exceptions

<table>
<thead>
<tr>
<th>exceptionCode value</th>
<th>HTTP code</th>
<th>Meaning of exception code</th>
<th>locator value</th>
</tr>
</thead>
<tbody>
<tr>
<td>InterpolationMethod-NotSupported</td>
<td>404</td>
<td>interpolation parameter indicated is not supported by this server (i.e., URL is not known to this server)</td>
<td>interpolation request parameter value</td>
</tr>
</tbody>
</table>

### 6.6 Encodings

#### 6.6.1 GET/KVP Encoding

**Requirement 7** interpolation/GetCoverage-getkvp:

In a GetCoverage request using the GET/KVP protocol as specified in [OGC 09-147r2], an Int::globalInterpolation parameter shall be represented as

```
INTERPOLATION=m
```

where $m$ is an interpolation method identifier.

Example The following KVP fragment resembles a valid interpolation request parameter:

```
...& INTERPOLATION=
    http://www.opengis.net/def/interpolation/OGC/1/linear &...
```

#### 6.6.2 XML/POST Encoding

**Requirement 8** interpolation/GetCoverage-xmlpost:

In a GetCoverage request using the XML/POST protocol as specified in [OGC 09-148r2], an Int::globalInterpolation parameter shall be represented by a GML

```
<int:globalInterpolation>
    http://www.opengis.net/def/interpolation/OGC/1/linear
</int:globalInterpolation>
```

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

```
<int:Interpolation>
    <int:globalInterpolation>
        http://www.opengis.net/def/interpolation/OGC/1/linear
    </int:globalInterpolation/>
</int:Interpolation>
```
6.6.3 SOAP Encoding

**Requirement 9 interpolation/GetCoverage-soap:**
In a _GetCoverage_ request using the SOAP protocol, an `Int::globalInterpolation` parameter **shall** be represented by a GML `int:globalInterpolation` element.

Example  See previous subclause.

7  **Interpolation-per-axis requirements class**

7.1 **Overview**

This Clause 7 establishes the optional Interpolation Extension conformance class, _interpolation-per-axis_. This conformance class specifies how to request and obtain coverages where individual interpolation modes can be applied independently to each axis of the coverage under processing. For those axes where no interpolation is specified in the _interpolation-per-axis_ structures, the default interpolation method passed in the core parameter, `Int::globalInterpolation`, applies.

7.2 **Modifications to GetCapabilities**

**Requirement 10 interpolation-per-axis/identifier:**
A WCS service implementing conformance class _interpolation-per-axis_ of this Interpolation 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_interpolation/1.0/conf/interpolation-per-axis

7.3 **Modifications to DescribeCoverage**

None.

7.4 **Modifications to GetCoverage**

7.4.1 **Modifications to the GetCoverage request**

**Requirement 11 interpolation-per-axis/getCoverage-request:**
The `Int::InterpolationPerAxis` parameter in a _GetCoverage_ request, if present, **shall** have a structure as defined in Figure 3 and Table 6.

**Dependency:**
Clause 6, http://www.opengis.net/doc/IS/WCS_service-extension_interpolation/1.0/Clause-6
Individually for each axis of the coverage, separate interpolation methods can be indicated.

**Requirement 12 interpolation-per-axis/getCoverage-axes:**

The Int::InterpolationPerAxis parameters in a GetCoverage request, if present, shall consist of an unordered sequence of Int::InterpolationPerAxis elements with a structure as defined in Table 6.

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
<th>Data type</th>
<th>Multiplicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>axis</td>
<td>Coverage axis along which the interpolation method is to be applied</td>
<td>anyURI</td>
<td>one (mandatory)</td>
</tr>
<tr>
<td>Interpolation-Method</td>
<td>Interpolation method to be applied along the specified axis during GetCoverage result preparation</td>
<td>anyURI</td>
<td>one (mandatory)</td>
</tr>
</tbody>
</table>

Each axis in the CRS of the coverage can appear at most once, to avoid ambiguities.
Requirement 13 interpolation-per-axis/getCoverage-axes-pairwise-distinct:
In a GetCoverage request containing Int::InterpolationPerAxis parameters, all axis values shall be pairwise distinct.

Requirement 14 interpolation-per-axis/getCoverage-existing-axis:
The axis value of each Int::InterpolationPerAxis parameter in a GetCoverage request shall be identical to the axis Abbrev element of some CRS axis of the CRS identified by the srsName attribute in the gml:Envelope element of the coverage generated.

Note Interpolation always is done towards a target structure (such as an output grid). In presence of an OUTPUTCRS parameter according to the WCS CRS Extension [OGC 11-053], therefore, interpolation has to be expressed on the axes of the CRS indicated in OUTPUTCRS. Otherwise, the coverage’s Native CRS is used.

7.4.2 Modifications to the GetCoverage response

Requirement 15 interpolation-per-axis/getCoverage-response:
The contents of the response to a successful GetCoverage request containing \( n > 0 \) Int::InterpolationPerAxis parameters consisting of \( a_1, \ldots, a_n \) axis identifiers and \( m_1, \ldots, m_n \) interpolation methods shall be obtained by applying interpolation method \( m_i \) on axis \( a_i \) any time interpolation takes place during preparation of the GetCoverage response; for those axes not appearing in this list, the method indicated in the int:globalInterpolation parameter shall be applied.

Example The following is a valid GET/KVP request snippet (see Subclause 7.6) specifying that in general (such as lat, long, height, or whatever axis is present in the coverage) linear interpolation is to be applied, only along the time axis nearest-neighbor is requested (assuming the coverage addressed contains such a temporal axis):

```plaintext
...& INTERPOLATION= http://www.opengis.net/def/interpolation/OGC/1/linear
& INTERPOLATIONPERAXIS=phenomenon-time,
   http://www.opengis.net/def/interpolation/OGC/1/nearest-neighbor
&...
```

7.5 Exceptions

<table>
<thead>
<tr>
<th>exceptionCode value</th>
<th>HTTP code</th>
<th>Meaning of exception code</th>
<th>locator value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NoSuchAxis</td>
<td>404</td>
<td>One or more axis names indicated in the request are not defined in the domain of the output coverage</td>
<td>axis request parameter value</td>
</tr>
<tr>
<td>InterpolationMethod-NotSupported</td>
<td>404</td>
<td>One or more interpolation methods indicated in the request are not supported by this server</td>
<td>first offending interpolation request parameter value</td>
</tr>
</tbody>
</table>
7.6 Encodings

7.6.1 GET/KVP Encoding

**Requirement 16 interpolation-per-axis/getCoverage-getkvp:**

In a GetCoverage request using the GET/KVP protocol as specified in [OGC 09-147r2], an Int::Interpolation parameter containing \( n > 0 \) (Int::axis, Int::interpolationMethod) components \((a_1:m_1),…,(a_n:m_n)\) **shall** be represented as:

\[
\text{INTERPOLATIONPERAXIS}=a_1,m_1 \& \ldots \& \text{INTERPOLATIONPERAXIS}=a_n,m_n
\]

**Example**

The following KVP fragment resembles a valid interpolation request:

```text
…& INTERPOLATION=
   http://www.opengis.net/def/interpolation/OGC/1/linear
 & INTERPOLATIONPERAXIS=lat,
   http://www.opengis.net/def/interpolation/OGC/1/quadratic
 & INTERPOLATIONPERAXIS=long,
   http://www.opengis.net/def/interpolation/OGC/1/quadratic
 & INTERPOLATIONPERAXIS=height,
   http://www.opengis.net/def/interpolation/OGC/1/cubic
 & INTERPOLATIONPERAXIS=phenomenon-time,
   http://www.opengis.net/def/interpolation/OGC/1/nearest-neighbor
 &…
```

7.6.2 XML/POST Encoding

**Requirement 17 interpolation-per-axis/getCoverage-xmlpost:**

In a GetCoverage request using the XML/POST protocol as specified in [OGC 09-148r2], the Int::InterpolationPerAxis parameters, if present, **shall** be represented by GML int:InterpolationPerAxis elements.

**Example**

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

```xml
<int:Interpolation>
  <int:globalInterpolation>
    http://www.opengis.net/def/interpolation/OGC/1/linear
  </int:globalInterpolation>
  <int:InterpolationPerAxis>
    <int:axis>lat</int:axis>
    <int:interpolationMethod>
      http://www.opengis.net/def/interpolation/OGC/1/quadratic
    </int:interpolationMethod>
  </int:InterpolationPerAxis>
  <int:InterpolationPerAxis>
    <int:axis>long</int:axis>
    <int:interpolationMethod>
      http://www.opengis.net/def/interpolation/OGC/1/quadratic
    </int:interpolationMethod>
  </int:InterpolationPerAxis>
  <int:InterpolationPerAxis>
    <int:axis>height</int:axis>
```
<int:interpolationMethod>
   http://www.opengis.net/def/interpolation/OGC/1/cubic
</int:interpolationMethod>
</int:InterpolationPerAxis>
<int:InterpolationPerAxis>
   <int:axis>phenomenon-time</int:axis>
   <int:interpolationMethod>
      http://www.opengis.net/def/interpolation/OGC/1/nearest-neighbor
   </int:interpolationMethod>
</int:InterpolationPerAxis>
</int:Interpolation>

7.6.3 SOAP Encoding

Requirement 18 interpolation-per-axis/getCoverage-soap:
In a GetCoverage request using the SOAP protocol as specified in [OGC 09-149r1], the
int::InterpolationPerAxis parameters, if present, shall be represented by GML
int::InterpolationPerAxis elements.

Example See previous subclause.
Bibliography

Annex A
(normative)

Abstract test suite

An Interpolation 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_interpolation/1.0/conf.

A.1 Conformance Test Class: interpolation

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

A.1.1 Interpolation/interpolation identifier

Test id: interpolation/interpolation-identifier:
Test Purpose: A WCS service implementing conformance class interpolation of this Interpolation Extension shall include the following URI in the Profile element of the ServiceIdentification in a GetCapabilities response: http://www.opengis.net/spec/WCS/2.0/conf/WCS_service-extension_interpolation/1.0/conf/interpolation

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 Interpolation/capabilities

Test id: interpolation/capabilities:
Test Purpose: The response to a successful GetCapabilities request shall adhere to Figure 1, Table 2, and the XML schema defined for this Interpolation Extension.

Test method: Send a GetCapabilities to server under test, and check for proper response.

Test passes if result is as expected.

A.1.3 Interpolation/wcs ServiceMetadata

Test id: interpolation/wcsServiceMetadata:
Test Purpose: The response to a successful GetCapabilities request shall contain an InterpolationMetadata element.
**A.1.4 Interpolation/wcs ServiceMetadata interpolation Methods**

**Test id:** interpolation/wcsServiceMetadata-interpolationMethods:

**Test Purpose:** The interpolationSupported item(s) delivered in the ServiceMetadata element of the response to a successful GetCapabilities request shall consist of a pairwise distinct list of URLs.

**Test method:** Send a GetCapabilities request to server under test, check that the interpolationSupported item(s) of the response consist of a pairwise distinct list of URLs.

Test passes if result is as expected.

**A.1.5 Interpolation/interpolation GetCoverage request**

**Test id:** interpolation/GetCoverage-request:

**Test Purpose:** A GetCoverage request shall adhere to Figure 2, Table 3, and the XML schema defined for this Interpolation Extension.

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

Test passes if expected result is delivered.

**A.1.6 Interpolation/interpolation GetCoverage response**

**Test id:** interpolation/GetCoverage-response:

**Test Purpose:** The contents of the response to a successful GetCoverage request containing an Int::globalInterpolation parameter with value \( m \) shall be obtained by applying interpolation method \( m \) any time interpolation takes place during preparation of the response, and along every axis of the coverage being processed.

**Test method:** Send a GetCoverage request containing an Int::globalInterpolation parameter to server under test, verify that the response is not an exception.

Test passes if result is as expected.
A.1.7 Interpolation/interpolation per axis GetCoverage getkvp

Test id: interpolation/GetCoverage-getkvp:
Test Purpose: In a GetCoverage request using the GET/KVP protocol as specified in [OGC 09-147r2], an int::globalInterpolation parameter shall be represented as
   INTERPOLATION=m
where m is an interpolation method identifier.

Test method: Send a Get/KVP GetCoverage request containing an int::globalInterpolation parameter represented as
   INTERPOLATION=m to server under test, verify that the response is not an exception.

Test passes if result is as expected.

A.1.8 Interpolation/interpolation per axis GetCoverage xmlpost

Test id: interpolation/GetCoverage-xmlpost:
Test Purpose: In a GetCoverage request using the XML/POST protocol as specified in [OGC 09-148r2], an Int::globalInterpolation parameter shall be represented by a GML int:globalInterpolation element.

Test method: Send a XML/POST GetCoverage request containing an Interpolation::InterpolationMethod parameter represented by an int::InterpolationMethod element, verify that the response is not an exception.

Test passes if result is as expected.

A.1.9 Interpolation/interpolation per axis GetCoverage soap

Test id: interpolation/GetCoverage-soap:
Test Purpose: In a GetCoverage request using the SOAP protocol, an Int::globalInterpolation parameter shall be represented by a GML int:globalInterpolation element.

Test method: Send a SOAP GetCoverage request containing an Interpolation::InterpolationMethod parameter represented by an int::InterpolationMethod element, verify that the response is not an exception.

Test passes if result is as expected.
A.1.10 Interpolation-per-axis/identifier

Test id: interpolation-per-axis/identifier:
Test Purpose: A WCS service implementing conformance class interpolation-per-axis of this Interpolation 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_interpolation/1.0/conf/interpolation-per-axis

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.1.11 Interpolation-per-axis/getCoverage request

Test id: interpolation-per-axis/getCoverage-request:
Test Purpose: The Int::InterpolationPerAxis parameter in a GetCoverage request, if present, shall have a structure as defined in Figure 3 and Table 6.
Dependency: Clause 6, http://www.opengis.net/doc/IS/WCS_service-extension_interpolation/1.0/Clauses-6

Test method: Send GetCoverage requests testing server response on the cases distinguished in said reference, and check for proper response.

Test passes if expected result is delivered.

A.1.12 Interpolation-per-axis/getCoverage axes

Test id: interpolation-per-axis/getCoverage-axes:
Test Purpose: The Int::InterpolationPerAxis parameters in a GetCoverage request, if present, shall consist of an unordered sequence of Int::InterpolationPerAxis elements with a structure as defined in Table 6.

Test method: Send GetCoverage requests testing server response on the cases distinguished in said reference, and check for proper response.

Test passes if expected result is delivered.

A.1.13 Interpolation-per-axis/getCoverage-axes-pairwise-distinct

Test id: interpolation-per-axis/getCoverage-axes-pairwise-distinct:
Test Purpose: In a GetCoverage request containing Int::InterpolationPerAxis parameters, all axis values shall be pairwise distinct.
Test method: Send GetCoverage requests to the service under test containing:

- two int::InterpolationPerAxis elements with different axis names. Verify that request succeeds.
- two int::InterpolationPerAxis elements with identical axis names. Verify that request fails.

Test passes if expected result is delivered.

A.1.14 Interpolation-per-axis/getCoverage existing axis

Test id: Test Purpose:
The axis value of each Int::InterpolationPerAxis parameter in a GetCoverage request shall be identical to the axisAbbrev element of some CRS axis of the CRS identified by the srsName attribute in the gml:Envelope element of the coverage generated.

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

- identical to the identifier of a domain axis in the coverage addressed. Verify that request succeeds.
- not identical to any domain axis identifier in the coverage addressed. Verify that request fails.

Test passes if expected result is delivered.

A.1.15 Interpolation-per-axis/getCoverage response

Test id: Test Purpose:
interpolation-per-axis/getCoverage-response:
The contents of the response to a successful GetCoverage request containing \( n > 0 \) Int::InterpolationPerAxis parameters consisting of \( a_1, ..., a_n \) axis identifiers and \( m_1, ..., m_n \) interpolation methods shall be obtained by applying interpolation method \( m_i \) on axis \( a_i \) any time interpolation takes place during preparation of the GetCoverage response; for those axes not appearing in this list, the method indicated in the int:globalInterpolation parameter shall be applied.

Test method: Send a GetCoverage request containing, an Interpolation::InterpolationAxes parameter with \( n > 0 \) Interpolation::InterpolationAxis components consisting of \( a_1, ..., a_n \) axis identifiers and \( m_1, ..., m_n \) interpolation method, check that response is correct.

Test passes if result is as expected.
A.1.16 Interpolation-per-axis/getCoverage getkvp

Test id: interpolation-per-axis/getCoverage-getkvp:
Test Purpose: In a GetCoverage request using the GET/KVP protocol as specified in [OGC 09-147r2], an Int::Interpolation parameter containing \( n > 0 \) (Int::axis, Int::interpolationMethod) components \((a_1:m_1), ..., (a_n:m_n)\) shall be represented as

\[
\text{INTERPOLATIONPERAXIS}=a_1:m_1 \quad \& \quad ... \quad \& \quad \text{INTERPOLATIONPERAXIS}=a_n:m_n
\]

Test method: Send a GET/KVP GetCoverage request containing an Int::Interpolation parameter containing \( n > 0 \) Int::InterpolationAxis components represented as INTERPOLATIONPERAXIS = \(a_1:m_1, ..., a_n:m_n,\) where each \(a_i\) is an axis identifier URL and each \(m_i\) is an interpolation identifier URL, verify that the response is not an exception.

Test passes if result is as expected.

A.1.17 Interpolation-per-axis/getCoverage xmlpost

Test id: interpolation-per-axis/getCoverage-xmlpost:
Test Purpose: In a GetCoverage request using the XML/POST protocol as specified in [OGC 09-148r2], the Int::InterpolationPerAxis parameters, if present, shall be represented by GML int:InterpolationPerAxis elements.

Test method: Send a valid XML/POST GetCoverage request containing int::InterpolationPerAxis elements, verify that the response is not an exception.

Test passes if result is as expected.

A.1.18 Interpolation-per-axis/getCoverage-soap

Test id: interpolation-per-axis/getCoverage-soap:
Test Purpose: In a GetCoverage request using the SOAP protocol as specified in [OGC 09-149r1], the int::InterpolationPerAxis parameters, if present, shall be represented by GML int:InterpolationPerAxis elements.

Test method: Send a SOAP GetCoverage request containing int::Interpolation elements, verify that the response is not an exception.

Test passes if result is as expected.

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

<table>
<thead>
<tr>
<th>Date</th>
<th>Release</th>
<th>Author</th>
<th>Paragraph modified</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012-06-20</td>
<td>0.0.1</td>
<td>Peter Baumann</td>
<td>All</td>
<td>Created</td>
</tr>
<tr>
<td>2012-08-12</td>
<td>0.0.2</td>
<td>Peter Baumann</td>
<td>All</td>
<td>Formalized requirements</td>
</tr>
<tr>
<td>2012-12-03</td>
<td>0.1.0</td>
<td>Peter Baumann, Jin-songdi Yu</td>
<td>Several, in particular: Annex A</td>
<td>Completed, added ATS</td>
</tr>
<tr>
<td>2014-01-01</td>
<td>1.0.0</td>
<td>Peter Baumann, Jin-songdi Yu</td>
<td>All</td>
<td>Finalized after adoption vote; removed interpolation method URL definition, as this is now supposed to be done by OGC-NA</td>
</tr>
</tbody>
</table>