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OGC® Name Type Specification for CRSs

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Preface

This document specifies a Name Type Specification (NTS) for predefined, combined, and parameterized Coordinate Reference System (CRS) definitions. This NTS augments the `/def/` namespace with http URI definitions for CRSs.

NTSs are maintained by the OGC Naming Authority (OGC-NA).

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

ii. 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.

iii. Submitting organizations

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

• Jacobs University Bremen	• rasdaman GmbH

iv. Document Contributor Contact Points

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v. Revision history

Date	Release	Author	Paragraph modified	Description
2011-09-19	0.0.1	Peter Baumann	All	Created, from 07-092r3
2011-10-10	0.0.2	Peter Baumann	All	Consolidated URL types
2012-06-22	0.9.0	Peter Baumann	All	Finalized as BP
2012-06-22	1.0.0	Peter Baumann	Annex B all	Added /equals comparison service A few editorial improvements

vi. Changes to the OpenGIS® Abstract Specification

The OpenGIS® 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:

- Eventually move this document to Policy Standard status
- Extend CRS URLs with CRS concatenation capabilities
- Investigate on the need of URL identifiers for Coordinate System, datum, ellipsoid, prime meridian, etc.
- Change Request CR to GML to establish EnvelopeWithCRSType (similar to EnvelopeWithTimePeriodType).

Foreword

This document establishes a Name Type Specification (NTS) for Coordinate Reference Systems (CRSs). It is based on the Name Type Specification – definitions – part 1 – basic name [OGC 09-048r3] and supersedes OGC document "Definition identifier URNs in OGC namespace" [OGC 07-092r3].

This document includes one Annex, a user guide to the OGC CRS resolver.

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

Practically all OGC specifications make heavy use of Coordinate Reference Systems to relate object locations in space and time to some reference position. A vast amount of different definitions is in practical use, covering horizontal (geodetic) extents, height, and time. New definitions arise, such as in planetary sciences.

For all of these CRSs, a simple, expressive, and Web compatible mechanism is required allowing software to create, identify, and understand CRSs and their definitions. This document establishes a convention for naming CRSs within OGC. In particular, the scheme supports the following use cases:

- Predefined CRSs, such as ISO 8601 for time;
- Families of predefined CRSs, such as the EPSG list;
- Compound CRSs, such as the result of an x/t slicing through an x/y/t datacube through a WCS or WCPS operation;
- Predefined dimensions (also referred to as “domain axes”), such as *latitude*.

OGC® Name Type Specification for CRSs

1 Scope

This OGC specification defines a syntax, based on http URIs, for specifying CRSs, including compound parameterized CRSs. Strings conforming to this syntax are called *CRS URIs*. The semantics of such definitions will be established by a registry service to be set up by OGC in the future. Consequently, the specification on hand does not define concrete URIs.

2 Conformance

This document establishes the following requirements and conformance classes:

- *crs*, of URI http://www.opengis.net/spec/crs-nts/1.0/req/crs; the corresponding conformance class is *crs*, with URI http://www.opengis.net/spec/crs-nts/1.0/conf/crs.

  This is the mandatory core of this Name Type Specification for CRS Policy Standard.

- *crs-axis*, of URI http://www.opengis.net/spec/crs-nts/1.0/req/crs-axis; the corresponding conformance class is *crs-axis*, with URI http://www.opengis.net/spec/crs-nts/1.0/conf/crs-axis.

- *crs-compound*, of URI http://www.opengis.net/spec/crs-nts/1.0/req/crs-compound; the corresponding conformance class is *crs-compound*, with URI http://www.opengis.net/spec/crs-nts/1.0/conf/crs-compound.

Standardisation target of all requirements and conformance classes are HTTP URIs.

Requirements and conformance test URIs defined in this document are relative to http://www.opengis.net/spec/crs-nts/1.0/.

3 Normative references

An OGC name may be provided for a *definition* of a type of object broadly classified as a "concept" or system parameter. The precise scope of definitions that may be identified with OGC Names is provided by the set of items in the register at http://urn.opengis.net/register/OGC-NA/deftype.

This Name Type Specification for CRSs is available for download from http://www.opengeospatial.org/standards/bp/.

The following normative documents 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.

OGC 08-015r2, *The OpenGIS Abstract Specification, Topic 2: Spatial Referencing by Coordinates, version 4.0*

OGC 09-046r2, OGC Naming Authority - Procedures http://www.opengis.net/doc/ogc-na-policies

OGC 09-048r3, *Name type specification – definitions – part 1 – basic name*, version 1.1

OGC 07-036, Geography Markup Language (GML) Encoding Standard, version 3.2.1

4 Name assignment policy

4.1 Document types

The register of document types http://www.opengis.net/register/ogc-na/doc-type is controlled by OGC-NA. Changes to this register (additions, deletions, and supercession) shall be initiated by a submission to the OGC Naming Authority names@opengeospatial.org .

4.2 Document element types

The registers of document element types is controlled by OGC-NA. Changes to this register (additions, deletions, and supercession) shall be by application to ogcna@lists.opengeospatial.org. The current state of the register of document element types is shown at http://www.opengis.net/register/ogc-na/doc-element-type.

4.3 Names

The register of names http://www.opengis.net/register/ogc-na/name is controlled by OGC-NA. Changes to this register (additions, deletions, and supercession) shall be initiated by a submission to the OGC Naming Authority names@opengeospatial.org .

Note The approval of any new public document by OGC shall automatically trigger a registration request to OGC-NA. The name assigned shall be included on the cover page of the document.

5 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.

5.1 CRS

Coordinate Reference System

5.2 CRS axis

fixed reference line of a →*CRS*

5.3 CRS definition

GML fragment whose root is of some instantiatable subtype of `GML::AbstractCRS` as defined in [OGC 07-036]

Example see Subclause 0.

5.5 CRS Identifier

URI resolving to exactly one well-known →*CRS definition*

Example 1 WGS84 has this CRS Identifier registered with OGC-NA 0:
http://www.opengis.net/def/crs/EPSG/0/4326
This is equivalent to:
http://www.opengis.net/def/crs?authority=EPSG&version=0&code4326

Example 2 ISO 8601 0 (for time axes) has this Unique CRS Identifier registered with OGC-NA 0:
http://www.opengis.net/def/crs/ISO/2004/8601

5.6 Compound CRS

non-repeating sequence of two or more single →CRSs, none of which can itself be compound

Note There are more constraints than this one (which stems from OGC Abstract Topic 2 [OGC 08-015r2]; however, as the detailed CRS semantics is not a focus of this specification, such constraints are not addressed further .

5.7 CRS Template

→*CRS* boilerplate which, when provided with concrete values for its formal parameters, resembles a →*CRS definition*

6 Conventions

6.1 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 1 — Namespace mappings

Prefix	Namespace URI	Description
`xsd`	http://www.w3.org/2001/XMLSchema	XML Schema namespace

gml	http://www.opengis.net/gml/3.2	GML 3.2.1
crsnts	http://www.opengis.net/crs-nts/1.0 (not yet authoritative)	CRS Name Type Specification

Note the crsnts namespace is only needed for dealing with CRS Templates as described in Annex A. It is not needed for handling CRS URIs, nor is it needed for handling GML CRS definitions.

7 CRS definition and identifier

7.1 Overview

When expressing the location of some object in space and time through coordinates, these coordinates need to have an unambiguous reference, which usually is given by a Coordinate Reference System (CRS). Typically, however, it is inconvenient for both producer and consumer of such information to communicate the complete definition of the CRS used; rather, a unique identifier is preferred – this even more as the vast majority of applications rely on some community accepted standard CRSs.

The OWS Common standard [OGC 06-121r9] specifies that each specific OWS shall always reference a CRS by using a XML attribute or element with the type `anyURI`. Such an `anyURI` value can be used to reference a CRS whether the definition of that CRS is included in the same data transfer, is NOT included in the same data transfer, cannot be electronically accessed, or can be electronically accessed. Subclause 10.3.2 of OWS Common specifies when and how to use URLs to reference a CRS or CRS-related object. Subclause D.14 summarizes many of the requirements considered when specifying how to reference CRSs.

The specification on hand defines the syntax of such `anyURI` items. In its basic form, a URI uniquely identifies a CRS (see Subclause **Error! Reference source not found.**). Through a parametrization mechanism, the mere identification is extended beyond single CRS Identifiers to also express sets of CRSs (See Subclause **Error! Reference source not found.**) and ad-hoc combination of CRS components (see Subclause **Error! Reference source not found.**).

OGC specifications may allow parameterized URIs in some places, and sometimes require Unique CRS URIs.

Example A typical situation occurs with the OGC Web Coverage Service (WCS) 0. Its CRS Extension 0 allows not completely specified CRS URIs in the Capabilities document, thereby enabling a compact presentation of the CRSs supported by a particular service. In a *GetCoverage* request, on the other hand, a Unique CRS URI must be passed to the server to concretely specify the coordinate transformation to be applied.

7.2 Conformance class

This Clause establishes conformance class *crs*. This is the mandatory core conformance class of this Policy specification.

BNF notation used is the same as in IETF RFC 2396 0.

7.3 Syntax

7.3.1 General CRS Identifier syntax

Requirement 1 /req/crs-nts/query-format:
In the RESTful format variant, a CRS Identifier **shall** be a URL which has the common URL format as defined in IETF RFC 2396 0:

```
[ ”http:” hier_part [ ”?” query ] ] [ ”#” fragment ]
```

Requirement 2 /req/crs-nts/reserved-chars:
In a CRS Identifier, characters in values which are reserved in [OGC 09-048r3] **shall** be encoded in the percent notation defined in IETF RFC 2396 0.

Example 1 A coverage document may contain a local CRS definition referred to by the `srsName` attribute:
`srsName="#my_local_CRS"`

Example 2 Company ACME may offer CRS definitions (i.e., employ a CRS Identifier resolver) understanding CRS URLs like http://www.acme.com/def/this-is-EPSG-4326.

Example 3 The following URL resolves to a set of CRSs, namely all EPSG CRSs, in their current version, available in the OGC CRS Name Resolver: http://www.opengis.net/def/crs/EPSG/0/.

Example 3 The following URL resolves to a set of CRSs, namely all EPSG CRSs, in their current version, available in the OGC CRS Name Resolver: http://www.opengis.net/def/crs/EPSG/0/.

NOTE Generally, not all possible parameter values will identify some existing (or meaningful) CRS. The authoritative decision about validity of OGC CRS URIs is with the OGC CRS Name Resolver with service endpoint www.opengis.net/def.

Example 1 The OGC CRS Name Resolver returns a GML CRS definition of the WGS84 reference system when provided with URL http://www.opengis.net/def/crs/EPSG/0/4326.

Example 2 The OGC CRS Name Resolver returns a 404 error code when provided with URL http://www.opengis.net/def/crs/EPSG/0/this-is-not-a-valid EPSG-identifier.

7.3.2 Query format

Requirement 3 /req/crs-nts/query-format:
In the query format variant, a CRS Identifier **shall** be constructed as an http GET query, following the common URL format as defined in IETF RFC 2396 0:
`"http:" hier_part "?" par1 "=" val1 "&" par2 "=" val2 "&" …`
where `par1`, `par2` etc. represent parameter names and `val1`, `val2`, etc. the value passed for the corresponding parameter as described in Table 2.

Note Like URIs in general 0, the domain part is case insensitive while the path and query part is case sensitive.

Example The following does not identify a CRS, but an (infinite) CRS set because the `CenterLatitude` parameter is not provided (cf. Annex A):
http://www.opengis.net/def/crs?authority=OGC&version=1.3&code=AUTO42003&UoM=m&CenterLongitude=-100

Admissible parameters for a query against a given CRS or set of CRSs are given by the service and by the individual CRS(s) interrogated. Table 2 lists CRS URI parameters reserved by OGC, together with their meanings. Further parameters are allowed, as long as they do not conflict with the definitions of this standard

Requirement 4 /req/crs-nts/no-dupes:
A CRS Identifier **shall** not contain duplicate keys.

Note A parameterless request to a resolver will return all CRSs known to this service. In case of a client side programming bug this would constitute an undesirable behaviour as the amount of data presumably will be substantial. A server, therefore, may implement internal limits in the amount of information delivered and respond with an exception upon transgression of this limit.

Table 2 — CRS URI query parameters

name	definition	data type
`authority`	the OGC-specified abbreviation for the authority organization that specified the referenced definition. As such, it identifies an authority recognized by the OGC. Example Among the admissible authorities are “EPSG” and “ISO”.	`NCName`
`Version`	the version of the authority or code for the referenced definition. When the referenced definition does not have a version the string “0” (without quotes) shall be used.	`String`
`Code`	Unique identifier of the referenced CRS definition, as specified by the referenced authority. Example “4326” is the EPSG code for WGS84.	`String`

Note The `version` format is sometimes “N.N.N” or “N.N”, where each “N” stands for an integer. If no other version identification is provided by the authority, a four-digit year or other date can be used. No "v" or other version prefix is used by OGC.

7.3.3 Path format

In the special case that the CRS identifier is one of

- Authority, but no version nor code;
- authority and version, but no code;
- authority and version and code,

the path variant, i.e., a RESTful syntax, can be used alternatively to the query syntax.

Requirement 5 /req/crs-nts/path-format:
A CRS Identifier in path format **shall** conform to one of the following syntax variants:
- `”http:” hier_part ”/” AUTHORITY`
  shall be equivalent to
  `”http:” hier_part ”?” authority ”=” AUTHORITY`
- `”http:” hier_part ”/” AUTHORITY ”/” VERSION`
  shall be equivalent to
  `”http:” hier_part ”?” authority ”=” AUTHORITY`


```
                    "&" version "=" VERSION
-   "http:" hier_part "/" AUTHORITY "/" VERSION "/" CODE
    shall be equivalent to
    "http:" hier_part "?" authority "=" AUTHORITY
                    "&" version "=" VERSION
                    "&" code "=" CODE
```

where the placeholders `AUTHORITY`, `VERSION`, and `CODE` denote admissible values for the corresponding lower-case variable parts defined in Table 2.

Example The two URIs below are equivalent:
http://www.opengis.net/def/crs/EPSG/0/4326
http://www.opengis.net/def/crs//0/4326&authority=EPSG

Example 1 The URI for the OGC CRS with code 4326 specified in the EPSG database 0 can be expressed as
http://www.opengis.net/def/crs/EPSG/0/4326

Example 2 The URI for all OGC / EPSG CRSs in the EPSG database 0 can be expressed as
http://www.opengis.net/def/crs/EPSG

Example 3 OGC time coordinates following ISO 8601 0 can be expressed as
http://www.opengis.net/def/crs/ISO/2004/8601

Example 4 A fictitious organization, ACME, might establish its own proprietary EPSG 4326 definition through http://www.acme.com/def/this-is-EPSG-4326.

Note This syntax establishes backward compatibility to pre-existing OGC CRS URIs.

7.4 Predefined CRS

A *Predefined CRS URI* is a CRS Identifier URI which does not contain any other component aside from those established in this Clause 6.

7.5 CRS definition

The resource pertaining to a CRS Identifier shall be the GML representation of the CRS identified. A CRS axis definition shall be given as an XML fragment with root element `gml:AbstractCRS` as defined in GML [OGC 07-036].

Note Such a GML document contains the definition of a single CRS.

Example A GML document describing the WGS84 reference system can be found at URL
http://www.epsg-registry.org/export.htm?gml=urn:ogc:def:crs:EPSG::4326

8 Axis identifiers

8.1 Overview

Coordinate system axes can be spatial (example: latitude, elevation), temporal, or none of both (example: pressure). While these concepts are uniquely defined, they frequently have several synonyms,

for example, elevation is synonymous to bathymetry, altitude, height, and z. Likewise, CRS Axis URIs uniquely define axes for use in CRS definitions, but allow synonyms.

8.2 Conformance class

This Clause 8 establishes conformance class *crs-axis*. It normatively depends on conformance class *crs* contained in this document.

8.3 Syntax

Requirement 6 /req/crs-axis/path-format:
A *CRS Axis Identifier* is a URL which has the common URL format as defined in IETF RFC 2396 0:
`[ "http:" hier_part [ "?" query ] ] [ "#" fragment ]`

Note Following URI construction rules 0, parameter keys in the `query` are case insensitive, while values are case sensitive.

Example 1 A coverage document may contain a local CRS definition containing a locally defined axis referred to by `#my_local_z_axis`.

Example 2 Company ACME may offer CRS definitions (i.e., employ a CRS Identifier resolver) understanding CRS URLs like http://www.acme.com/def/axis/this-is-latitude.

Example 3 The OGC definition of latitude is retrieved through this URL when passed to the OGC CRS Name Resolver: http://www.opengis.net/def/axis/latitude

.

Requirement 7 /req/crs-axis/reserved-chars:
In an Axis Identifier, characters in values which are reserved in [OGC 09-048r3] **shall** be encoded in the percent notation defined in IETF RFC 2396 0.

8.4 Semantics

Requirement 8 /req/crs-axis/semantics:
The resource pertaining to an Axis Identifier **shall** be the GML representation of the coordinate axis identified, as a GML document with root element `gml:CoordinateSystemAxis`.

Example Axis URL http://www.opengis.net/def/axis/elevation identifies this axis:

```
<epsg:AxisName gml:id="epsg-axisname-9904">
  <metaDataProperty>
    …
  </metaDataProperty>
  <description>Height influenced by the Earth's gravity field.
    In particular, orthometric height or normal height which are both
    approximations of the distance of a point above sea level.
    Positive upwards.
  </description>
  <identifier codeSpace="OGP">
    http://www.opengis.net/def/axis-name/EPSG/0/9904
```

```
  </identifier>
  <name>Gravity-related height</name>
  <remarks>Used in a 1D vertical coordinate system.</remarks>
</epsg:AxisName>
```

Requirement 9 /req/crs-axis/compatibility:
In a CRS Identifier, a particular axis **shall** not occur more than once.

Note This will likely be formalized in future by normatively defining synonyms; see OGC Abstract Topic 2 / ISO 19111 [OGC 08-015r2] for a naming scheme.

9 Compound CRS

9.1 Overview

A *Compound CRS* is a CRS consisting of a non-repeating sequence of two or more single coordinate reference systems, none of which can itself be compound, as defined in OGC Abstract Topic 2 / ISO 19111-2 [OGC 08-015r2]. This way, Compound CRSs allow to establish higher-dimensional CRSs. This Clause 8 describes a URI-based naming scheme for Compound CRSs.

9.2 Conformance class

This Clause 9 establishes conformance class *crs-compound*. It normatively depends on conformance classes *crs* and *crs-template* contained in this document.

9.3 Syntax

A special case of a CRS URI is when the parameter value provided itself is a URI, such as CRSs and coordinate axes.

Note In future, further CRS components may become included here, such as datum.

A *Compound CRS URI* is a CRS Identifier with code `crs-compound`, together with further numbered parameters whose values are URIs themselves. A Compound CRS URI describes recombination of CRSs into a new CRS.

Requirement 10 /req/crs-compound/format:
A CRS Identifier in *Compound CRS URI* format **shall** contain a path element `crs-compound`.

Requirement 11 /req/crs-compound/input-crs-list:
A CRS Identifier in *Compound CRS URI* format **shall** contain *n*>1 query parameters with keys "1" through "*n*" whose corresponding values are CRS Identifiers.

Requirement 12 /req/crs-compound/predefined-crs-only:
A CRS Identifier in *Compound CRS URI* format **shall**, in its query parameters, only contain Predefined CRS Identifiers.

Requirement 13 /req/crs-compound/no-duplicates:
A CRS Identifier in *Compound CRS URI* format **shall** not contain duplicate CRS Identifiers in the numbered query parameters.

Note 1 A CRS Identifier respecting requirements class *crs-compound*, regardless of whether expressed in query or path format, may contain additional query parameters, as long as no parameter name conflicts occur.

Note 2 There does not need to pre-exist any well-known CRS definition matching this new CRS.

Example Obtaining pressure/time slices from a 4D latitude/longitude/time/pressure atmospheric data cube requires a pressure/time CRS, for which no CRS standard exists.

Requirement 14 /req/crs-compound/unique-axes:
In a Compound CRS URI, all axes in the CRSs listed **shall** be pairwise different.

Note Axes can be the same while their identifiers are distinct.

Example 1 To define a 3D spatio-temporal CRS for satellite image time series, with axis order latitude-longitude-time, WGS84 may be combined with ISO 8601:

http://www.opengis.net/def/crs-compound?
1=http://www.opengis.net/def/crs/EPSG/0/4326
&2=http://www.opengis.net/def/crs/ISO/2004/8601

Example 2 The URI for combining the CRSs EPSG 4269 (NAD83) and EPSG 5713 (Canadian Geodetic Vertical Datum of 1928 height is:

http://www.opengis.net/def/crs-compound?
1=http://www.opengis.net/def/crs/EPSG/0/4269
&2=http://www.opengis.net/def/crs/EPSG/0/5713

Requirement 15 /req/crs-compound/axis-sequence:
In the CRS definition resulting from resolving a Compound CRS, axes **shall** appear in the order (i) of the query parameters listed in the URI and (ii) of the axis order within each CRS listed.

Example In a request like

/def/crs-compound?1=crs1&2=crs2

where crs1 has axis order (a,b) and crs2 has axis order (c,d), the resulting CRS will have an axis order of (a,b,c,d).

Bibliography

[1] ISO 8601:2004(E) *Data elements and interchange formats — Information interchange — Representation of dates and time*
[2] www.epsg.org
[3] IETF RFC 2396 (August 1998), *Uniform Resource Identifiers (URI): Generic Syntax*, http://www.ietf.org/rfc/rfc2396.txt
[4] IETF RFC 5234 *Augmented BNF for Syntax Specifications: ABNF* (2008). http://tools.ietf.org/html/rfc5234
[5] OGC 09-110r3, OGC *Web Coverage Service 2.0 Interface Standard Core*, version 2.0. http://www.opengeospatial.org/standards/wcs
[6] OGC 11-053, OGC *Web Coverage Service 2.0 Interface Standard – CRS Extension*, version 1.0. http://www.opengeospatial.org/standards/wcs
[7] JSR-233 *Scripting for the Java Platform*. http://jcp.org/aboutJava/communityprocess/final/jsr223/
[8] W3C, *XQuery 1.0: An XML Query Language (Second Edition)*, W3C Recommendation, 14 December 2010. http://www.w3.org/TR/xquery/

Annex A
(non-normative)

OGC CRS Name Resolver

This Annex describes the OGC CRS Name Resolver for CRS URIs as defined in this specification. The OGC CRS Name Resolver delivers definitions identified by CRS and Axis URIs, provides CRS Template definitions, and builds CRS specifications through composition and concatenation.

A.1 Implementation and availability

The source code of this CRS Name Resolver, SECORE, is provided open-source under GNU LGPL as part of the rasdaman software available from www.rasdaman.org.

SECORE is implemented in Java using the BaseX embedded XML database system. In the rasdaman source tree it can be found in subdirectory applications/secore.

A.2 Service elements

The OGC CRS Name Resolver accepts Axis Identifiers, CRS Identifiers, and CRS Template Identifiers as input URLs. Further, it accepts general XQuery requests on its CRS database.

A.3 Service URI

The OGC CRS Name Resolver is accessible at the following service endpoint:

- http://www.opengis.net/def/axis for Axis Identifier URLs
- http://www.opengis.net/def/crs for CRS Identifier URLs and CRS Template URLs
- http://www.opengis.net/def/crs-compound for Compound CRS URLs
- http://www.opengis.net/def/crs-equals for semantic CRS URL comparison
- http://www.opengis.net/def/crs-query for XQuery requests

A.4 Service syntax

The OGC CRS Name Resolver accepts queries in GET-KVP and RESTful syntax as defined in this Name Type Specification.

A.5 Resolution

Resolution of a CRS URL results in either a CRS Definition, a CRS Template, or an exception.

Parameters in the URL query shall all match; non-matching parameters shall raise an exception.

A.6 CRS Templates

A.6.1 Overview

CRS Templates are CRSs parameterized with one or more named parameters which are declared explicitly in the CRS Template definition. As such, they describe (possibly infinite) sets of concrete CRSs.

Note The term "parameterized" is generally avoided because it may lead to confusion with the term "parametric" in OGC Abstract Topic 2 / ISO 19111-2 [10] which has a significantly different meaning.

Parameters can be resolved through values provided in the CRS URI, or through defaults defined in the CRS Template definition. Additionally, expressions ("formulae") can be associated with a CRS Template which evaluate to values when instantiated with parameter values. All values, whether instantiated in a URL request or coming from a default or a formula, can be substituted in one or several places in the concrete CRS definition associated with the CRS Template.

Example The following URI defines the Auto Orthographic CRS 42003 specified in Subclauses 6.7.3.4 and B.9 of WMS 1.3 **Error! Reference source not found.** for "meter" as unit of measure and centered at 100° West longitude and 45° North latitude:
http://www.opengis.net/def/crs?authority=OGC&version=1.3&code=AUTO42003&UoM=m&CenterLongitude=-100&CenterLatitude=45

Note Additional examples of not-completely-specified objects are specified in Subclauses B.7, B.8, B.10, and B.11 of WMS 1.3 **Error! Reference source not found.**, and in Subclauses 10.1 through 10.3 of [OGC 05-096r1] **Error! Reference source not found.**.

A.6.2 Structure

Formally, a *CRS Template* is a GML document with root `crsnts:AbstractCRSTemplate`. It references a target, concrete CRS of some instantiatable subtype of `gml:AbstractCRS` together with a list of formal parameters.

Parameters are `crsnts:parameter` elements listed in the `crsnts:parameters` section. A formal parameter consists of a locally unique name, an optional XPath target expression indicating one or a set of substitution points relative to the CRS subnode, and an optional value which can be a mathematical formula.

The `crsnts:value` element contains a well-formed formula adhering to the JSR scripting syntax as specified in JSR-233 [7]. The type associated in the formula's `crsnts:parameters` element denotes the result type of the expression. Names enclosed in ${ and } which are used in a formula must contain only references to parameter names defined in the same CRS Template, and no (direct or indirect) recursive references across formulae.

Note In particular, a formula cannot have its own parameter name as a free parameter.

The target expression in `crsnts:target` indicates the places where, during request evaluation, the resulting parameter (obtained from URL input, or formula evaluation, or by using the default) gets applied to the CRS definition, assuming `crsnts:CrsDefinition` as the relative document root for XPath evaluation.

Example The following XML snippet defines a geodetic CRS Template with formal parameter `x` substituting parameter values in all (fictitious) `axisName` elements appearing the `GeodeticCRS` root of the CRS definition:

```
<crsnts:ParameterizedCRS>
  <gml:identifier>http://www.opengis.net/def/crs/AUTO/1.3/42001
  </gml:identifier>
  <gml:scope>…</gml:scope>
  <crsnts:parameters>
    <crsnts:parameter name=”lon”>
      <crsnts:value>90</crsnts:value>
      <crsnts:target>//longitude | //Longitude</crsnts:target>
    </crsnts:parameter>
    <crsnts:parameter name="zone">
      <crsnts:target>//greenwichLongitude</crsnts:target>
      <crsnts:value>
        min(floor((${lon} + 180.0) / 6.0) + 1,60)
      </crsnts:value>
    </crsnts:parameter>
  </crsnts:parameters>
  <crsnts:targetReferenceSystem
   xlink:href="http://www.opengis.net/def/crs/EPSG/0/4326"/>
</crsnts:ParameterizedCRS>
```

A.6.3 Resolution

The result of a URI request against a CRS Template depends on the degree of parameter matching, it is GML document with its root being an instantiatable subtype of either `gml:AbstractCRS` or `crsnts:AbstractCRSTemplate`. The response is:

- In case all formal parameters in the CRS Template addressed are matched: a CRS definition where all parameters matched are resolved.

  Example Assuming that the name of the above CRS Template example is `my-own-crs`, a possible instantiation of this CRS Template to a concrete CRS Identifier is
  `http://www.opengis.net/def/crs/my-own-crs?lon=47.6`

  The response to this instantiation is

  ```
  <gml:GeodeticCRS>
    …
  <gml:GeodeticCRS>
  ```

- In case not all parameters are matched: a CRS Template where all parameters matched are resolved, their corresponding `crsnts:Parameter` is removed, and only the non-matched parameters remain in the template.

  Example Assuming the same example as above, the CRS Template itself can be obtained through
  `http://www.opengis.net/def/crs/my-own-crs`

  The response to this request is

```
<crsnts:ParameterizedCRS>
  <gml:identifier>http://www.opengis.net/def/crs/my-own-crs
  </gml:identifier>
  <gml:scope>…</gml:scope>
  <crsnts:parameters>
    …
  </crsnts:parameters>
  <crsnts:targetReferenceSystem xlink:href="…"/>
</crsnts:ParameterizedCRS>
```

The corresponding XML Schema is available from http://schemas.opengis.net/crs-nts.

A.7 CRS equality

It is possible that one and the same CRS, axis, etc. is identified by a number of syntactically different URLs, and it is not straightforward for applications to decide about equivalence of two given URIs. To remedy this, a comparison predicate is available in the resolver. A request sent to URL

http://www.opengis.net/def/equals

containing two URLs listed as GET/KVP parameters with names `1` and `2`, respectively, will result in a response of `true` if and only if both URLs identify the same concept, and `false` otherwise; the response is embedded in an XML document.

Example Comparing EPSG codes 4327 and 4326 can be done with this URL:
http://www.opengis.net/def/crs-equals?
1=http://www.opengis.net/def/crs/EPSG/0/4327
&2=http://www.opengis.net/def/crs/EPSG/0/4326

The response will look like this (note that the name space is not yet authoritative):

```
<crsnts:comparisonResult
  xmlns='http://www.opengis.net/crs-nts/1.0'>
  <crsnts:equal>false</crsnts:equal>
  <crsnts:reason>
    <![CDATA[ ...description text... ]]>
  </crsnts:reason>
</crsnts:comparisonResult>
```

A.8 XQuery

An XQuery GET or POST request sent to URL http://www.opengis.net/def/crs-query will result in a document obtained from evaluating the XQuery request according to the XQuery standard [8].

A.9 Exceptions

Table 3 — CRS resolver exception codes

`exceptionCode` value	HTTP code	Meaning of exception code	`locator` value
NO_SUCH_CRS	404	CRS not available on this server.	First offending range field name in the parameter list
CANNOT_ENUMERATE_CRS_SET	404	Query resolves to an infinite number of CRSs.	none
DUPLICATE_KEY	404	Query contains duplicate keys in the query part.	First duplicate
NO_SUCH_KEY	404	Query contains a non-matching key (i.e., a key which has no meaning for the resolver) in the query part.	First non-matching key
XQUERY_ERROR	404	XQuery request passed is not well-formed or cannot be evaluated against database contents	none