

# GeoSPARQL 1.1 Release Notes

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### *Preface*

This document provides the set of revision notes for OGC GeoSPARQL 1.1 [OGC 22-047] and does not modify that standard.

This document provides the details of edits, deficiency corrections, and enhancements of the above-referenced standard. It also documents those items that have been deprecated. Finally, this document provides implementations details related to issues of backwards compatibility.

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.

## Abstract

*GeoSPARQL defines a core set of Semantic Web classes, properties and datatypes for the representation of spatial information on the web and SPARQL extension functions for spatial data queries.*

# Introduction

## Scope

The OGC GeoSPARQL standard supports representing and querying geospatial data on the Semantic Web. GeoSPARQL defines a vocabulary for representing geospatial data in RDF, and it defines extensions to the SPARQL query language for processing geospatial data.

GeoSPARQL Version 1.1 contains no breaking changes to 1.0, but does contain additions and clarifications. Profile resources, new ontology elements, and new functions were added. The major changes are summarized in the tables below.

## Major changes between versions 1.0 and 1.1

The major changes are given in the tables below.

| New resource                             | Location  |
|--|---|
| Profile definition                       | <a href="http://www.opengis.net/def/geosparql">http://www.opengis.net/def/geosparql</a>                                       |
| GeoSPARQL Rules in RIF                   | <a href="http://www.opengis.net/def/geosparql-rifrules">http://www.opengis.net/def/geosparql-rifrules</a>                     |
| RDF validation file (SHACL Shapes)       | <a href="http://www.opengis.net/def/geosparql-shapes">http://www.opengis.net/def/geosparql-shapes</a>                         |
| SPARQL Service Descriptions              | <a href="http://www.opengis.net/def/geosparql/servicedescription">http://www.opengis.net/def/geosparql/servicedescription</a> |
| Requirements of GeoSPARQL modeled in RDF | <a href="http://www.opengis.net/def/geosparql/reqs">http://www.opengis.net/def/geosparql/reqs</a>                             |

The SHACL Shapes are also available as a test suite.

The following new ontology elements and new functions are normatively defined in the OGC GeoSPARQL 1.1 specification document.

| New element    | Section |
|----------------|---------|
| <b>Classes</b> |         |

| New element                                   | Section  |
|---|--|
| Spatial Object Collection class               | Class: <a href="#">geo:SpatialObjectCollection</a>     |
| Feature Collection class                      | Class: <a href="#">geo:FeatureCollection</a>           |
| Geometry Collection class                     | Class: <a href="#">geo:GeometryCollection</a>          |
| <b><i>Spatial Object Properties</i></b>       |  |
| hasSize                                       | Property: <a href="#">geo:hasSize</a>                  |
| hasMetricSize                                 | Property: <a href="#">geo:hasMetricSize</a>            |
| hasLength                                     | Property: <a href="#">geo:hasLength</a>                |
| hasMetricLength                               | Property: <a href="#">geo:hasMetricLength</a>          |
| hasPerimeterLength                            | Property: <a href="#">geo:hasPerimeterLength</a>       |
| hasMetricPerimeterLength                      | Property: <a href="#">geo:hasMetricPerimeterLength</a> |
| hasArea                                       | Property: <a href="#">geo:hasArea</a>                  |
| hasMetricArea                                 | Property: <a href="#">geo:hasMetricArea</a>            |
| hasVolume                                     | Property: <a href="#">geo:hasVolume</a>                |
| hasMetricVolume                               | Property: <a href="#">geo:hasMetricVolume</a>          |
| <b><i>Feature Properties</i></b>              |  |
| hasBoundingBox                                | Property: <a href="#">geo:hasBoundingBox</a>           |
| hasCentroid                                   | Property: <a href="#">geo:hasCentroid</a>              |
| <b><i>Geometry Serializations</i></b>         |  |
| geoJSONLiteral                                | RDFS Datatype: <a href="#">geo:geoJSONLiteral</a>      |
| asGeoJSON                                     | Property: <a href="#">geo:asGeoJSON</a>                |
| asGeoJSON function                            | Function: <a href="#">geof:asGeoJSON</a>               |
| kmlLiteral                                    | RDFS Datatype: <a href="#">geo:kmlLiteral</a>          |
| asKML   | Property: <a href="#">geo:asKML</a>                    |
| asKML function                                | Function: <a href="#">geof:asKML</a>                   |
| dggsLiteral                                   | RDFS Datatype: <a href="#">geo:dggsLiteral</a>         |
| asDGGS  | Property: <a href="#">geo:asDGGS</a>                   |
| asDGGS function                               | Function: <a href="#">geof:asDGGS</a>                  |
| <b><i>Non-topological Query Functions</i></b> |  |
| area  | Function: <a href="#">geof:area</a>                    |
| boundingCircle                                | Function: <a href="#">geof:boundingCircle</a>          |
| concaveHull                                   | Function: <a href="#">geof:concaveHull</a>             |
| coordinateDimension                           | Function: <a href="#">geof:coordinateDimension</a>     |
| dimension                                     | Function: <a href="#">geof:dimension</a>               |

| New element                               | Section  |
|---|--|
| geometryN                                 | Function: <a href="#">geof:geometryN</a>         |
| geometryType                              | Function: <a href="#">geof:geometryType</a>      |
| is3D                                      | Function: <a href="#">geof:is3D</a>              |
| isEmpty                                   | Function: <a href="#">geof:isEmpty</a>           |
| isMeasured                                | Function: <a href="#">geof:isMeasured</a>        |
| isSimple                                  | Function: <a href="#">geof:isSimple</a>          |
| length                                    | Function: <a href="#">geof:length</a>            |
| maxX                                      | Function: <a href="#">geof:maxX</a>              |
| maxY                                      | Function: <a href="#">geof:maxY</a>              |
| maxZ                                      | Function: <a href="#">geof:maxZ</a>              |
| metricArea                                | Function: <a href="#">geof:metricArea</a>        |
| metricDistance                            | Function: <a href="#">geof:metricDistance</a>    |
| minX                                      | Function: <a href="#">geof:minX</a>              |
| minY                                      | Function: <a href="#">geof:minY</a>              |
| minZ                                      | Function: <a href="#">geof:minZ</a>              |
| numGeometries                             | Function: <a href="#">geof:numGeometries</a>     |
| spatialDimension                          | Function: <a href="#">geof:spatialDimension</a>  |
| transform                                 | Function: <a href="#">geof:transform</a>         |
| <b><i>Spatial Aggregate Functions</i></b> |  |
| aggBoundingBox                            | Function: <a href="#">geof:aggBoundingBox</a>    |
| aggBoundingCircle                         | Function: <a href="#">geof:aggBoundingCircle</a> |
| aggCentroid                               | Function: <a href="#">geof:aggCentroid</a>       |
| aggConcaveHull                            | Function: <a href="#">geof:aggConcaveHull</a>    |
| aggConvexHull                             | Function: <a href="#">geof:aggConvexHull</a>     |
| aggUnion                                  | Function: <a href="#">geof:aggUnion</a>          |

GeoSPARQL 1.1 also adds several new helpful resources:

- Profile Definition: a formal listing of all the GeoSPARQL 1.1 resources, defined using [the W3C Profiles Vocabulary](#).
- GeoSPARQL Rules in Rule Interchange Format (RIF)
  - and a RIF rule generation script
  - GeoSPARQL 1.0 indicated a RIF template but not a RIF file
- RDF data validation file
  - defined using SHACL shapes

- GeoSPARQL / CQL mappings
  - informative description of interoperability between the Common Query Language & GeoSPARQL
  - of relevance to the the delivery of GeoSPARQL data via systems such as the OGC's Web Feature Service [WFS] and OGC API Features [OGCAPIF] which implement CQL
- Alignments (mappings) to fifteen other well known and/or spatial ontologies
  - that are either commonly used with GeoSPARQL or could be

## Document contributor contact points

All questions regarding this document should be directed to the contacts provided below or the referenced standard editor(s).

*Table 1. Contacts*

| Name                | Organization               |
|---------------------|----------------------------|
| Linda van den Brink | Geonovum                   |
| Nicholas J. Car     | SURROUND Australia Pty Ltd |

## References

The following normative documents are new or updated references in the standard to which these Release Notes apply.

- [OGCOM ISO19156](#), *ISO 19156: Geographic information — Observations and measurements*
- [IETF3987](#), Internet Engineering Task Force, *RFC 3987: Internationalized Resource Identifiers (IRIs)*
- [OWL2](#) *OWL 2 Web Ontology Language Document Overview (Second Edition)*
- [RDF](#), *RDF 1.1 Concepts and Abstract Syntax*
- [RDFS](#) *RDF Schema 1.1*
- [RIFCORE](#), *RIF Core Dialect (Second Edition)*
- [SPARQL](#), *SPARQL 1.1 Query Language*
- [SPARQLPROT](#), *SPARQL 1.1 Protocol*
- [SPARQLRESX](#), *SPARQL Query Results XML Format (Second Edition)*
- [SPARQLRESJ](#), *SPARQL 1.1 Query Results JSON Format*

## Terms and definitions

GeoSPARQL 1.0 contained only acronyms in its Terms & Definitions section, for example:

GeoJSON      Geographic JavaScript Object Notation

|     |   |
|-----|---|
| GFM | General Feature Model (as defined in ISO 19109) |
| XML | Extensible Markup Language                      |

GeoSPARQL 1.1 contains those acronyms, with additions such as *Spatial Reference System* (SRS), but it also contains a list of 11 defined terms such as:

## RDFS

RDF Schema provides a data-modelling vocabulary for RDF data. RDF Schema is an extension of the basic RDF vocabulary.

and

## coordinate reference system

A coordinate reference system (CRS) is a coordinate system that is related to an object by a datum.

These definitions have been included to clear up ambiguity regarding the origin and exact use of terms in GeoSPARQL.

# Change Log

## KEY

- Source:
  - Change Request
  - GitHub Issue
  - Other
- Identifier: Change Request number or issue number and pull request/commit in GitHub
- Type:
  - A=Administrative
  - S=Substantive
  - C=Critical

See [Description of Critical Changes](#) for more information on critical changes and [Description of Substantive Changes](#) for more information on substantive changes.

- Section: Section number in the updated document
- Description: Brief text describing the change
- Purpose: the reason for the change:
  - Clarity
  - Consistency

- Interoperability
- Perfunctory
- Readability
- Usability

## Change Table

Table 2. Change Log

| Source | Identifier              | Type | Section      | Description  | Purpose  |
|--------|-------------------------|------|--------------|--|--|
| 1      | <a href="#">PR #48</a>  | S    | 8.8.3        | GeoJSON literals in GeoSPARQL  | Add support for a format that is very common for representing geospatial data on the Web.                        |
| 2      | <a href="#">PR #88</a>  | S    | 8.8.5        | Discrete Global Grid System (DGGs) literals in GeoSPARQL   | Add support for using a list of DGGs identifiers to describe a geometry.   |
| 7      | <a href="#">PR #57</a>  | S    | 8.10         | SPARQL functions for performing spatial aggregations of data.  | To be able to work with sets of geometries.  |
| 33     | <a href="#">PR #72</a>  | S    | 6.3          | New properties <i>hasSize</i> , <i>hasLength</i> , <i>hasArea</i> , <i>hasVolume</i> and <i>hasSpatialResolution</i> | Extension of the ontology for indicating spatial resolution, areas, proportional relations (e.g. area overlaps). |
| 69     | <a href="#">PR #75</a>  | S    | 8.8.4        | KML literals in GeoSPARQL  | Add support for OGC KML for completeness.  |
| 5      | <a href="#">PR #117</a> | S    | 6.4.3, 6.4.4 | New properties <i>hasCentroid</i> , <i>hasBoundingBox</i>  | Useful for visualization, indexing and discovery.  |
|        | <a href="#">PR #140</a> | A    | Annex C      | Simple Features for SQL mappings   | Describe interoperability between functions and properties from Simple Features for SQL to GeoSPARQL             |
|        | <a href="#">PR #145</a> | A    | Annex B      | Query example for min and max functions  | Show how min and max work  |
|        | <a href="#">PR #146</a> | S    | 8.9          | Functions <i>isEmpty</i> , <i>isSimple</i> , <i>dimension</i> , <i>length</i> , <i>area</i> .                        | Extra functions for performing non-topological spatial operations  |
| 148    | <a href="#">PR #150</a> | S    | 6.2.3        | Class SpatialObjectCollection  | To support OGC API   |
| 148    | <a href="#">PR #150</a> | S    | 6.2.4        | Class FeatureCollection  | To support OGC API   |

| Source | Identifier              | Type | Section           | Description   | Purpose  |
|--------|-------------------------|------|-------------------|---|--|
| 148    | <a href="#">PR #150</a> | S    | 8.6.2             | Class GeometryCollection  | To support OGC API   |
|        | <a href="#">PR #151</a> | S    | 8.9.15,<br>8.9.30 | <code>geometryN</code> and <code>numGeometries</code> functions | To work with geometries in collections   |
| 142    | <a href="#">PR #155</a> | S    | 6.3,8.7           | Metric properties   | Convenience properties without the need to indicate units when working with metres.  |
| 164    | <a href="#">PR #193</a> | A    | 3, 4              | Terms & definitions and normative references                    | To have direct access to explanations of terms that are used in the specification but not defined in the ontology.   |
| 204    | <a href="#">PR #210</a> | S    | 6.3.5,<br>6.3.6   | Perimeter properties  | To distinguish between length and perimeter of a thing.  |
|        | <a href="#">PR #216</a> | A    | 6                 | Ontology overview figure  | Understanding the spec   |
| 191    | <a href="#">PR #221</a> | A    | Separate resource | JSON-LD context   | Implementation of GeoSPARQL ontology in JSON-LD  |
| 113    | <a href="#">PR #173</a> | A    | Separate resource | SHACL shapes  | Validation   |
| 212    | <a href="#">PR #225</a> | A    | B.1               | Functions summary table   | Better documentation of functions, inputs and outputs, and whether they apply specifically to 2d or 3d objects.  |
| 206    | <a href="#">PR #226</a> | A    | 8.9.1             | Description of function behaviours                              | Clarification of behaviour of functions.   |
| 74     | <a href="#">PR #234</a> | A    | Annex E           | Alignments to other ontologies                                  | Support common usage patterns for GeoSPARQL with external ontology elements, and provide guidance on how GeoSPARQL can be used with other, existing, spatial ontologies. |
| 43     | <a href="#">PR #240</a> | A    | Separate resource | German translation of ontology                                  | For greater worldwide adoption.  |
|        | <a href="#">PR #245</a> | A    | 8.4               | Explanation of role of CRS in geometric computations            | Clarification  |



| Source | Identifier              | Type | Section       | Description  | Purpose  |
|--------|-------------------------|------|---------------|--|--|
| 259    | <a href="#">PR #274</a> | A    | 8.3           | Recommendation to use QUDT for units of measure                            | Offers guidance on unit of measure vocabulary                        |
| 273    | <a href="#">PR #275</a> | A    | 8.9.13        | Clarification of <b>distance</b> function                                  | Explanation of the <b>unit</b> argument.                             |
| 247    | <a href="#">PR #284</a> | A    | 10.3.1        | Improvement of examples  | Documentation.   |
| 278    | <a href="#">PR #300</a> | A    | 8.2           | Paragraph about GeoSPARQL and Simple Features Access - Common Architecture | Explain how GeoSPARQL is based on SFA-CA.                            |
| 286    | <a href="#">PR #324</a> | S    | 8.9.5, 8.9.12 | Metric buffer and distance functions                                       | Functions without unit argument, to simplify implementation and use. |

## Description of Critical Changes

There are no critical changes in this release.

## Description of Substantive Changes

### Collection classes

GeoSPARQL 1.1 adds three classes for collection types:

- **SpatialObjectCollection**
- **FeatureCollection**
- **GeometryCollection**

These classes allow the organization of spatial objects, features and geometries in collections and are added to support the sorts of data models used by systems such as OGC APIs.

The collection class and the object class, such as **FeatureCollection** & **Feature** class, are related by the standard RDFS property **rdfs:member** whereby the collection class *has as a member* the object.

In RDF, an example of this for **FeatureCollection** / **Feature** may look like this:

#### NOTE

```
ex:col-1
  a geo:FeatureCollection ;
  rdfs:member ex:feature-a ;
  .
```

```
ex:feature-a
  a geo:Feature ;
  .
```

This is noted here to avoid confusion as to the direction of the object/collection relation.

## New size properties

GeoSPARQL 1.1. includes several new scalar Spatial Object properties related to size for indicating spatial resolution, areas, and proportional relations (e.g. area overlaps):

- `hasSize`
- `hasLength`
- `hasPerimeterLength`
- `hasArea`
- `hasVolume`
- `hasSpatialResolution`

Note that a property `hasLength` was already present in GeoSPARQL 1.0; `hasPerimeterLength` was added to distinguish between length (e.g. the length of a football field) and perimeter (i.e. the added lengths of all sides, in the case of a polygon) of a thing.

These properties do not have tightly defined range values so that they may be used with any RDF measurement/metrology system although GeoSPARQL makes a recommendation to use [QUDT](#) for measurements and units of measure. Annex C exemplifies these properties with QUDT.

## Metric properties

GeoSPARQL 1.1 also adds convenience properties for working with scalar values in metres as datatype properties, not value/unit properties as per QUDT standard use. For each `has...` property in the section above, there is a `hasMetric...` property with a datatype range specified to be in metres. For example `hasMetricArea` in `m^2` for `hasArea`.

## New Feature properties

GeoSPARQL 1.1. includes two new properties `hasCentroid` and `hasBoundingBox`. These can be used to link a Feature with a point geometry corresponding with the centroid of its geometry, or with a simplified geometry-representation corresponding to the envelope of its geometry, respectively. The centroid is typically used to show location on a low-resolution image, and both centroid and bounding box are useful for indexing and discovery functions.

# New geometry serializations

GeoSPARQL 1.1 includes support for representing geometry data in RDF in several additional formats:

- GeoJSON
- Keyhole Markup Language (KML)
- Discrete Global Grid System (DGGS)

As with the geometry serializations that were already supported in v1.0, for each new serialization an RDFS Datatype, a property and a function are defined:

- `geoJSONLiteral`
- `asGeoJSON`
- `asGeoJSON` function
- `kmlLiteral`
- `asKML`
- `asKML` function
- `dggsLiteral`
- `asDGGS`
- `asDGGS` function

## Extra functions for performing non-topological spatial operations

GeoSPARQL 1.1 adds several new functions for performing spatial operations:

- `isEmpty`
- `isSimple`
- `dimension`
- `length`
- `area`

## Functions for geometry collections

GeoSPARQL 1.1 adds two functions for working with geometries in collections:

- `numGeometries`
- `geometryN`

These functions can be used to get the number of geometries in a collection, and to get the nth geometry in a collection.

# Spatial aggregate functions

GeoSPARQL 1.1 defines a set of functions for performing spatial aggregations of data:

- `aggBoundingBox`
- `aggBoundingCircle`
- `aggCentroid`
- `aggConcaveHull`
- `aggConvexHull`
- `aggUnion`

These functions support working with sets of geometries, e.g. to calculate the minimum bounding box or centroid of a set of geometries.

## Metric buffer and distance functions

To accompany metric properties, GeoSPARQL 1.1 also adds several functions that assume metres. These functions can be used without unit argument, and were added to simplify implementation and use.

The functions are:

- `metricBuffer`
- `metricDistance`

## Future Work

As of the release of GeoSPARQL 1.1, the GeoSPARQL Standard Working Group proposes a next minor release of GeoSPARQL 1.2 in late 2022 or early 2023. The SWG is also considering a more major release, perhaps GeoSPARQL 2.0, after that. The intention is that backwards-compatible additions only will be added to GeoSPARQL 1.2, but potentially major, breaking, changes will be added to GeoSPARQL 2.0.

Determining scope for future GeoSPARQL releases is an open and public process undertaken by the SWG in the course of their regular meetings.

Release scope is shown by the SWG allocating Issues raised against the Standard in its online source code repository:

- <https://github.com/opengeospatial/ogc-geosparql/issues>

Milestones indicate Issue's potential release, for example the [Issue #301 "Handling of Z-coordinates by geometry functions is underspecified"](#) is allocated Milestone GeoSPARQL 1.2.

# Appendix A: Revision History

| Date       | Release | Editor           | Primary clauses modified | Description                         |
|------------|---------|------------------|--------------------------|-------------------------------------|
| 2022-07-15 | 0.1     | L. van den Brink | all                      | initial version                     |
| 2022-07-21 | 0.2     | N.J Car          | all                      | minor formatting updates            |
| 2022-07-21 | 0.3     | L. van den Brink | all                      | minor formatting updates            |
| 2022-07-27 | 0.4     | N.J Car          | all                      | minor formatting & template updates |
| 2024-01-12 | 0.5     | N.J Car          | metadata                 | final published version numbers     |